EFFECT OF CLIMATIC SEASON ON THE REPRODUCTIVE PERFORMANCE OF RED SOKOTO GOATS FED GRADED LEVELS OF SUN-DRIED CASSAVA PEEL MEAL AS ENERGY SOURCE IN PREGNANCY

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Abstract

This study evaluated the effect of climatic season on the reproductive performance of Red Sokoto Goats fed graded levels of sun-dried cassava peel meal as an energy source in pregnancy. Treated cassava peel (sun-dried) was used as an energy source to replace maize offal at levels of 0 (Treatment 1) 18.5, (Treatment 2) 37.0, (Treatment 3) 55.0, (Treatment 4) and 74.0% (Treatment 5) in the ration of goats. A sixth ration (Treatment 6) comprised only cotton seed cake and common salt. Thirty (30) pregnant Red Sokoto goats aged between 1.5-2.0 years were allotted to six (6) treatments with a mean weight of 26.1-26.6kg in a randomized complete block design. Each of the six rations was fed to five Red Sokoto goats during pregnancy at the rate of 1.5% of the live weight daily before allowing the goats to graze on native pastures in a specific paddock. The result of the experiment showed that season had no significant ($P<0.05$) effect on birth weight (BTWT), litter weight (LWT) and litter size (LS) of the kids. However, weight loss due to kidding (WLDK) was significantly ($P<0.05$) higher during the Cold-Dry season (October-December). No mortality was reported in this study in terms of reproductive wastage like abortion and still birth. The study concluded that without adjusting for energy, Cassava peel meal can be used to replace maize offals in the diets of pregnant Red Sokoto goats up to 74% inclusion level during the Hot-dry season, late-wet season and cold-dry season without having any adverse effects on birth weight (BTWT), litter weight (LWT) and litter size (LS).

Keywords: climatic season, energy source, red Sokoto goats, reproductive performance, sun-dried cassava peel meal.

Introduction

Small ruminants such as goats are of economic importance to rural farmers or smallholders (Ojo & Ogunbosoye, 2022; Abdul-Rahman, 2017) and nations at large. In Nigeria, goats represent a valuable resource of economic emancipation, poverty alleviation and sustainable livelihood in addition to meeting several socio-cultural imperatives (Yakubu, Salako, Imumorin, Ige & Akinyemi, 2010, Oseni & Ajayi, 2014). Animal breeders in conjunction with government are making concerted efforts to improve the reproductive performance of goats as one of the possible means to meet the demands of food supply of the increasing population. (Bishop & Wooliams, 2004). Seasonal variations as well as environmental and genetic factors are among the major hindrances and influences on the production performance of several breeds of goats in the tropics (Sacker and Trail, 1996 In: Tizhe, Shua, Kubhomawa and Kwaji, 2017). Similarly, reproductive efficiency in any type of animal species depends on several other factors, which include age, estrus cycle, litter size, gestation length, length of breeding season, suckling period and duration of reproduction period (Hoferz, 1982).

Feed is one of the most crucial factors that play a major role in spheres of livestock production viz-a-viz production performance as well as reproductive performance (Anaeto, Sawyerr, Alli, Tayo., Adeyeye & Olarinmoye,2013). Energy is one of the most limiting nutrients in livestock production in Nigeria (Balogun, 1997). The conventional feedstuffs (cereal grains) maize inclusive which are traditionally used as sole energy sources have become expensive due to competition for its use among man, livestock and industry. This trend has astronomically increased the cost of these feed ingredients. The quest to address this challenge has led researchers, animal nutritionists, feed manufacturers, animal scientists, livestock farmers and other professionals to source for alternatives that are cheaper, readily available, less competitive and nutritionally rich for livestock feed production.

Cassava, being one of the staple food crops grown in tropical Africa is consumed by over 200 million people in Africa (Waisundara, 2017). Recently, Nigeria as the largest cassava root-producing nation in the world, harvested over 59 Metric tonnes of fresh cassava roots annually with the average yield per hectare being 10.6 tonnes (FAOSTAT, 2021), resulting in about 15 million wet peels. This waste constitutes an environmental menace to the community. Thus, the judicious use of this waste will not only mitigate the environmental hazard occasioned by the indiscriminate disposal of these wastes but also reduce the cost incurred on goat production. Various reports have suggested the inclusion of cassava peel meal and other cassava wastes in the feed of goats with satisfactory results (Amole, 2024; Okpara, Omunizua, Sorhue & Bratte, 2024).

