
Improved metabolic profiles, body condition score and body weight as positive modulators of conception rate of nondescript pre-partum does fed concentrates

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Abstract Does fed with roughage and concentrate had higher average body weight ($p < 0.01$) and body condition score ($p < 0.05$) from the second month until the end of the feeding period. Mean serum cholesterol concentrations were higher ($p < 0.05$) in does fed roughage and concentrate compared to those fed roughage alone except during the first blood collection, while no significant differences ($p > 0.05$) were found in mean serum triglyceride and glucose levels. Does fed with roughage and concentrate showed 100% estrus, 80% conception rate, shorter estrus cycle length (29.4 days vs. 32.6 days), and higher conception rate (80% compared to 37.5%) than does fed with roughage only.

Keywords: Nondescript goats, Blood metabolites, BCS and Conception rate

Introduction

Backyard raisers dominate the goat industry in the Philippines. About 99.2 percent of the goat population in the country is raised by backyard raisers (Philippine Statistics Authority, 2023). Goats are preferred by backyard raisers because they are known to have short gestation length, short kidding intervals, and require minimum inputs (Bondoc *et al.*, 2002). Most goats raised by backyard raisers are considered nondescript, a product of indiscriminate breeding.

The goat population is smaller compared to other livestock. It is affected by the higher slaughter rate and low productivity due to limited knowledge of raisers on improved management practices, seasonality of breeding, low

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conception rate, high pre-weaning mortality rate (26%) and poor nutrition (Alo, 2017).

Nutrition plays a key role in the reproductive performance of animals. In the Philippines, female goats are commonly raised in free-range system wherein the availability of roughage depends on the season - abundant during the wet season and limited during the dry season. Generally, these animals are not supplied with concentrate to augment the nutritional requirements of the animals. Furthermore, these animals, even with inadequate nutrition, are expected to be bred. These practices cause a higher chance of reproductive failure. The interaction of nutrition and reproduction is a vital process that needs to be considered to have a better conception rate.

Success of reproduction depends mainly on nutrition that modulates hormonal secretion necessary for onset of puberty, estrous cycle, expression of heat, ovulation, and maintenance of pregnancy. Cholesterol is the precursor of the steroid hormone estradiol needed for heat expression and ovulation. This can be an indicator of nutritional status of the animals that can be used to predict the readiness for breeding. Other blood plasma metabolites like insulin, glucose, leptin and non-esterified fatty acids can be candidate predictors of reproduction (Francisco *et al.*, 2002).

Supplementation with good quality concentrates and/or roughage is essential for the animals to reach their full production potential (Marques *et al.*, 2016). Concentrates are higher in energy compared to roughage, thus supplementation of concentrates can help increase energy balance of goats, and thus increased reproductive performance such as return to estrus and conception rate. The addition of concentrate in the diet of the animals compared to the common practice of roughage alone, intends to increase energy intake of animals, and thus increasing energy balance that could influence the levels of blood plasma metabolites that directly influence reproductive competence.

Specifically, the study aimed to determine the difference between nondescript goats fed with roughage (Diet 1) and fed roughage and concentrate (Diet 2) in terms of body weights and body condition scores, blood metabolites (cholesterol, glucose and triglycerides) and estrous cycle and conception rate.

Materials and methods

Experimental animals

This study ensured that all animal handling procedures complied with the guidelines established by the Animal Welfare Act (Republic Act No. 8485) of the Philippines. A total of 20 nondescript pre-partum does and two junior bucks

were used in the study. They were sourced from several municipalities of Cavite. They were kept in a semi-monitor type of housing with slatted flooring, individually penned and provided with feeders and drinkers.

