INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 25, No. 6, p. 323-329, 2024

RESEARCH PAPER OPEN ACCESS

Response of grower goats (*Capra hircus*) to varying levels of vitamin ADE and calcium supplementation

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Key words: Goat, Forage, Growth performance, Supplementation

http://dx.doi.org/10.12692/ijb/25.6.323-329 Article published on December 08, 2024

Abstract

To evaluate the response of grower goats to vitamin ADE and calcium supplementation, a total of 12 grower goats are divided into 4 groups and assigned to one of the 4 dietary supplements with 0, 0.5ml, 1.0ml, and 1.5ml of both ADE and Calcium Supplementation following the Completely Randomized Design (CRD). The study was conducted at the Cagayan Valley Small Ruminants Research Center located at Isabela State University, Echague, Isabela from December 21, 2023 to February 06, 2024 for 45 days in a full confinement system. Result of the study revealed that there was no significant difference obtained from the average weekly gain in weight of the goat and the weekly and cumulative feed consumption also showed no significant differences among the treatments. However, Vitamin ADE and Calcium supplementation are still required though, the results were not significant, and as the proximate analysis of forages used are not enough to sustain growth and development of grower goats. In addition, administration of Vitamin ADE and Calcium were still being beneficial like in Treatment 3 which obtained the highest net income and return of investment among all the treatment groups.

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Introduction

Goat (*Capra hircus*) production has played a vital role in rural areas, as these animals can easily adapt to different environmental conditions. Goats require simple management and low-cost production inputs and can transform feed into high-quality foods such as meat and milk (Castel *et al.*, 2010; Alcedo *et al.*, 2015; Domínguez *et al.*, 2018; Tajonar *et al.*, 2022). In 2020, data from the Food and Agriculture Organization (FAO) showed that the average production share of goat meat is mostly produced in Asia at 73.2%, followed by Africa at 22.4%, the Americas at 2.2%, Europe at 1.7%, and Oceania at 0.5%.

The foliage of grasses, legumes and trees, and bushes is what goats naturally eat. Although these forages include certain vitamins and minerals, not enough to meet the animals' needs. Goat nutrition and health are significantly influenced by vitamins and minerals. Vitamins A, D, and E are components of a diet suitable for goats. Thus, they usually do not need to be supplemented because rumen bacteria manufacture both vitamin K and B vitamins. Goats on specific medications or with specific health issues, however, might need to take supplements, particularly B vitamins.

Essential minerals are categorized as macrominerals (also referred to as major minerals) and microminerals (also known as trace minerals). Microminerals are needed in lower levels than macrominerals but are no less important. Essential minerals include calcium, phosphorus, magnesium, sodium chloride (salt), potassium, sulfur, iron, iodine, zinc, copper, molybdenum, selenium, and cobalt. Minerals make up less than 5% of the animal body; however. Their functional importance in various physiological and metabolic functions is considerable. Certain macro minerals are required in large quantities and include calcium, chloride, magnesium, phosphorous, potassium, sodium and sulphur (Schweizer *et al.*, 2017). Despite representing just 4-5% of the body weights of animals, minerals are of vital importance in various tissues for metabolic processes, the maintenance of osmotic pressure, acid-base equilibrium, and cellular permeability. These are also key components in the formations of hormones, enzymes, and tissues, such as bones, (Gomes *et al.*, 2011).

Vitamins are essential components of the body's metabolic machinery and function as cofactors in numerous metabolic reactions. Vitamin deficiencies cause symptoms of slowing down or stopping of a vitamin the metabolic process in which the vitamin is involved. There are two types of vitamins: water soluble vitamins (B vitamins and C) and fat soluble (A, D, E and K).

In tropical areas, the supplementation of diets based on pastures is necessary to ensure a proper supply of nutrients, mainly for ruminants with high productive potential. However, the use of concentrates as conventional supplements is almost prohibited for small and medium-sized raisers. Hence, shrubs are commonly used as supplements in the feeding systems of ruminant in tropical and subtropical areas. The tree species are important due to their high protein content, their contribution with easy fermentation carbohydrates and fiber of better degradability, as well their positive effect on the use of nitrogen within the rumen. These elements allow for an increase in the productivity animals fed on pastures (Rodriguez, 2014).