The use of unprocessed cassava peel and other cassava by-products as supplements for livestock has been limited by the content of cyanogenic glycosides in cassava plants (Ogundu, Eyoh, Idiong & Udo, 2018). The glycosides linamarin and lotaustralin are hydrolyzed by some enzymes in the plant to hydrocyanic acid (HCN), which is toxic when consumed. The amount of HCN in cassava varies from 568-950mg/kg in root bark to 2.200mg/kg in fresh root pulp (Miles, Jansson, Mai, Azer, Day, Shadbolt, Stitt, Kiermeier & Szabo, 2011). Even though concentrations lower than 50mg/kg are considered to be harmless, the lethal concentration of HCN in cassava is not only manifested in the mortality of animals but could have effects on their performance traits (Waisundara, 2017). Processed cassava peel as a good energy source offers a promising and sustainable alternative feed resource (Balogun, 1997; Ojo & Ogunbosoye, 2022; Adegun & Aye, 2022; Amin, 2022). Given the large quantities of cassava peel produced annually accompanied by the large quantity of peel generated, this study aimed to assess the effect of climatic season on reproductive performance of goats fed graded levels of sun-dried cassava peel meal as energy sources in pregnancy.

Materials and Methods

Location of Experiment

The study was carried out at the National Animal Production Research Institute (NAPRI), Shika, Zaria, Nigeria on latitude 11° 12'N, Longitude 7° 33' E and on an altitude of 610m above sea level. Shika is within the Northern Guinea Savanna Zone and has a sub-humid tropical climate with an average rainfall of 1092mm, which falls mainly between April and October. The mean maximum temperature ranges from 27 to 35°C (Ovimap, 2015).

System of Management of Animals

The Red Sokoto Goats used in this study were managed semi-intensively and were individually identified using numbered plastic ear-tags. The animals were housed in individual feeding pens between 8:00 - 10:00 am each day for supplementation. Thereafter, the goats were released to graze in specific paddocks with natural pastures under the close supervision of a herdsman till 6.00 pm before they were returned to their enclosures (holding pens) to drink water and to pass the night. At the commencement of the experiment, the animals were dipped with an acaride (Stelladone Solution) against ectoparasites and dewormed with an anthelmintic (Banminth F) against endoparasites.

Experimental Procedures

Graded levels of sun-dried cassava peel meal (SDCPM) were used as an energy source to replace maize offals at levels of 0% (Treatment 1); 18.5% (Treatment 2); 37.0% (Treatment 3); 55.0% (Treatment 4); and 74.0% (Treatment 5) in the compound rations. An additional ration (Treatment 6) comprised only Cotton Seed Cake (CSC) and Common Salt (Table 1). A proven breeding buck was introduced and allowed to run with the goats. A breeding harness with crayon was fitted ventral to the sternum of the buck. The goats were examined at 18:00 and 07:30 hrs. of the following day for marks of the crayon on their rump. The day the crayon mark was observed on the does (female goats) was recorded as the breeding day. The buck was withdrawn after all the does had been bred.

Thirty (30) pregnant Red Sokoto goats aged between 1.5 and 2 years were weighed and equally allocated to six Treatments (1-6) in a Complete Randomized Block Design. Each goat was placed in an individual feeding pen at 08:00 hrs. daily and offered a weighed quantity of the appropriate ration equivalent to 1.5% of its weekly body weight. They were allowed 2 hours to eat rations provided and fresh clean drinking water was provided to them ad libitum before being released to gaze on natural pasture in a specified paddock. The leftovers of the rations in the individual feeding pens were weighed to determine the daily feed intake of the goats before grazing. Samples of the rations offered to the animals and the leftovers were separately collected every week and bulked for proximate analysis while the goats were weighed weekly to determine any live weight change during the 168-day feeding trial.

