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ORIGINAL RESEARCH ARTICLE

Growth Performance and Blood Mineral Composition of Yankasa Sheep Fed Vitamin A-Supplemented Diet

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ABSTRACT

This study investigated influence of dietary supplementation of vitamin A on the growth performance and mineral component of pregnant West African Dwarf ewes. Data were collected on body weight and feed intake, and blood samples were taken for mineral analysis. The results showed that all growth performance parameters measured were not ($p>0.05$) significantly influenced by the supplemented levels of vitamin A. However, the mineral component of the ewes was significantly affected, except for iron and calcium. Ewes fed diets containing 280,000IU vit A had the highest (113.33 ppm) zinc level, while those in the control group had the least (101.85 ppm). Magnesium was higher (2.85 ppm) in ewes fed 280,000IU vit A, with the least (0.65) observed in those fed 140,000IU vit A. Copper value ranges from the least (60.83 ppm) to the highest (71.68 ppm) observed in the ewes fed 280,000 and 140,000IU vit A, respectively. The study concluded that the supplemented vitamin A was involved more in physiological functions of the ewes in preparation for parturition so as to maintain the normal functioning of the immune system.

Key words: Vitamin A, Yankasa sheep, performance, blood mineral, supplementation

INTRODUCTION

Small ruminant such as sheep and goats play important role in the livestock sector of the Nigerian agricultural economy (Lakpini *et al*., 2002). Their importance is mainly due to their small size; this is an advantage over large animal herds because it supports low investments, higher reproductive output and economic use of available land (Omoike, 2006). Tropical ruminants are generally on natural grasses that have low digestibility, nutritive value and are not available during the dry season (Babayemi, 2009). During the dry season, the performance of ruminant animals which is dependent on the native pasture is seriously impaired; the quality is associated with the fibrous and lignified nature of the pasture which limits intake, digestibility and utilization (Olafadehan and Adewumi, 2009).

This deficit in nutritional quality highlights the need for a more comprehensive approach to nutrition, especially during gestation. Vitamins and minerals are necessary for growth, body function, and reproduction of animals. Vitamin A, also known as retinol, is required for a number of physiological functions such as vision, immunological function, reproduction, and embryonic development, including cell proliferation and differentiation (Blomhoff and Blomhoff, 2006; Stephensen, 2001; Mora *et al*., 2008). Vitamin A itself is inactive in organisms, but is oxidized in tissues to retinaldehyde and sunsequently to retinoic acid (Blomhoff and Blomhoff, 2006), which regulates the transcription of many target genes through the activation of specific receptors, including retinoic acid receptors and retinoid X receptors (Blomhoff and Blomhoff, 2006; Ziouzenkova and Plutzky, 2008; Shulman and Mangelsdorf, 2005). Vitamin A and b-carotene has been shown to reduce maternal mortality and morbidity in females (Gogia and Sachdev, 2010; Christian, 2002), and improve udder health in dairy cows during weaning and weaning period (Tjoelker *et al*., 1990). Cows with mastitis exhibit higher serum retinol levels after birth than cows without mastitis (Johnston and Chew, 1984). Vitamin A supplementation also protects animals against uterine and mammary gland infections (Inaba *et al*., 1989; Johnston and Chew, 1984). Normal values for serum vitamin A in domestic animals are between 25 and 60 g/dl (Radostits *et al.*, 2000). Severe vitamin A deficiency causes infertility or reproductive disorders in many vertebrates (Hurley and Doane, 1989; Bates, 1983), thus indicating the relative importance of retinol in pregnant sheep. Providing pregnant animals with high-quality feed is important for their health and performance, especially during the dry months, because malnutrition can affect health and reproductive performance, leading to abortion, stillbirth, or low-birth-weight babies. Therefore, this study aims to evaluate the effect of vitamin A supplementation on the growth performance and blood mineral concentration of pregnant West African Dwarf sheep.

MATERIALS AND METHOD

Experimental site

This experiment was conducted at the Small Ruminant Unit of the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta, Ogun State. The site is in the rain forest vegetation zone of South – Western Nigeria on Latitude 7 º 10' N, Longitude 3º 2' E and altitude 76 mm above the sea level. The climate is humid with a mean annual rainfall of 1037 mm and mean temperature and humidity of 34.7 º C and 83 % respectively (Google Earth, 2020).

