

EFFECT OF VARYING ENERGY-PROTEIN DIETS AND PGF₂ α ADMINISTRATION ON REPRODUCTIVE AND BIOMETRIC CHARACTERISTICS OF TWO BREEDS OF SHEEP

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Abstract

A study was conducted to determine the effect of feeding three different energy diets on reproductive parameters and biometric characteristics of two breeds of sheep in the Sudan savannah zone of Nigeria. Eighteen (18) mature non-pregnant sheep (9 Uda and 9 Yankasa) with an average live weight of 34.33 ± 1.25 kg was fed diets containing Low, Medium and High energy levels. The diets comprised of 45%, 55% and 65% energy designated as T1, T2, and T3, respectively. The animals were allotted to the three dietary treatments in a 2 \times 3 factorial arrangement in a Completely Randomized Design, replicated three times. The experiment lasted for 36 weeks, and experimental diets were fed at 10% of the experimental animal's body weight. A significant ($P < 0.05$) difference was observed in T3 (HED), which plays a vital role in controlling the estrous and gestation period in Yankasa breeds while in Uda breeds T1 (LED) influences the estrous and gestation period. Similarly, a significant ($P < 0.05$) differences were observed in Yankasa breeds fed (HED) on Pregnancy rate, lambing rate, twinning rate, no abortion, and still birth records. Also, the Yankasa breed scores 100% rate in all three energy diets (LED, MED and HED) but Uda scores 33.33 and 33.33% Pregnancy rate, lambing rate and abortion rate. Significant ($P < 0.05$) differences were observed on body and neck length in both breeds (MED) for body length (76.73 cm) and neck length (33.06 cm) neck length in the Yankasa while Uda breeds T1 (LED,) body length (81.31 cm) and neck length (32.76 cm) was recorded. Data generated were coded and then subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) of Statistical Analysis System (2009). Where significant differences between the means were observed, Fisher's least significant difference (LSD) was used to separate them at 5% level of probability ($P < 0.05$).

Keywords: Low energy diets, medium energy diets, High energy diet, Yankasa, Uda Breeds Reproductive, Biometrics Characteristics

Introduction

Livestock play a vital role in Nigerian agriculture, contributing up to 12.7% of the total Gross Domestic Products (Sudi *et al.*, 2019). Nigeria is one of the four leading livestock producers in Saharan Africa region with a total livestock population of 20.6 million cattle, 42.1 million sheep, 74 million goats and 279,802 camels (FAO, 2016). Sheep are important domestic livestock for their contribution towards meat, milk, skin, and fiber production (Akubuo *et al.*, 2020). They also

provide manure and a subsidiary source of livelihood for large number of small and marginal farmers (Khaleel *et al.*, 2020). Therefore, sheep contribute significantly to the subsistence and socio-economic livelihoods of a large human population in developing countries including Nigeria. Sheep are kept in almost all parts of Nigeria because they are easy to handle and manage (Sa'ayinzat *et al.*, 2021). However, over 80% of sheep populations are largely found in arid and semi-arid regions of Northern Nigeria (Bellof and Pallauf, 2004). This is because, arid and semi-arid regions are the major grain producing areas in the country.

Nutritional feeds are necessary for the effective reproductive cycle of the ewe. Nutrition and reproduction interaction has been known to have important implications on the reproductive performance of farm animals (Abdu *et al.*, 2012). Ewes undergo a period following parturition when they are not able to become pregnant. The delay in resumption of reproductive activities is a natural way of ensuring that the dam has sufficient resources to meet her demand and that of her newborn offspring (Bellof and Pallauf, 2004). Many factors influence the resumption of ovarian activities in postpartum ewes, these include lambing interval, breed, level of nutrition, lactation period frequency, and intensity of suckling (Ascari *et al.*, 2016). The effect of feeding high-energy diets on reproduction is not well documented in ewe sheep. However, feeding sheep with high-energy diets stimulates follicular development and ovarian changes (Ascari *et al.*, 2016).