Supplementation needs within forage-based systems are a direct response to the lack of adequate forage nutrients and to increase the grazing capacity under pasture and range conditions. Additionally, supplementation can also provide a vehicle for carrying non-nutritive additives, antimicrobials and other compounds for the prevention for treatment of potential health problems such as parasitism (Kawas *et al.*, 2010).

Napier grass (*Pennisetum purpureum* Schumach) comprises up to 80% of the forage ingested by goats in many tropical and subtropical countries, Mohammed *et al.* (2024). On the other hand,

Indigofera (*Indigofera zollingeriana*) are leguminous species that have known to contain high nutrient, production, and tolerant to abiotic stresses. It can be harvested at the age of eight months with an average production of 2,595 kg of fresh biomass/tree, with a total production of fresh approximately 52 tons/ha (Herdiawan and Krisnan, 2014). A research conducted by Kotten *et al.* (2014) that *Indigofera* sp contains a high value of nutrient such as protein, calcium, and phosphorus. It was found that the leaves contain 23.20% crude protein, 90.68 organic matters, 36.72% NDF, 0.83% phosphorus, and 1.23% Calcium.

Lastly, the second Sustainable Development Goal (SDG) aims to achieve the "no poverty" and "zero hunger" goals, the administration of vitamins and minerals and development of feeding recommendation guide for all goat raisers may increase the production of goats, thereby increasing the farmer's income and ensuring sustainable food supply.

Materials and methods

The experimental site

The Experiment was conducted at the Production Farm of the Isabela State University- Cagayan Valley Small Ruminants Research Center (CVSRRC), Isabela State University, Echague, Isabela.

Experimental goat

A total of twelve (12) grower goats, aged range from 6-9 months old from ISU-CVSRRC Farm were used in this study.

Sanitation of the experimental site

The experimental pens were cleaned and sanitized before the conduct of the experiment. Moreover, weekly removal of waste was also done throughout the study.

Feeds and feeding

The forage provided to the experimental animals were harvested from the forage production area of the CVSRRC Farm. The experimental animals were fed ad libitum with a ratio of 70 % Napier and 30% *Indigofera* with 3-4 kilograms per animals daily.

The experimental animals were fed five times daily, and the daily forage ratio is divided into five following the schedule of feeding at 7:30 and 11:00 in the morning and 1:00, 3:00 and 5:00 in the afternoon.

A commercial feed was also supplied equally at 100 grams per animal. The feed manufacturer claimed that it contains 16 % crude protein, 6% crude fiber, 4% crude fat, 1.25-1.50% calcium and 0.5% phosphorus based on product description. The feed consumption per treatment was observed and recorded.

Provision of drinking water

The animals were provided with clean and plain drinking water daily throughout the study at 1liter per day. The water was replaced daily to ensure that it is free from contaminants.

Vitamins ADE and calcium administration

After gathering the initial weight of the animals, the grower goats subjected for ADE and Calcium administration. The dosage depends on the different treatments from 0.50 ml, 1.0 ml and 1.50 ml per 10 kilograms body weight. The administration of the biologics was done through intramuscular injection (IM) based on the product's recommendation for vitamin ADE and Calcium. The administration was done in the same day at different body part. For this particular study, Vitamins ADE was injected on the right triangular area of the neck; while calcium was injected on the left triangular area of the neck.

Experimental design and treatments

The different treatments are designate as follows:

T1- Control (No ADE and Calcium)

T2- 0.5 ml ADE + 0.5ml Calcium

T3- 1.0 ml ADE + 1.0 ml Calcium

T4- 1.50 ml ADE + 1.50 ml Calcium

The experiment in this study was laid-out using Complete Randomize Design (CRD).

Data gathered

Initial and Weekly Body Weight (kg): The initial body weight of the goats was taken using hanging weighing

scale before the start of the study. The weight of the animals also served as basis for distribution in different treatments. Thereafter, weekly body weights were taken and recorded. The final body weight was recorded at the end of the study.