Feeding

The animals were randomly divided into two diets. Ten goats were fed *ad libitum* with an assortment of roughages (Diet 1) napier (*Pennisetum purpureum*), madre de agua (*Trichanthera gigantea*), madre de cacao (*Gliricidia sepium*), mulberry (*Morus alba*), peanut grass (*Arachis pintoii*), ipil ipil (*Leucaena leucocephala*), makahiya (*Mimosa pudica*), Amaranthus (*Amaranthus spp.*), mungbean (*Vigna radiata*), corn stalk (*Zea mays*), gumamela leaves (*Hibiscus rosa-sinensis*) while the other ten does were fed with *ad libitum* roughage and concentrate (Diet 2) at an average of 250g/day, based on dry matter (DM) requirement at 6% of body weight. The concentrate (finisher pellets have 13.5% CP) was fed twice a day at 8-9 am and 4-5 pm daily to those animals assigned to roughage with concentrate. Roughage was provided through the cut-and-carry system on a daily basis while the concentrate feeds were provided inside the pen. All animals were allowed to graze 6-8 hours a day providing access to mineral blocks and water with salt.

Body condition score

Monthly body condition scores of does were evaluated by two trained personnel using a body scoring scale ranging from 1.0 to 5.0, with increments of 0.5 (Ghosh *et al.*, 2019). A goat with a BCS of 1.0 is very thin, lacking fat reserves, whereas a BCS of 5.0 indicates an over-conditioned animal (Smit, 2014). Most goats are recommended to be maintained around 3.0–3.5 during the breeding period (Ghosh *et al.*, 2019).

Estrus observation

Estrus was observed at 8 to 10 a.m. and 5 to 7 p.m. daily. The different signs of behavioral estrus were observed such as constant vocalization (calling and bleating), tail flagging, aggression, mountings and unusual feeding patterns.

Day to first estrus and estrous cycle length

The first manifestation of estrus was observed and considered as day to first estrus. Estrous cycle length was determined as the days between two

successive estruses. Estrus detection was done two months after the feeding of the diets.

Breeding

Does that were detected in heat were bred. Animals first noticed to be in heat in the morning were bred in the afternoon, and animals first noticed to be in heat in the afternoon were bred the following morning.

Pregnancy detection

Animals that did not return to estrus after one estrous cycle were considered to be pregnant. Frequent physical checks were done 18-24 days after estrus to observe signs of return to estrus. Other indicators like lack of interest to buck, belly getting tight and swelling of the udder were also considered.

Conception rate

The conception rate was calculated by dividing the number of goats confirmed pregnant by the total number of goats bred multiplied by 100 for each treatment group.

Blood collection and analysis

After two months of feeding, bi-monthly blood samples (3ml) were collected from all the animals via jugular venipuncture in the morning at 7 am for three months. The samples were collected in 0.5 mL microtainer tubes (containing gel and clot activator) using sterile needle syringe. The samples were analyzed using a Clindia Fully Automated Biochemistry Analyzer® to determine serum cholesterol, glucose, and triglycerides through enzymatic methods. Two samples per animal per collection were run to obtain two readings.

Statistical analysis

The data were analyzed using a t-test (SAS, 2006) for the differences of the two diet means.

Results

Body weight and body condition score

The average body weight of does fed roughage and concentrate was significantly higher ($p<0.01$) from the second month of feeding until the end of the feeding period compared to those fed roughage alone (Figure 1 and Table 1). Similarly, the average monthly BCS of does fed with roughage and concentrate was higher ($p<0.05$) compared to the group fed with roughage alone from the second to the eighth month of feeding. The final BCS of does fed with roughage and concentrate was 2.47 versus 1.90 for does fed roughage alone (Figure 2 and Table 1).