Table 1: *Composition of Experimental Rations (kg DM)*

Treatments/Rations	Maize Offal (%)	Sun-Dried Cassava Peel Meal (SDCPM %)	Cotton Seed Cake (CSC) (%)	Common Salt (%)
1	74.0	0	25.0	1.0
2	55.5	18.5	25.0	1.0
3	37.0	37.0	25.0	1.0
4	18.5	55.5	25.0	1.0
5	0	74.0	25.0	1.0
6	0	0	99.0	1.0

Inventory and Abundance of Plant Species

An inventory (botanical survey) of the plant species in the grazed paddock (5ha) was undertaken at the beginning of the study. In addition, visual estimates to determine the relative abundance of each species were carried out. One hundred (100) quadrats (1m x 1m) were observed per hectare in the paddock. Plant species in each quadrat were rated either as present (rare), common, abundant or most abundant (Table 4). The different pasture species identified to be grazed by the animals and rated to be of medium to high acceptability/palatability were sampled weekly for chemical analysis.

Chemical Analysis

The milled feed and pasture samples were subjected to proximate analysis for Dry Matter (DM), Total N, Ether Extract (EE), Crude Protein (CP) and Ash (ASH), Crude Fibre (CF) and Nitrogen Free Extract (NFE) as described by the Association of Official Analytical Chemists (AOAC, 2004). The Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) were determined by the methods of (Van Soest, 1965, Van Soest and Wine, 1967) as described in Mongeau and Brooks (2016) and Wirchern et al. (2018).

Statistical Design

The data collected were analyzed for feed and nitrogen intakes and conversion and reproductive performance using the General Linear Models Procedure and Duncan’s Multiple Range Test of the Systems Analytical Statistics Package (SAS, 2020).

Results

Chemical Analysis of the Supplement Ration and Grazed Forages

The results of the chemical analysis of the supplement rations and grazed forages are given in Tables 2 and 3 respectively. The crude protein (CP) content of the energy-based rations decreased from 18.6% in ration 1 to 11.3% in ration 5. Ration 6 being primarily a protein supplement contained 23.5% CP. The NDF, ADF and ASH of the supplements did not show any definite trends (Table 2).

Table 2: *Chemical Components of the Supplement Rations (%)*

Ration	DM	ASH	EE	NDF	ADF	CP
1	90.2	4.2	4.5	55.6	21.8	18.6
2	93.1	10.9	4.1	44.5	23.4	16.5
3	90.6	6.2	2.9	49.1	29.9	13.6
4	91.2	7.0	1.4	46.8	31.0	12.8
5	88.0	7.2	3.3	54.1	35.6	11.3
6	93.4	5.2	4.6	65.9	41.7	23.5

Key: DM – Dry Matter; ASH - Ash; EE Ether Extract; NDF - Neutral Detergent Fibre, ADF - Acid Detergent Fibre, CP - Crude Protein

Table 3 shows that herbaceous (4.3-12.3% CP) and shrub legumes (7.5-15.8% CP) contained more CP than grasses (4.9-7.5% CP).

Table 3: *Chemical Composition of Grazed Forage (%)*

Forage	DM	ASH	EE	NDF	ADF	CP
Gramineae:						
Andropogon gayanus	93.2	12.1	73.7	52.8	0.7	4.9
Chloris Pilosa	94.2	15.6	71.3	46.4	1.1	6.9
Panicum phragmitoides	94.1	15.7	70.6	39.1	1.1	7.0
Setara anceps	93.8	4.2	75.1	40.1	0.9	6.0
Urelytrum nutricatum	93.8	15.6	68.7	38.0	1.2	7.5
Caesalpiniceae:						
Piliostigma thonningii	92.8	7.1	57.7	45.5	1.1	7.1
Compositae:						
Aspilia Africana	93.3	20.6	62.7	46.9	0.7	4.3
Malvaceae:						
Sida rhombifolia	91.7	4.9	60.3	40.1	1.9	12.3
Urena lobate	92.2	9.6	53.1	37.8	1.7	10.6
Papilionaceae:						
Desmodium velutinum	93.0	7.2	66.3	45.0	1.6	10.3
Indigofera arrecta	92.6	7.1	52.1	43.6	2.5	15.8
Indigofera pulchra	92.6	11.8	54.5	38.6	1.4	9.0
Stylosanthes hamata	93.6	6.6	68.6	52.7	1.2	7.5
Tephrosia linearis	93.2	5.1	80.8	80.7	1.6	10.0
Zornia diphylla	92.1	5.5	59.3	45.1	1.9	11.9

Table 4 shows an inventory of the plant species in the grazed paddock. Most of the moderately to highly palatable species were of the family, Papilionaceae. The species in the Composite, Rubiaceae, Caesalpiniaceae, Tiliaceae, Scrophulariaceae and Sterculiaceae were mostly of low acceptability in the forage value rating.