Total gain in weight (kg): The gain in weight of the goats were calculated by subtracting the initial weight from the final weight.

Weekly and Cumulative Feed Consumption (kg): The weekly feed consumption of the goats was taken and recorded by taking the number of feeds offered and the amount of feed consumed. The leftover was subtracted from the amount of feed offered to determine the actual feed consumption.

Feed Conversion Ratio: It is determined by dividing the feed consumption to the gain in weight. It is also important for us to know the amount of food it takes to gain weight.

Feed conversion ratio = Feed consumed/ Gain in weight

Economic analysis: Economic analysis is determined by subtracting sales per goats with total feed cost per goat.

Income over feed cost= Total sales – Feed cost

Statistical analysis of data

All the data gathered and recorded were analysed using the analysis of variance (ANOVA) following a Complete Randomized Design (CRD). Treatment means comparison were analyzed using the Least of Significant Test (LSD).

Results and discussion

Bodyweight of the experimental animals

Table 1 shows the initial and weekly body weight of grower goats. As shown on the table below, comparable body weights were obtained from the initial body weight with means ranging from 14.33 to 14.90 kilograms.

The result implies that even without supplementation, the nutritional requirement of the animals is provided by providing grass-legume alone. This result is in accordance to the study of Niepes *et al.* (2023) which states that Napier grass-*Indigofera* forage ration can provide necessary nutritional requirements to the animals.

Gain in weight

The weekly and total gain in weight of goats was presented in Table 2. As shown on the table below, the result of the study, there is no significant differences from 1st week to 7th week of the study in the average weekly gain in weight of the grower goats with the range of 0.68 to 1.16 kilograms. Furthermore, the total gain in weight results revealed no significant differences among treatment means, ranges from 5.40 to 6.20 kilograms.

On the average, a goat can obtain an additional 115 grams of weight daily (Lu and Potchoiba, 1990) or at 805 g/ week and at least 3.4 kg per month. In this study, the expected gain in weight in achieved at Week 7. The gain in weight is generally affected by palatability, and availability of high-quality forages and the result implies that the different dosage of vitamin ADE and calcium supplementation did not influence the gain in weight of experimental goats.

With regards to the total gain in weight of the control group with no ADE and calcium administration that were fed with Napier grass and *Indigofera* was obtained a not significant result which implies that the nutritional value of the forage crops helps the goats to maintain their body weight based on the research conducted by Kotten *et al.* (2014) that *Indigofera* sp contains a high value of nutrient including the protein, calcium, and phosphorus.

Feed consumption

The feed consumption of the goats is presented in Table 3. Based on cumulative feed consumption, no significant differences were observed among the treatments with the mean ranges from 179.17 to 183.50 kilograms. A similar result was observed from the 1st to 7th week of the study, with an insignificant ($P>0.05$) result.

Table 1. Initial and weekly bodyweight of grower goats fed with forages with vitamins ADE and calcium supplementation

Treatments	Initial and weekly body weight (kg)							
	Initial	1st	2nd	3rd	4th	5th	6th	7th
T1-Control(No ADE and Calcium)	14.83	15.56	16.31	17.17	18.01	18.77	19.58	20.53
T2- 0.50 ml ADE + 0.50 ml Calcium	14.50	15.18	15.86	16.58	17.37	18.21	18.95	19.90
T3- 1.0 ml ADE + 1.0 ml Calcium	14.90	15.70	16.43	17.26	18.13	18.99	19.94	21.10
T4- 1.5 ml ADE + 1.5 ml Calcium	14.33	15.07	15.84	16.61	17.39	18.23	19.20	20.10
ANOVA	ns	ns	ns	ns	ns	ns	ns	ns
CV (%)	21.16	20.11	19.12	18.35	17.34	16.52	16.12	15.90

ns= not significant

Table 2. Weekly and total gain in weight of grower goats fed with forages with vitamins ADE and calcium supplementation