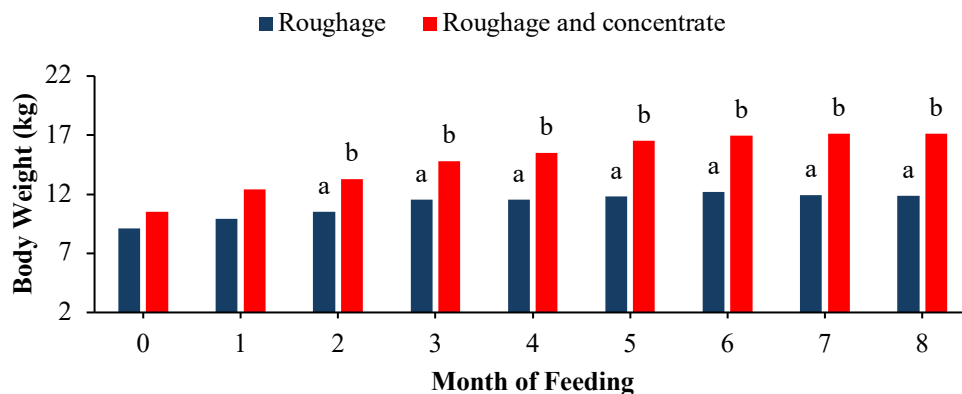


Figure 1. Monthly average body weight of nondescript pre-partum does fed with roughage (n=10) and roughage and concentrate (n=10). *Means with different superscripts differ at ($p<0.01$)

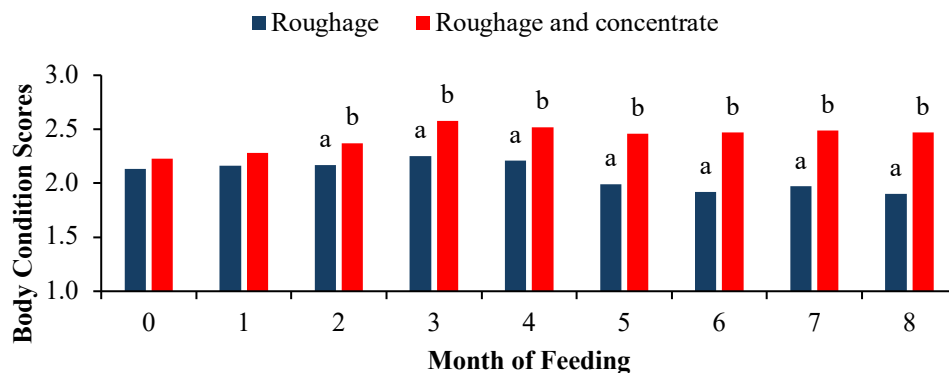


Figure 2. Monthly average body condition score of nondescript pre-partum does fed with roughage and roughage and concentrate. *Means with different superscripts differ at ($p<0.05$)

Table 1. Monthly average body weight and body condition score (BCS) of nondescript pre-partum does fed with roughage (n=10) and roughage with concentrate (n=10)

Month of Feeding	BODY WEIGHT*		BCS**	
	Roughage (n=10)	Roughage and concentrate (n=10)	Roughage (n=10)	Roughage and concentrate (n=10)
0	9.10	10.53	2.13	2.23
1	9.92	12.41	2.16	2.28
2	10.51 ^a	13.28 ^b	2.17 ^a	2.37 ^b
3	11.55 ^a	14.82 ^b	2.25 ^a	2.58 ^b
4	11.57 ^a	15.51 ^b	2.21 ^a	2.52 ^b
5	11.82 ^a	16.55 ^b	1.99 ^a	2.46 ^b
6	12.19 ^a	16.97 ^b	1.92 ^a	2.47 ^b
7	11.95 ^a	17.14 ^b	1.97 ^a	2.49 ^b
8	11.87 ^a	17.15 ^b	1.90 ^a	2.47 ^b

*p<0.01 **p<0.05

Blood metabolites

Serum cholesterol

The average blood serum cholesterol concentration of does was significantly different ($p<0.05$) between the two groups (Figure 3 and Table 2). Does fed with roughage and concentrate have consistently shown higher ($p<0.05$) serum cholesterol levels than does fed with roughage alone (n=10) except on the first blood collection.