Table 4: *Inventory of Plant Species in the Grazed Paddock*

Family/Sub-Family	Plant Species	RAR	FVR
Gramineae	*Andropogon gayanus*	XX	3
	Andropogen schrirensis	XX	2
	Chloris Pilosa	XX	2
	Digitaria tanata	X	3
	Elionurus pobeguinii	XX	1
	Hyparrehenia rufa	X	3
	Loudetia simplex	X	1
	Monocymbium ceresiiforme	X	3
	Panicum phragmitoides	X	3
	Pennisetum pedicellatum	XX	3
	Setara anceps	XX	3
	Sporobolus pyramidalis	XXX	1
	Urelytrum muricatum	X	2
Caesalpiniceae	*Cassia nigricans*	XX	1
	Cassia rotundifolia	X	1
	Cassia tora	X	1
	Isoberlinia doka	XX	1
	Piliostigma thonningii	X	2
Compositae	*Ageratum conyzoides*	XX	1
	Aspilla Africana	XXX	2
	Blumea aurita	X	1
Malvaceae	*Sida rhombifolia*	XX	2
	Urena lobate	XX	3
Papilionaceae	*Desmodium velutinum*	X	2
	Indigofera arrecta	XX	3
	Indigofera dendroides	X	2
	Indigofera secundiflora	X	1
	Stylosanthes hamate	XX	3
	Tephrosia bracteolate	X	3
	Tephrosia linearis	X	3
	Tephrosia pedicellate	X	2
	Zornia diphylla	X	2
Rubiaceae	*Borreria radiate*	XX	1
	Borreria verticillate	X	1
Scrophulariaceae	*Striga species*	X	1
Sterculiaceae	*Waltheria indica*	XX	1
Tiliaceae	*Corchorus tridens*	X	1

Key: RAR -Relative Abundance Rating,
X - Present / Rare,
XX- Common,
XXX- Abundant,
FVR- Forage Value Rating
1 -Low Acceptability/palatability
2- Medium acceptability/palatability
3- High acceptability/palatability

Table 5 shows the effect of season on the Birth Weight (BTWT), Litter Weight (LWT) and Litter Size (LS) of the kids. The season had no significant effect ($P>0.05$) for BTWT, LWT and LS for kids. However, weight loss due to kidding (WLDK) was significantly ($P<0.05$) higher during the Cold-dry season (October-December).

Table 5: *Effect of Supplementation on Birth Weight (BTWT), Litter Weight (LWT), Weight Loss Due to Kidding (WLDK) and Litter Size.*

Season	BTWT (Kg)	LWT (Kg)	WLDK (Kg)	LS (g)
1. Hot-dry season (Jan-Mar)	1.52	2.11	- 2.75[a]	1.33
2. Late-wet season (Jul-Sept)	1.73	2.29	- 4.58[a]	1.33
3. Cold-dry season (Oct-Dec	1.52	2.79	- 6.75[b]	1.88
Overall mean	1.59	2.39	-4.69	1.51
SED	±0.062	±0.201	±0.504	±0.114

Means within columns with different superscripts differ significantly (P<0.05)