Experimental animals and management

A total of eighteen (18) matured ewes were used for this study. Prior to their arrival, the pens were thoroughly washed and disinfected. It was also be equipped with feeding and drinking throughs. The sheep were isolated for 4 weeks and housed individually in a pen made of corrugated iron sheet with a raised floor. Prior to introduction of treatments to ewes, they were acclimatized for 4 weeks, fed only basal diet Guinea grass, for the first week of acclimatization while concentrate diet was gradually introduced during the second week of acclimatization. The Ewes were synchronized using Synchro mate a Follicle Stimulating Hormone (FSH) at the end of 4 weeks of acclimatization to bring all eighteen (18) ewes to ovulation at the same period. Rams were introduced to the ewes 12 hours after administration of the synthetic hormone to service them under close monitoring to ensure successful mating. No return date method of pregnancy testing was used to detect and confirm pregnancy at an early stage. Two months into gestation, ultrasound scanning was done for accuracy and precision.

The experimental diet (Table 1) contained a basal diet *M. maximus* and a supplemented diet of concentrate. The ewes were fed with the basal diet at an *ad-libitum*, while the concentrate diet was fed at 4% body weight. This experiment lasted for 150 days.

Experimental Design and Management

A total of eighteen (18) matured ewes were randomly assigned to three (3) treatment groups consisting of six (6) replicates.

Treatment 1 (Control) = Basal feed and concentrate fed without Vitamin A

Treatment 2 = Diet supplemented with 140,000IU vit A per Kg

Treatment 3 = Diet supplemented with 280,000IU vit A per Kg

Table 1: Composition (%) of experimental diet

Feed Ingredient	0 IU
Corn Bran	15
Rice Bran	30
Cassava Peel	20
PKC	15
Wheat Offal	17
Salt	1
Bone Meal	2
Total (%)	100
Crude Protein (%)	12.5
Metabolizable Energy (MJ/Kg DM)	11.55

*****Vitamin A was added as a supplement not an additive to the diet

Data collection

Growth performance of WAD Ewes

Data on body weight (BW) was taken at the beginning of the experiment and subsequently on weekly basis. Feed intake (FI) was collected daily at first, second and third phase of gestation and were used to calculate average weekly gain (AWG) and feed conversion ratio (FCR).

$$\text{Average feed intake (g)} = \frac{Total\ feed\ intake}{Total\ number\ of\ days}$$

$$\text{Average Weekly weight gain (g)} = \frac{Final\ weight - Initial\ weight}{Number\ of\ Ewes\ per\ Treatment}$$

$$\text{Feed Conversion Ratio (FCR)} = \frac{Total\ feed\ intake}{Total\ weight\ gain\ of\ ewes}$$

Blood Sample Collection

Blood samples were collected at the last week of gestation for mineral analysis. The blood samples from individual animal were collected by jugular vein puncture into plain sample tubes. The serum was separated by centrifugation of the blood samples at 2500 rpm for 15 min. and stored in vials at -20 °C.

Minerals analysis

The serum samples were analysed for minerals (zinc, iron, calcium, magnesium and copper) using inductively coupled plasma mass spectrometry (ICP-MS) as described by Harrington *et al*. (2014)

RESULTS

Table 2 shows the effect of dry season dietary supplementation of vitamin A on the growth performance of pregnant West African Dwarf ewes. All parameters measured were not significantly ($p>0.05$) influenced by the supplemented levels of vitamin A.

Table 2: Dry season dietary supplementation of vitamin A on the growth performance of pregnant West African Dwarf ewes

	Vitamin A Inclusion Level			
Parameters	0 IU	140,000 IU	280,000 IU	SEM

Initial weight (kg)	14.95	15.17	14.85	0.48
Final weight (kg)	18.45	17.67	18.18	0.61
Weight gain (kg)	3.82	2.72	3.33	0.24
Weight gain (g)	382.00	272.00	333.00	362.89
Weight gain (g/day)	2.5	1.81	2.22	3.24
Metabolic weight (g/day$W^{0.75}$)	86.41	66.98	83.17	1.17
Feed intake (g/day)	271.38	256.25	267.06	8.28
Dry matter intake (g DM/day^{-1})	241.53	228.06	273.68	9.10
Feed conversion ratio	0.71	0.94	0.80	67.47

