Effects of Different Levels of Feed Restriction on Nitrogen Intake and Excretion from Male Bean Goats in Tropical Areas

Yulius Subani, *Paulus Klau Tahuk, and Oktovianus R. Nahak T.B
Animal Husbandry Study Program, Faculty of Agriculture, Science and Health, University of Timor
*Corresponding Author: Paulus Klau Tahuk
E-mail: paulklau@yahoo.co.id

Abstract

The study aimed to determine the intake and nitrogen excretion of male Peanut goats fed different feed restrictions. The study was conducted for three months at the livestock experimental barn of the Faculty of Agriculture, Science and Health, University of Timor, in Kefamenanu, North Central Timor District, Indonesia. A total of 9 (nine) male Kacang goats with initial body weights ranging from 9 to 13 kg and ages between 12 to 14 months were divided into three groups, each representing a different treatment. The animals were given 3 (three) treatments, each treatment T0: goats without feed restriction; T1: goats were given 100% feed restriction according to basic living needs; and T2: goats were restricted to feed only 50% of basic living needs. The results showed that the average nitrogen consumption of each treatment was T1 at 3.50 g/head/day, T1 at 3.09 g/head/day, and T2 treatment at 3.24 g/head/day. Fecal nitrogen excretion of T0 treatment was 1.24 g/head/day; T1 treatment was 1.61 g/head/day, and T2 treatment was 1.77 g/head/day. While the urinary nitrogen excretion of each treatment was T0 treatment of 0.35 g/head/day, T1 treatment of 0.64 g/head/day, and T2 treatment of 1.09 g/head/day, it can be concluded that feed restriction can reduce nitrogen consumed compared to animals that receive normal feed. In contrast, nitrogen excreted through feces and urine increased in livestock that experienced feed restriction of 100% of the basic diet and 50% of the basic diet.

Keywords: Nitrogen Intake, Nitrogen excretion, Goat nuts, Feed Restriction

Introduction

Increasing the productivity of ruminant livestock, including Peanut goats, in tropical areas is largely determined by availability and sufficiency (Suwignyo et al., 2012). Livestock that receive sufficient quality feed will show higher productivity compared to livestock that lack feed.

Even though the role of feed is very important, a problem that often occurs in raising goats in tropical countries like Indonesia is that the availability of feed is not continuous throughout the year. In the rainy season, food availability is sufficient and even abundant, so livestock show positive growth (Tahuk and Dethan, 2010). On the other hand, in the dry season, there is a shortage of feed resulting from reduced forage production (Aryanto et al., 2013). Such conditions of lack of feed have an impact on reducing livestock growth and often even lead to death (Tahuk and Dethan, 2010; Tahuk et al., 2018).

Limited feed availability during rearing results in farmers providing less feed to livestock during the dry season compared to the rainy season. This condition is known as feed restriction, and the impact on the physiological condition of livestock is very large, such as a decrease in body weight ((Abouheif et al., 2013; Suryanarayana and Prasad, 2014; Tahuk et al., 2023); as well as other physiological impacts such as a decrease in body temperature below the normal

range, a decrease in heart rate and respiration even though it is still within the normal range (Aryanto, 2012).

Restricting feed impacts the low levels of nutrients obtained by livestock due to decreased dry matter consumption; conversely, increasing feed consumption during the alimentation phase will contribute positively to increasing the DM consumption obtained by livestock (Suryanarayana and Prasad, 2014; Tahuk et al., 2023). Sastrawan (2009) stated that local sheep and goats in Indonesia often lack protein. Therefore, protein requirements in feed must be carefully calculated.

According to various research reports, many factors influence feed consumption. These include body weight, gender, age, genetic factors, the food given, and the environment (Aboelmaaty et al., 2008). Nuraini et al. (2014) stated that the digestibility coefficient, quality or chemical composition of feed, fermentation in the rumen, food movement through the digestive tract, and the physiological status of livestock greatly influence protein (nitrogen) consumption.