Adequate nutrition is one of the fundamental factors regulating reproductive function in females whereas under-nutrition affects the breeding activities (Ascari *et al.*, 2016). The use of energetic nutritional supplementation during the postpartum period can induce estrus behavior and ovulation (Abdu *et al.*, 2012). Several studies have shown that the nutritional and metabolic states of the animal affect reproductive functions (Bellof and Pallauf, 2004). Nevertheless, there is limited number of reports that have studied the mechanisms by which nutritional factors affect the hypothalamic pituitary-ovarian and the return of postpartum ovarian activity (puerperal period) (Ascari *et al.*, 2016). It is known that energy is one of the main nutrients required by females for efficient reproduction while an inadequate supply of energy has a deleterious effect on reproductive efficiency (Sartori and Mollo 2007).

Synchronization of estrus (heat) involves manipulating the estrous cycle of female animals so that they can be bred at approximately the same time (Najafi *et al.*, 2014). Estrus synchronization or induction is an interesting tool for increasing the pregnancy rate in ewes. Modern ewe husbandry has improved the efficiency of extensive production and controlled the reproductive process for intensive production. Basically, the synchronization of estrus in ewes focuses on the manipulation of the estrus cycle (Zonturlu *et al.*, 2011), the manipulation of either the luteal or the follicular phase of the estrus cycle. In this sense, hormonal treatment to control ovulation and reproduction is an interesting alternative for successful breeding and increasing the number of pregnant females (Abdalla *et al.*, 2014). Applications of exogenous hormones for increased reproductive performance in domestic ewes usually focus on estrus synchronization (Najafi *et al.*, 2014).

Ewes tend to be a seasonal polyestrous-animals, expressing their sexual activity in short photoperiods; i.e., at the times of low luminosity (Bellof and Pallauf, 2004). Light rays are captured by the photoreceptors in their eyes and then transmitted by the central nervous system to the hypothalamus and later to the pineal gland, where they are converted from nervous to hormonal signal, which has the characteristic of a melatonin-secretion circadian rhythm (Souza *et al.*, 2016). By contrast, when reared in tropical climates, ewes will typically cycle all year long, thus classified as continuous polyestrous. After lambing, the nutritional requirements of

ewes increase. When these requirements are not met, their body reserves are mobilized and reduced, which leads to a decline in the production of milk and reproductive hormones that eventually possibly causing anestrus (Sasa *et al.*, 2011). Anestrus is the term given to a lack of estrus behavior and ovulation (Bellof and Pallauf, 2004). Postpartum anestrus is the period between lambing and the onset of the first estrus when uterine involution takes place and ovarian activity is resumed. The length of this period depends on nutritional and physiological factors to the animal (Assis *et al.*, 2011), and the reproductive performance of ewes is related to how late postpartum-ovarian activity resumed (Eloy *et al.*, 2011). The nursing period directly contributes to prolonging anestrus, as it reduces luteinizing hormone pulses (Urbano *et al.*, 2017).

Linear body traits have been suggested as objective measures of body conformation in sheep. Body conformation highly influences the market value of meat sheep in traditional markets (Gizaw *et al.*, 2008). Linear body measurements (mean \pm SEM or mean \pm SD expressed in centimeters) among them, the wither height, body length, back circumference, and chest circumference were the most significant sources of weight variation (Juma and Alkass 2006). The chest circumference was the best indicator of the weight variations at different ages (Juma and Alkass 2006). The objective of the research was to determine the effect of three varying energies on reproductive parameters and biometric characteristics of two breeds of sheep in the Sudan savannah zone in Nigeria.

Materials and Method

Study Area

The study was conducted at Teaching and Research Farm of the Department of Animal Science, Aliko Dangote University of Science and Technology, Wudil, Kano State. Wudil is located within the Sudan savannah region of Nigeria. The experimental site is located at the latitude 11^o 37'N and longitude 8^o 58'E and at an altitude of 403 m above sea level. The annual rainfall ranges from 850 mm – 870 mm with minimum and maximum temperature of 26^oC and 36^oC, respectively. The relative humidity of the region is always low and ranges between 40% - 51% (Dambazau, 2008).

Experimental Animals and Their Management

Eighteen (18) adult non-pregnant sheep (2 – 3 years old), consisting of 9 Yankasa and 9 Uda breeds were used for this study. The animals were treated against internal and external parasites using Ivermectin + Clorsulon (Ivotek super®) at a dose of 200 μ g/kg body weight. They were vaccinated against *pnuemo-enteritis complex (peste-des-petits ruminants* (PPR) at a dose of 1 ml/animal subcutaneously at the neck region and were quarantined for two (2) weeks with water and mineral licks provided for them *ad libitum*. They were kept in individual pens in a constructed shed to eliminate any variations attributed to environmental and management changes.