Discussion

Chemical Analysis of the Supplement Ration and Grazed Forage

The grazed natural pastures were relatively high in CP content because most of the species were in the vegetative stage. Higher CP content and digestibility have been associated with pasture species during this stage compared with the flowering / seeding stage. Furthermore, the growth of the species was enhanced by the amount of rainfall (742.7mm) during the experimental period. Preference for the leaf by grazing animals is higher than the stem part. Leaves are more palatable than stems, and new growth or regrowth is more nutritious than older tissue (Trlica, 2013). This was attributed partly to the higher CP content of the leaf over other parts of the whole plant (Santamaria-Fernandez and Lubeck, 2020). In this study, the mean CP content of the whole plant of most species was above 7.0%, thus it could be inferred that the performance of the goats was not limited by the protein content of the herbage. The ADF of the grass species except, *A. gayanus* and *C. pilosa,* were close to 24.7-57.4% as reported for most tropical grasses, and this is in concordance with the findings of (Jayasinghe, Ramilan, Donaghy, Pembleton and Barber (2022) and Bayble, Melaku and Prasad (2007). The NDF values of the grass species in this study were generally higher than other species.

However, the season of kidding had a significant (P<0.05) effect on WLDK. This was more pronounced during the Cold-dry season probably because of the more abundant feed resources during the pregnancy, which might have led to the retention of more body fluids in the Cold-dry season than in the Hot-dry season. The result of the present study concurs with the findings of Tizhe et al (2017) that the season of birth has a direct influence on litter size. Tizhe et al (2017) report the highest litter size during the early dry/cold season (October-December) and the late wet season (July-September) in the Sahel and Red Sokoto Does. This was attributed to the availability of feeds during these periods. This corroborated with the findings of this study, which revealed the highest litter size (1.88) in the Red Sokoto breed during the Cold-dry season. The reason behind this result could be due to the availability of feed/pasture during the stated season (October-December) and the ability of the Red Sokoto goats to utilize browses and other forage for useful purposes during the stated seasons (Manousidis, Kyriazopoulos, Parissi, Abraham, Korakis & Abas, 2016). Good nutrition enhances good body weight and has been reported to improve litter size in mature Indian goats (Akpa, Alphonsus, Dalha, Yakubu & Garba, 2011).

Goats had higher litter sizes and birth weights in the Cold-dry season. This was attributed to feed availability during the rainy season (Kaura, 1989). This observation was not well confirmed by this result, which indicated that goats had bigger litter sizes and smaller birth weights though not significantly different (P>0.05) in the Cold-dry season. This disparity could be attributed to breed differences, ecological and seasonal variations as well as feeding management. According to Ojo and Ogunbosoye (2022), forage obtainable during the dry season has low quality, insufficient crude protein (as low as 2%) high lignin and fibre, the consumption of which predisposes ruminants (goats inclusive) to low feed intake, depressed digestibility, reduced nutrient utilization, weight loss, low birth weight and low disease resistance.

The lack of good nutritive feed during the dry season is partly responsible for the low productivity and reproduction of livestock in Sub-Saharan Africa (Anaeto et al, 2013 Ojo & Ogunbosoye, 2022; Amin, Audu, Haruna, Salisu & Isa, 2020). The lower litter size (1.33) obtained in this study during the Hot-dry season (January-March) and late Wet-dry season (July-September) could be due to inadequate nutrition and climatic conditions/seasonal influences which could depress ovarian/reproductive activities in the Red Sokoto Does. This conforms with Ojo and Ogunbosoye (2022) and Amin et al (2020) who reported differences in litter size across seasons in farm animals. The lower litter size observed during the late wet season could be also attributed to the fact that goats generally are known to have a lower tolerance threshold for rain due to their high susceptibility and septicemic conditions coupled with high disease prevalence and parasitic infestation during the rainy/wet seasons; thereby lowering their productivity. These observations are in concordance with the reports of Butswat and Zaharadeen (1998) and Tizhe et al. (2017). However, contrary to the findings of this study, Thiruvenkadan, Panneerselvam and Kandasmy (2000a) reported higher litter size during the wet season in Kanni Adu goats in India. The higher litter sizes recorded were attributed to low temperatures and good herbage growth. Assan (2021) also reported that kidding during the early rainy season had the largest litter size at birth which was at variance with the findings of this study.

Conclusion

In conclusion, the study showed that without adjusting for energy, cassava peel meal can be used to replace maize offal in the ration for Red Sokoto goats up to 74% level during the hot-dry season, late-wet season and cold-dry season without adverse effects on reproductive performance in terms of birth weight (BTWT), litter weight (LWT) and litter size (LS).

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