SEM= standard error of mean

Table 3: Effect of dry season dietary supplementation of vitamin A on the mineral composition of pregnant West African Dwarf ewes

Parameters	Treatment (vitamin A inclusion IU)			
Minerals	0IU	140,000IU	280,000IU	SEM
Zn (ppm)	101.85^{b}	106.48^{b}	113.33^{a}	1.72
Fe (µg/dL)	155.90	114.95	162.53	11.81
Ca (ppm)	3.28	2.98	4.70	0.56
Mg (ppm)	0.78^{a}	0.65^{b}	2.85^{a}	0.26
Cu (ppm)	64.23^{b}	71.68^{a}	60.83^{b}	1.57

$^{a, b}$: means in same column with different superscript are significantly ($p<0.05$) different
SEM= standard error of mean

The effect of dry season dietary supplementation of vitamin A on the mineral component of pregnant West African Dwarf Ewes is presented in Table 3. All parameters measured were significantly ($p<0.05$) affected expect iron (Fe) and calcium (Ca). Ewes fed diet containing 280,000IU Vit A had the highest (113.33ppm) zinc content while those in the control group had the least (101.85ppm). Mg was increased (2.85ppm) in ewes fed 280,000IU Vit A with the least observed in those fed 140,000IU Vit A with a value of 0.65ppm. Copper value ranges from the least (60.83ppm) to the highest (71.68ppm) observed in the ewes fed 280,000 and 140,000IU vit A, respectively.

DISCUSSION

Livestock production relies on the quality and quantity of feed provided to the animals (Kim *et al*., 2012). In the rural areas of Africa where many resource-poor farmers live, sheep play a crucial socio-economic role and are integral to the cultural life of Nigeria's peasantry (Ajala *et al*., 2003; Anaeto *et al*., 2009). Vitamins and minerals are essential for the growth, physiological function, and reproduction of animals. Vitamin A, in particular, is vital for ruminants, as its deficiency can negatively impact reproduction, potentially leading to reabsorption or abortion of foetus (Bates, 1983; White *et al*., 2000).

The non-significant results obtained in the growth performance indices of the ewes is in tandem with study of Bryant *et al*. (2010) who observed similar effect when vitamin was fed to black yearling steer. The feed intake recorded in this study was not significantly affected and this agrees with the study of Oka *et al*. (1998) who reported no differences in the feed intake of cattle fed diets containing varying levels of vit. A. Similar metabolic weight gain observed across the treatments was also in line with the work of Peng *et al*. (2020) indicating no changes in the metabolic weight of calves fed vitamin A. The reason for the non- significant results obtained in the growth parameters of the pregnant ewes can be adduced to the fact that retinol can be converted to retinoic acid which can be utilized for most essential physiological functions of vitamin A such as maintaining healthy reproduction, supporting bone health and maintaining the body defense rather than growth as reported by (Wellik *et al*., 1997). However, contrary to the present study is the study by Puvogel *et al.* (2008) who reported improved weight gain in cows fed diet containing Vitamin A during late gestation. Utilizing dietary minerals aids in optimal physiological functioning of the dam. Insufficient nutrition by ewes, particularly from mid to late pregnancy, affects mammary development, milk production, birth weight, and the health and survival of the offspring. (Nwosu, 2019). Zinc and magnesium levels in the treated groups were higher, supporting the theory that vitamin A supplements enhance blood absorption (Parul and Keith, 2021). This finding aligns with Al-Enazi's (2017) study, which reported increased minerals levels in animals fed vitamin E supplements. The values for zinc, magnesium, copper, iron, and calcium remained within the typical reference range for healthy West African Dwarf sheep, indicating that vitamin A supplementation did not negatively affect the animals' health. The normal blood mineral levels also indicate no contraindication for the supplemented vitamin A.

CONCLUSION

Though, similar growth performance was observed with supplementation of Vitamin A, the elevated and normal range of minerals indicated that the supplemented Vitamin A played a significant role in the physiological functions of the ewes, particularly in preparation for parturition, thereby maintaining the normal immune system functioning.

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