Experimental Procedure

Eighteen (18) sheep were randomly allotted into three groups of six animals per group. Each group consists of (3) Yankasa, and (3) Uda sheep. Formulated feeds were served to the experimental animals with varying levels of energy (45%, 55% and 65%) designated as low, medium and higher energy, respectively. The experimentation lasted for nine months intensively.

Experimental Design

A completely randomized design (CRD) with 2 x 3 factorial arrangements using individual breed as the experimental unit with 3 energy levels per group was used.

Determination of Proximate Composition of Experimental Diets

Samples of the experimental diets were collected for proximate analysis to determine their proximate composition according to AOAC (2005) to obtain the dry matter (DM), ash (minerals) and total nitrogen (to determine crude protein), crude fiber (CF), ether extract (EE) and nitrogen-free extract (NFE) proximate composition was determined in food science laboratory Aliko Dangote University of Science and Technology Wudil.

Reproductive Performance of Ewe

Administration of the Synchronizing Agent

Prostaglandin injection (PGF_{2α}) was administered to the experimental animals at a dosage of 1 ml intramuscularly on day 0 at the first dose and repeated after 11 days with a second dose of prostaglandin.

Mating of the Ewe

After estrus confirmation, ewes were exposed to a ram with proven fertility for mating at 12-hours after the onset of estrus and again at 12-hour intervals for as long as they remained in estrus. After 10 days the ewes were again tested with vasectomized rams to identify those ewes returning to service. This procedure was performed for two cycles following the induced estrous period.

Conception Rate

Conception rate (%): were recorded as the percentage of the ewes conceived in each treatment after mating. $CR = \frac{\text{Number of ewes that conceived}}{\text{Total number of ewes mated}} \times 100/1$

Conception rate can be measured using various methods as the breeding season progresses, although the accuracy varies with both method and time (West *et al.*, 2009).

Non-Return to Estrus Rate

The absence of repeats (or non-returns) for a period equivalent to approximately three cycles or 60 days is an indicator of pregnancy. The 60 days non-return rate can therefore be used to give an early indication of conception rate as the breeding season progresses (West *et al.*, 2009).

$$NRE = \frac{\text{No of non-returns} \times 100}{\text{No of ewes} > 60 \text{ days since last service}}$$

Pregnancy Rate

Pregnancy diagnosis was conducted with reasonable accuracy by ultrasound scanning approximately 90 days after service or by rectal palpation approximately 40 days after service. This also presents an opportunity for apparently non-cycling/problem ewes to be examined by the veterinary practitioner.

$$PR (\%) = \frac{\text{No of ewes with +ve Prg. Diag.} \times 100}{\text{Total No. of Services}}$$

Lambing Rate

The most accurate assessment of conception rate was calculated when all the ewes had subsequently lambed, with the assessment also taking account of services in ewes subsequently culled, for whatever reason.

$$\text{LR (\%)} = \frac{\text{No. of ewes with subseq. Calving} \times 100}{\text{Total No. of Services (including cull)}}$$

Lamb Mortality

Lamb mortality was recorded as the percentage of the lamb that died after successfully lambing by the dam (experimental animal). Corner *et al.* (2015) reported that lamb mortality may occur at about 20% in their first three days after birth.

Body Linear Measurement

- i. Chest circumference (cm): This was taken by measuring the distance from the backbone at the shoulder to the brisket between the front legs.
- ii. Withers height (cm): this was measured as the distance from the surface of a platform to the withers.
- iii. Neck length (cm): this was measured as the distance between the lower jaws to the point of the shoulder.
- iv. Back length (cm): the animal back length was measured by using tape from dorsal to lumbar region of the experimental animal.

Statistical Analysis

Data generated were coded and then subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) of Statistical Analysis System (2009). Where significant differences between the means were observed, Fisher's least significant difference (LSD) was used to separate them at 5% level of probability ($P < 0.05$).