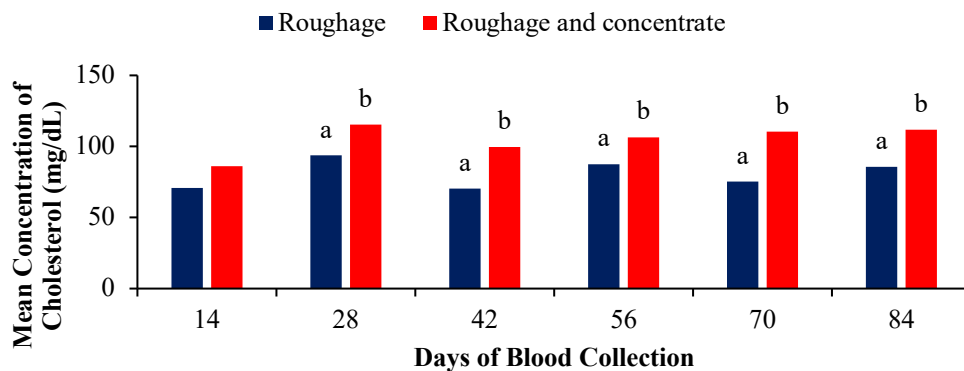


Figure 3. Mean cholesterol concentration (mg/dL) in does fed with roughage (n=10) and roughage and concentrate (n=10) after two months in their assigned diets. Means with different superscripts vary ($P<0.05$)

Table 2. Average bi-monthly blood serum metabolite concentration (mg/dL) of pre-partum does fed with roughage (n=10) and roughage with concentrate (n=10)

Month of Feeding	3		4		5	
Blood Collection (days)*	14	28	42	56	70	84
DIETS	Cholesterol (mg/dL)					
Roughage	70.80 ±8.25	93.55 ^a ±5.44	70.35 ^a ±2.94	87.3 ^a ±4.65	75.1 ^a ±5.45	85.75 ^a ±5.45
Roughage and concentrate	86.05 ± 4.47	115.3 ^b ±6.44	99.45 ^b ±6.87	106.25 ^b ±6.33	110.25 ^b ±8.13	111.6 ^b ±9.79
	Triglycerides (mg/dL)					
Roughage	24.55 ±1.71	37.45 ±1.53	29.15 ±2.61	28.80 ±2.38	20.85 ±1.99	19.2 ±1.87
Roughage and concentrate	30.3 ±2.40	41.65 ±1.20	30.20 ±3.68	28.95 ±3.49	26.25 ±3.77	21.4 ±2.78
	Glucose (mg/dL)					
Roughage	59.45 ±4.03	41.45 ^a ±2.73	28.75 ±1.87	42.30 ±3.72	23.50 ^a ±1.68	37.90 ±6.35
Roughage and concentrate	66.05 ±3.46	49.25 ^b ±1.84	26.25 ±1.79	49.45 ±2.84	30.40 ^b ±2.27	45.25 ±4.79

Means with different superscripts vary ($p < 0.05$), * Blood samples were collected after two months of the feeding trial

Serum triglyceride concentration

There was no difference ($p > 0.05$) in serum triglyceride concentration of does fed with roughage alone and those fed roughage and concentrate as shown in Table 2. Although not significant, does fed with concentrate tend to have higher serum triglyceride concentrations than those fed with roughage alone.

Serum glucose concentration

The average serum glucose concentration of does (n=10) fed with roughage alone and does (n=10) fed with roughage and concentrate was significantly different ($p < 0.05$) only at days 28 and 70 of blood collection. Although not significant, in general does fed with roughage and concentrate tended to have higher plasma blood glucose concentration except on Day 42.

Estrus, estrous cycle and conception rate

Results showed the reproductive performance differences of the does fed with roughage alone and those fed with roughage and concentrate (Table 3). The number of does that expressed estrus was higher (100%) in the group fed with

roughage and concentrate compared with (90%) does fed with roughage alone. Similarly, 100% was bred in the group fed with roughage and concentrate while only 80% in group fed with roughage. Average estrus cycle was shorter in does fed with roughage and concentrate (29.4 days) versus the other diet (32.6 days).