Treatments	Weekly and total gain in weight (kg)							
	1st	2nd	3rd	4th	5th	6th	7th	Total gain in weight
T1-Control (No ADE and Calcium)	0.73	0.75	0.86	0.84	0.76	0.82	0.95	5.70
T2- 0.50 ml ADE + 0.50 ml Calcium	0.68	0.67	0.72	0.79	0.84	0.73	0.95	5.40
T3- 1.0 ml ADE + 1.0 ml Calcium	0.80	0.73	0.83	0.87	0.86	0.95	1.16	6.20
T4- 1.5 ml ADE + 1.5 ml Calcium	0.74	0.76	0.78	0.77	0.84	0.97	0.90	5.77
ANOVA	ns	ns	ns	ns	ns	ns	ns	ns
CV (%)	6.74	9.71	6.74	12.26	10.85	23.26	23.36	8.51

ns= not significant

Table 3. Weekly and cumulative feed consumption of grower goats fed with forages with vitamins ADE and calcium supplementation

Treatments	Weekly and cumulative feed consumption							
	1st	2nd	3rd	4th	5th	6th	7th	Cumulative
T1-Control(No ADE and Calcium)	26.00	25.83	26.17	26.00	26.25	26.42	22.50	179.17
T2- 0.50 ml ADE + 0.50 ml Calcium	26.58	26.58	26.92	26.08	27.75	26.58	23.00	183.50
T3- 1.0 ml ADE + 1.0 ml Calcium	26.42	28.08	27.25	27.17	28.17	28.08	24.75	189.92
T4- 1.5 ml ADE + 1.5 ml Calcium	26.17	26.42	26.50	26.00	26.25	26.67	22.50	180.50
ANOVA	ns	ns	ns	ns	ns	ns	ns	ns
CV (%)	7.04	4.24	3.52	6.15	7.83	8.41	6.12	5.02

ns= not significant

Based on cumulative feed consumption, no significant differences were observed among the treatments. This means that all the goats from different treatments consumed statistically the same number of feeds, regardless the administration of vitamin ADE and Calcium. In general, consumption is generally affected by palatability, and availability of high-quality forages which the experimental animals used to feed napier and *Indigofera* prior and throughout the study. This result of the study verifies the study of Orodho (2006) that Napier grass is a high-yielding fodder crop with good palatability, highly nutrition content Yumiaty (2006).

Feed conversion ratio

The result of the study on the feed conversion ration of the experimental goats supplemented with vitamin ADE and calcium is presented in Table 4.

Treatment 2 was obtained the highest FCR of 34.34 followed by Treatment 4 and 1 with on FCR of 31.48 and 31.47, respectively.

Table 4. Feed conversion ratio of grower goats fed with forages with vitamins ADE and calcium supplementation

Treatments	FCR
T1-Control (No ADE and Calcium)	31.47
T2- 0.50 ml ADE + 0.50 ml Calcium	34.34
T3- 1.0 ml ADE + 1.0 ml Calcium	30.66
T4- 1.5 ml ADE + 1.5 ml Calcium	31.48
ANOVA	ns
CV (%)	9.76

ns= not significant

The higher the FCR, the poorer is the performance of the experimental goats. Treatment 3 with on FCR of 30.66 the lowest among the treatments is far from 4.5-4.5

expected FCR when good quality forages were provided to goats. Moreover, the result is also not in agreement with the published result of Abdullah *et al.*, (2012) that combined *Indigofera* and Napier grass in the ration for goat can achieved feed conversion ratio at 8% to 17%.

Conclusion

It is therefore concluded that Vitamin ADE and Calcium supplementation to grower goats are still required because the proximate analysis revealed that the nutrients available of the forages provided to the animals were not enough to sustain their growth and development. Treatment 3 resulted to the highest net income and return of investment among the treatments. The utilization of high-quality forages based on the recommended ratio of grass and legumes are recommended to support the growth and development of goats. However, it is also recommended that the administration of the 1.0 ml ADE+1.0 ml Calcium in Treatment 3 as it was obtained the highest net income with a return on investment at 26.01%.

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