In ruminant livestock, providing ration protein is very important to meet basic living and production needs. Ruminant livestock protein sources come from food proteins that escape degradation in the rumen and microbial proteins formed in the rumen. Rumen microbes do not completely degrade the feed protein consumed by ruminants; some of the feed protein passes into the small intestine along with microbial proteins and endogenous proteins (Kumiawati, 2004).

Nitrogen excretion is nitrogen excreted through feces or urine (Retnani et al., 2019). Nitrogen that comes out through urine includes keratin, ammonia, amino acids, and urea. Most of the urine nitrogen comes from urea which is formed in the liver, then filtered by the kidneys and excreted in the urine. Nitrogen loss through urine is the result of a metabolic process in body tissues called endogenous urinary nitrogen (Wu et al., 2005). Nitrogen levels in urine vary depending on the level of nitrogen consumption, protein level of the diet, protein digestibility coefficient, energy level of the diet, physical form and type of food ingredients, and absorption of nitrogen in the livestock's body (Mardewi, 2006). Fecal nitrogen comes from undigested food proteins, endogenous nitrogen, which consists of digestive enzymes and other fluids that are excreted into the digestive tract, eroded mucosal cells containing protein, and digestive tract microbes which will come out with fecal fractions (Tobing and Esther, 2009). Factors that influence nitrogen excretion through feces are body weight, dry matter consumption, crude fiber content, energy, and dietary protein (Yan et al., 2007).

Although feed restriction contributes to reducing goats' nitrogen intake, scientific information regarding the high and low levels of nitrogen intake in Kacang goats is still lacking. Therefore, it is important to carry out this research to obtain the information in question.

Materials and Methods

Time and Place of Research

The research was carried out for three months in the experimental cage of the Faculty of Agriculture, University of Timor. Analysis of feed N, feces N, and urine N was carried out at the Feed Chemistry Laboratory, Faculty of Animal Husbandry, Fisheries and Marine Sciences, Nusa Cendana University, Kupang.

Feed materials, cages, and equipment

The feed used in this research was a complete ration composed of natural grass, corn meal, fish meal, pollard bran, and rice bran. Tables 1 and 2 show the chemical composition of the feed and the proportion of forage and concentrate in the ration.

Table 1. Nutrient Content of Complete Feed Ingredients

Nutritional Content	Feed ingredients				
	Natural grass*	Fish flour*	Ground corn*	Pollard bran*	Rice bran*
BK (%)	90,668	91,034	88,423	87,611	90,010
BO (%)	82,318	70,148	87,126	82,854	75,964
PK (%)	2,773	55,674	9,161	18,957	8,220
SK (%)	35,659	4,894	2,478	8,780	18,279
FI (%)	1,387	8,922	3,080	4,560	8,752
CHO (%)	78,159	5,552	74,885	59,337	58,992
BETN (%)	45,500	0.658	72,407	50,557	40,713
TDN (%)	62,611**	-	91,880**	84,284**	89,594**
GE:-(MJ/kg.BK)	14,667	17,498	16,226	16,416	15,154
-(Kcal/kg.BK)	3492, 05	4166.17	3863.36	3908.49	3615.19
EM (Kcal/kg.BK	2053.42	2958.92	3691.04	3784.31	2815.46

Note:*Results of Feed Chemistry Laboratory Analysis, Faculty of Animal Husbandry, Undana (2021); **According to the equation of Hartadi et al. (1980); BETN: extract material without nitrogen, TDN: Total digestible nutrients.

Table 2. Use of forages and concentrates (%) in the study (BK basis)

Type of feed	**Proportion of use**	**Forage to concentrate ratio**
Natural grass	30.00	
Fish flour	11.00	
Yellow corn	40.00	30: 70
Pollard bran	15.00	
Rice bran	4.00	
Total	**100**	

The cages used in this research were individual, elongated cages. The cages consisted of 9 plots, with the size of each plot being 140x69 cm, the height of the cage being 200 cm, and each cage plot being equipped with a feeder and drinking water.