Conception rate

Does fed with roughage and concentrate showed higher conception rate at 80.0% compared to does fed with roughage only at 37.5 % (Table 3).

Table 3. Reproductive performance of does fed with roughage (n=10) and roughage and concentrate (n=10)

Reproductive Parameters	Dietary Treatment	
	Roughage	Roughage and Concentrate
Does that expressed estrus (%)	90.0	100.0
Does bred (%)	80.0	100.0
Does that conceived (%)	30.0	80.0
Does that failed to conceive (%)	50.0	20.0
Average estrus cycle length (days)	32.6	29.4
Conception Rate (%)	37.5	80.0
Mortality Rate (%)	20.0	0.0

Mortality rate

There was no mortality in the does fed with roughage and concentrate group compared to the does under roughage diet incurred 20% mortality.

Discussion

The results proved that increasing the energy content by incorporating concentrates in the diet of the goats improved body weight as well as body condition score. Adequate nutrition could produce higher body weight that could reflect higher body condition scores. Body weight and BCS significantly influence the fertility of goats during the breeding season (Gallego-Calvo *et al.*, 2014). It is necessary to provide goats with higher energy feeds (Hafez *et al.*, 2011).

Higher energy and fat content in the feed can be utilized by the animal to increase their fat reserves. This fat reserve is necessary for upcoming reproductive activity since cholesterol is the precursor of steroid hormones like estradiol and progesterone (Francisco *et al.*, 2003 and Payne and Hales, 2004). Similar results were obtained by Abou-Elkhair *et al.* (2020), that concentrate supplemented goats have significantly higher serum cholesterol concentration than goats fed with roughages. Similarly, goats grazing on native pasture were

found to have lower blood serum concentrations of total cholesterol (Khaled *et al.*, 1999, and Žubčić, 2001).

Circulating blood triglycerides contribute significantly to milk fat synthesis and may have effect on lactation after birth of the young (Bickerstaffe and Annison, 1971). Higher fat content of the milk could mean higher growth rate for the young after birth. The practice of feeding concentrates to does pre-partum may have impact after birth especially to the young.

Similar finding showed that goats supplemented with concentrate tend to have higher glucose concentrations compared to the goats fed with plain nutrition (Mellado *et al.*, 2020).

In most goat breeds, the average estrous cycle length is 21 days and ranges from 18 to 24 days. The goats in the study were nondescript does, belonging to no particular breed, which may have contributed to the variability of the estrous cycle length. Furthermore, some goats exhibited silent heats.

The occurrence of both short and long estrous cycles in goats is a normal physiological phenomenon (Corteel, 1975; Prasad and Bhattacharyya, 1979 and Armstrong and Evans, 1983). Similar result was suggested by Fatet *et al.* (2011) that the length of the successive cycles is dependent on the length of the breeding season and the breed of the goats. The genetic variance of the estrous cycle and some other basis may explain the reason for abnormal cycles of Angora goats (Shelton, 1978).

The positive effect of concentrate supplementation that increased the energy level and may have influenced ovulation in this study similar to the work of Acero *et al.* (2006) where supplementation improved ovulation and implantation of the fetus in the uterus.

The reproductive performance, including pregnancy, of goats can be influenced by various factors. The primary factors are related to environmental conditions such as nutrition, weather, age, season, the buck, and breeding type (Uzabaci *et al.*, 2014).

The interplay of nutrition and reproduction has been very evident in the results of this study. The feeding of concentrates at ≈ 250 g/day have not only improved body weight and body condition scores but further increased serum concentration of metabolites (cholesterol, glucose and triglycerides) which positively modulated conception rate.

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Conflicts of interest

The authors declare no conflict of interest.

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