The following models were used.

$$Y_{ij} = \mu + O_i + e_{ij}$$

Where:

Y_{ij} = Individual observation

μ = overall mean

O_i = effect of the energy levels in the diet

e_{ij} = random error

Results and Discussion

There were significant ($P < 0.05$) differences in body length across treatments in Yankasa sheep T2 (MED) had the highest mean value (76.73 cm) followed by T1 (LED) with mean value of 73.11 cm while the least mean value was recorded in T3 (72.38 cm). Similarly, significant ($P < 0.05$) differences were observed in neck length, where animals in T2 (MED) had the highest mean value (33.06 cm) followed by T1 (LED) with mean value of 32.21 cm while the least mean value was recorded in T3 (HED) with mean value of 26.78 cm. Significant ($P < 0.05$) differences were also observed in Uda sheep across treatments. In body length T1 (LED) had the highest mean value (81.31 cm) followed by T3 (MED) with mean value of 74.23 cm while the least mean value was recorded in T2 (MED) (72.38 cm). Similarly, significant ($P < 0.05$) differences were observed in neck length where animals in T1 (LED) had the highest mean value (32.76 cm), followed by T2 (MED) with mean value of 31.56 cm while the least mean value was recorded in T3 (HED) (28.33 cm).

Yankasa Breed of Sheep treated with PGF2 α had the highest pregnancy and lambing rate compared with the Uda breed fed medium and low energy and protein diets. This may be caused by the fact that some sheep breeds might have shown pseudo-estrus after being injected with PGF2 α like the Uda breed. Santos *et al.* (2004) reported embryonic loss as the factor contributing to low pregnancy rate when ewes are fed with low or medium energy diets. The result of this finding was at variance with the report of Paul *et al.* (2015), who reported PGF2 α to be more effective at increasing pregnancy rate compared with GnRH in small ruminants. Also, Sozbilir *et al.* (2006) reported that PGF2 α injection increases conception rate in primiparous cows. The pregnancy and lambing rate reported in this study for the Uda breed of sheep treated with PGF2 α agreed with the report of Moghaddam *et al.* (2012), who reported a pregnancy rate of 87.5% and a lambing rate of 97.5% in ewes treated with PGF2 α .

Table 1: Composition and Calculated Values of the Experimental Diets (%)

Ingredients	Experimental diets		
	Low-energy Diet	Medium-energy Diet	High-energy Diet
Maize	4.00	7.00	10.00
Maize offal	10.00	15.00	20.00
CSC	10.00	10.00	10.00
GNC	8.00	8.00	8.00
Cowpea husk	10.00	10.00	10.00
Rice bran	25.00	20.00	15.00
Groundnut haulms	5.00	5.00	5.00
Molasses	2.00	3.00	8.00
Sorghum chaff	22.00	18.00	10.00
Limestone	3.25	3.25	3.25
Ruminant premix	0.25	0.25	0.25
Salt	0.50	0.50	0.50
TOTAL	100.00	100.00	100.00
Calculated values			
CP (%)	16.97	17.61	18.02
Energy(KCal/Kg)	2493.12	2575.35	2701.10
CF (%)	11.89	12.30	12.57
EE (%)	3.88	4.23	4.65
DM (%)	90.50	91.60	93.30
Ash (%)	6.45	6.63	6.67
NFE (%)	51.31	50.83	51.39

CSC=Cotton seed cake, **GNC**=Ground nut cake; **CP**= Crude protein; **EE**= Ether extract; **CF**= Crude Fiber; **DM**= Dry matter; **NFE**= Nitrogen free extract

Table 2: Reproductive Parameters (Conception to Delivering Rate) of Two Breeds of Sheep after Injection with PGF2a Fed the Experimental Dies

Tag number	Energy levels	Conception rate (%)	Lambing rate (%)	Twinning rate (%)	Abortion (%)	Still birth (%)
Yankasa breeds						
068	Low energy	100	100	0.00	0.00	0.00
067	Low energy	100	100	0.00	0.00	0.00
073	Low energy	100	100	0.00	0.00	0.00
	Medium energy	100	100	0.00	0.00	0.00
061	Medium energy	100	100	33.33	0.00	0.00
062	Medium energy	100	100	0.00	0.00	0.00
063	High energy	100	100	0.00	0.00	0.00
062	High energy	100	100	0.00	0.00	0.00
078	High energy	100	100	33.33	0.00	0.00
Uda breeds						
069	Low energy	100	100	0.00	0.00	0.00
070	Low energy	100	100	33.33	0.00	0.00
065	Low energy	100	100	0.00	33.33	0.00
	Medium energy	100	100	0.00	0.00	0.00
064	Medium energy	100	100	0.00	0.00	0.00
072	Medium energy	100	100	0.00	0.00	0.00
074	High energy	100	100	0.00	0.00	0.00
	High energy	100	100	33.33	0.00	0.00