The supporting equipment used in this research is a feed container, drinker, scales, measuring tape, grass-cutting machine, grinding machine or feed-chopping machine, bucket, stationery dipper, measuring cup, and pipette. A proximate analysis tool is used to analyze the nutritional value of feed ingredients and rations. Other ingredients are used, such as formalin (H2CO), sulfuric acid solution (H2SO4), Aquades, indicator mix, NaOH, and 0.2 N HCL.

Research methods

The method used in this research is the experimental method according to a completely randomized design (RAL). Nine peanut goats were used and divided into three treatments, with each treatment consisting of three livestock. In the restriction phase, the three groups received the respective treatment T0: peanut goats received unlimited feed (control); treatment T1: livestock were limited to 100% feeding according to basic living requirements, and T2 treatment of livestock was limited to feeding only 50% of basic living requirements.

Research procedure

Complete Feed Production. The basic ingredients used in making complete feed are natural grass and concentrate, which consists of corn, rice bran, fish meal, and pollard bran. Natural grass is collected fresh and then dried in the sun until dry and ground. The next stage is natural grass and concentrate packed in sacks and ready to be given to livestock.

Livestock Adaptations. Weighed peanut goats are initially placed in individual cages to be adapted to the ration and research pen for two weeks or until the peanut goats consume

the ration in a constant amount. The purpose of adaptation or adjustment is so that livestock can adapt to the feed provided.

Providing Feed and Drinking Water. After all the feed ingredients have been processed, complete feed is applied to all treated livestock twice a day at a rate of 3% of the livestock's body weight. Drinking water is provided ad libitum (unlimited drinking water); that is, it is continuously provided in buckets and plastic jerry cans placed next to the eating area.

CollectionFeces and Urine. Feces and urine are collected by collecting them using a rectangular filter made from mounted bamboo frame filters made of parent and clear plastic, which aim to separate feces and urine so they don't mix; each animal is given one container. Clear plastic functions to drain urine excreted by livestock into a container made of jerry cans that have been treated with a sulfuric acid solution(H2SO4). The holding process lasts for 24 hours, and then the fresh weight of the feces is taken, and the fresh weight of the feces and the volume of urine are measured using a measuring cup. Fresh feces that have been weighed are then sampled at 50 grams/head and then preserved using formalin (H2CO), which is sprayed and then dried using an oven at a temperature of 105°C; after drying, the dry weight is weighed and then analyzed. Meanwhile, the urine that has been measured is then stored in a plastic bottle and then analyzed. The process of collecting feces and urine is carried out consecutively for ten days.

Research variable

The variables measured in this study were nitrogen consumption, urine nitrogen, and feces nitrogen. Nitrogen consumption is determined by the equation for feed DM consumption multiplied by the feed PK content divided by a constant factor of 6.25 (Anggorodi, 1985).

$$\text{N consumption} = \frac{ration\ consumption\ (g\ DM/head/h)\ x\ PK\ ration\ (\%)}{6.25}$$

Information
BK: Dry ingredients
PK: Crude protein

Nitrogen excreted in feces is calculated by the equation of the amount of DM feces excreted (g/day) multiplied by the PK content of feces (%) divided by a constant factor of 6.25. The equation is as follows:

$$\text{N feces (g/head/day)} = \frac{Fecal\ Crude\ Protein\ x\ Feces\ Production\ g\ DM/head/day}{6.25}$$

Urine nitrogen is determined by the amount of urine produced multiplied by the urine N content (%). The equation is as follows:

N urine = Urine Production x % N Urine.

Data analysis

The data obtained during the research were tabulated and analyzed according to the ANOVA (Analysis of Variance) procedure. Next, to see the differences in each treatment, Duncan's multiple test was used (Hedita, 2011). To facilitate the data, SPSS Version 25 software was used.

Results and Discussion

Nitrogen Consumption

Nitrogen consumption is nitrogen obtained from feed ingredients. Nitrogen consumption from bean goats for each treatment can be seen in Table 3.

Table 3: Average nitrogen consumption, fecal nitrogen, and urine nitrogen from male peanut goats experiencing different levels of feed restriction (g/head/day).