076	High energy	100	100	0.00	0.00	33.33
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Table 3: Biometrics of two Breeds of Sheep (Yankasa and Uda) Fed three Varying Energy and Protein Levels

Parameters	Treatments			SEM
	T1 (LED)	T2 (MED)	T3 (HED)	
Yankasa breed				
Body Length (cm)	73.11 ^b	76.73 ^a	72.38 ^c	2.198
Chest Circumference (cm)	80.28	81.55	79.21	2.609
Wither Height (cm)	73.55	78.01	71.61	2.795
Neck Length (cm)	32.21 ^b	33.06 ^a	26.78 ^c	1.134
Uda breed				
Body Length (cm)	81.31 ^a	72.38 ^c	74.23 ^b	2.031
Chest Circumference (cm)	76.36	77.15	79.08	2.721
Wither Height (cm)	73.71	78.26	75.08	2.908
Neck Length (cm)	32.76 ^a	31.56 ^b	28.33 ^c	0.759

^{abc} means with same raw with different superscripts differ significantly ($P < 0.05$) SEM=Standard error of means; body length and neck length.

The conception rate reported in Yankasa breeds treated with $PGF2\alpha$ was in agreement with the result obtained by Yavuzer *et al.* (2010), who used double injection of $PGF2\alpha$ at 10 days apart with or without FSH injection and obtained 100 and 95% conception rate, respectively. In contrast to the present study, Zohara *et al.* (2014) observed a conception rate of 75% in Bangladesh indigenous ewes treated with $PGF2\alpha$. The present findings recorded for the pregnancy rate of the Yankasa breed were higher than the findings of Homeida *et al.* (2009) in Naeimi ewes treated with $PGF2\alpha$ (81.25%). Furthermore, variations in conception rate observed among different studies might be due to differences in the breeds and geographical location (Yavuzer *et al.*, 2010), energy diet levels and breeding season (Paul *et al.*, 2015). The results of lambing rate in this study were higher than the findings of Sozbilir *et al.* (2006), who have reported 60% and 73% lambing rate in Tuj ewes with double injections of $PGF2\alpha$ at 10 and 14 days intervals, respectively. No (0%) twinning and abortion were recorded in Yankasa breeds fed diet containing (Low, Medium and High) energy diet levels. But twinning, abortion, and still-birth were recorded in Uda breed fed (Low and Medium) energy diets levels (33.33%) and (33.33%) treated with $PGF2\alpha$ was recorded. The abortion rate reported here disagreed with (Bellof and Pallauf, 2004), who reported 45% as a mean abortion rate in early pregnancy. The still birth (40%) recorded in sheep on $PGF2\alpha$ treatment might be caused by progestagen deficiency. Maintenance of pregnancy, in part, is dependent on the secretion of progesterone during the pregnancy. With regards to that, $PGF2\alpha$ treatment has been used extensively as treatment for losses that might be associated with mistiming of embryonic development to maternal recognition of pregnancy Yavuzer *et al.* (2010). The effect of $PGF2\alpha$ on embryo survival may occur through GnRH-stimulated LH surge, stimulating production of P4 by CL and causing ovulation and formation of accessory CLs (Khan *et al.*, 2003).

Conclusion: Its concluded that Yankasa breeds of sheep are more fertile than Uda breeds having a score 100% pregnancy rate, lambing rate, twinning rate, 33.33% abortion and still birth in (LED), (MED) and (HED) but Uda breeds scored 33.33 and 33.33% rates, also medium energy

has affected biometric characteristics in Yankasa breed while Uda breed low energy diets is better.

Recommendation: It is also recommended that high-energy diets should be used in feeding small Ruminants especially sheep for higher twinning rate, less abortion and still-birth, Medium energy had influenced in biometric characteristics in Yankasa breed. while the Uda breed low-energy diets are better.

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