Variable	Treatment

	T0		T1		T2	
	g/e/d	%	g/e/d	%	g/e/d	%
Nitrogen Consumption (g/head/day)	3.50	9.0284	3.09	6.7965	3.24	8.4982
Fecal nitrogen (g/head/day)	1.24	4.4868	1.61	2.6593	1.77	2.3403
Urine nitrogen (g/head/day)	0.35	1.4445	0.64	1.3385	1.09	1.3597

Description: T0: Livestock without feed restrictions; T1: Livestock are limited to feeding 100% according to basic life; T2: Livestock is limited to 50% of basic living needs; ns Different treatments were not significant (P>0.05).

The statistical test results showed that the different treatments were not significant (P>0.05) on nitrogen consumption in Kacang goats. The research result (Table 3) shows that in the feed restriction phase, livestock in treatments T1 and T2 had relatively similar nitrogen consumption as livestock in treatment T0.

Even though the results of the statistical analysis of nitrogen consumption were relatively the same, quantitatively there was a tendency for nitrogen consumption in treatment T0 to be higher compared to T1 and T2. The average nitrogen consumption per treatment, namely in treatment (T0) was 3.50 g/head/day (9.0284%) of the DM consumed by livestock), (T1) was 3.09 g/head/day (6, 7965%) and in treatment (T2) 3.24 g/head/day (8.4982%) Aboelmaatyet al. (2008) stated that nitrogen consumption is influenced by the amount of dietary protein consumed. According to Atyanto et al. (2013), the level of protein (nitrogen) consumption is greatly influenced by the fermentation process in the rumen and the movement of food through the digestive tract.

N intake is closely related to feed consumption and protein levels as a source of nutrition in metabolic processes. In the T0 treatment, more feed consumption resulted in higher nitrogen consumption, with a percentage of 9.02% compared to T1 and T2 livestock. In T1 livestock, feed consumption is lower, so nitrogen consumption is low, with a percentage of 6.79% lower than T0 and T2; in the T2 treatment, feed consumption is less than T1, but the percentage of nitrogen consumption is higher, namely 8.49% than T1. This pattern of feed availability results in farmers providing less feed than usual, which is called feed restriction. The feed restriction program also increases the body's mineral content and reduces blood triglycerides, cholesterol, and fat levels in the body and meat (Santoso, 2008).

In the feed restriction phase, N consumption of T1 and T2-treated livestock was lower than T0. Feed restriction treatment (feed restriction) for a certain period (around 5-10 weeks) followed by full feeding (refeeding) is reported to cause compensatory growth in goats and sheep (Dashtizadeh et al., 2008; Aboulheif et al., 2013; Suryanarayana and Prasad, 2014). However, several previous research results state that food restriction can result in metabolic and reproductive changes. Research on cattle and deer shows that limiting or reducing feed intake causes a decrease in blood glucose and protein concentrations (Buckelet al., 2009); Saekkinenet al., 2005; Klinhomet al., 2006). In male Ettawa crossbreed goats, it was also found that limiting feed intake to 80% of basic living requirements resulted in a decrease in blood glucose concentrations (Widiyonoet al., 2013). In addition, goats that were fed 1.1 kg of basic living necessities showed weaker reproductive performance compared to goats that received a higher feed of 1.6 kg of basic living necessities (Zarazaga et al., 2009).

Fecal Nitrogen

Nitrogen that comes out through feces comes from digested feed protein, endogenous N, which consists of digestive enzymes and other fluids that are excreted into the digestive tract, and eroded mucosal cells containing protein and microbes in the digestive tract (Trigan, 2009). The average value of fecal nitrogen for goats in treatment (T0) was 1.24 g/head/day (percentage 4.4868%), treatment (T1) was 1.61 g/head/day (percentage 2.6593 %), and in treatment (T2) it

was 1.77 g/head/day (2.3403%). The statistical test results showed that the different treatments were not significant (P>0.05) on fecal nitrogen in peanut goats (Table 3).

Even though statistically they are relatively the same, the results of this research are quantitative and illustrate that livestock that experience food shortages/restrictions (T1 and T2) tend to have higher excretion of nitrogen through feces than livestock that do not experience feed shortages/restrictions (T0). The high fecal N excretion of livestock treated with T1 and T2 illustrates that low protein and energy intake will reduce rumen microbial activity in digesting feed. As a result, it increases nutrients lost through feces, including nitrogen. Yan et al. (2007) stated that various factors, including livestock body weight, consumption of dry matter, crude fiber, and protein content in the ration, influence nitrogen excretion through feces. Meanwhile, Wu et al. (2005) and Widya et al. (2008) stated that limiting feed to an excessive percentage can cause microbes in the rumen not to develop optimally. As a result, the role of microbes in feed digestion cannot run optimally. According to Aryanto (2012), peanut goats and PE goats that were treated with feed restriction had lower organic matter digestibility than goats that were given ad libitum feed treatment.

According to Paramita et al. (2008), factors that influence fecal N are digested N from the efficiency of N use in the rumen. If less N is excreted through feces, then the digested N will increase, and the use of N will be more efficient. Several factors that influence nitrogen excretion through feces are animal body weight, dry matter consumption, crude fiber content, energy and protein rations as well as the digestive process as well as the type of food consumed, and the type of digestive tract (Hidanah et al., 2013).

Urine Nitrogen

The average urine nitrogen value (Table 3) for each treatment was treatment (T0) of 0.35 g/head/day (1.4445%), treatment (T1) of 0.64 g/head/day (1, 3385%), and treatment (T2) was 1.09 g/head/day (1.3597%). The results of statistical tests showed that the different treatments were not significant (P>0.05) on urinary nitrogen excretion in peanut goats. Even though statistically it is relatively the same, quantitatively it can be seen that livestock that experience increasingly severe levels of food shortages (getting only 50% of their basic living needs) and receiving feed according to their basic living needs (100% of their basic living requirements) (T1 and T2) have excretion Urinary N is higher than cattle that receive normal feed (T0).

The high urinary N excretion in goats that received T1 and T2 treatment was caused by feed restriction causing increased catabolism (breakdown) of body protein to be used as a source of energy and amino acids. As a result, residual nitrogen is produced, which must be excreted by the kidneys in the form of urea through urine. Energy is an important nutrient for livestock to maintain survival. Lack of energy has an impact on the dismantling of body tissue to meet energy needs, both protein and body fat. Thus, urinary nitrogen is the result of ration protein that is not metabolized (Putra, 2006). According to Pradeepta et al. (2015), urine N comes from ammonia, which is produced from the degradation of ration protein by excess rumen microbes and absorbed by the rumen wall to the liver via the bloodstream and converted into urea, which is excreted in the urine.

According to various research reports, optimizing microbial protein synthesis will increase the efficiency of N utilization and reduce N excreted in urine (Namroud et al., 2008). Therefore, the high urinary N excretion from T1 and T2 treatment livestock whose feed consumption was limited reflects the low microbial protein synthesis of the livestock. As a result, the efficiency of N utilization is lower, as indicated by the high level of nitrogen excreted through urine. Nitrogen excreted through urine includes keratin, amino acids, and urea. Most of the urea excreted in the urine comes from urea formed in the liver, which is then filtered by the kidneys and excreted in the urine (Namroud et al., 2008).

Conclusion

Based on the research results, limiting feed can reduce the nitrogen consumed by livestock. On the other hand, nitrogen excreted through feces and urine increased in livestock that experienced feed restrictions of 100% according to basic life and 50% of basic life. The average nitrogen consumption for each treatment was T1 of 3.50 g/head/day; T1 was 3.09 g/head/day, and T2 treatment was 3.24 g/head/day. Fecal nitrogen excretion in the T0 treatment was 1.24 g/head/day; the T1 treatment was 1.61 g/head/day, and the T2 treatment was 1.77 g/head/day. Meanwhile, urinary nitrogen excretion for each treatment was treatment T0 of 0.35 g/head/day; T1 treatment was 0.64 g/head/day, and T2 treatment was 1.09 g/head/day.

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