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FEED INTAKE AND REPRODUCTIVE PERFORMANCE OF GRAVID WAD DOES FED GUINEA GRASS (*PANICUM MAXIMUM*) SUBSTITUTED WITH MULBERRY LEAVES (*MORUS ALBA*)

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ABSTRACT: *This study investigated the impact of substituting fresh Panicum maximum with fresh mulberry (Morus alba) leaves at different levels (0, 25, 50, 75, and 100%) on feed intake, and reproductive performance of intensively managed gravid West African Dwarf (WAD) does. Twenty-five gravid WAD does were divided into five groups, each consisting of five does, and were subjected to a 150-day experiment. Feed intake results indicated that does fed on a diet containing 50% Panicum maximum and 50% mulberry (P50M50) had the highest total dry matter intake (TDMI) across three trimesters (356.63, 488.69, and 539.63 g/day). Weight gain was notably higher ($p<0.05$) in does on a diet of 100% mulberry (P0M100). Offspring weaned from dams fed a diet with 75% mulberry substitution exhibited higher weaning weights and daily weight gains. The study concludes that substituting mulberry in the diet of traditionally managed WAD goats enhances pregnancy development without health concerns and contributes to improved udder development and potential milk yield enhancement.*

KEYWORDS: Gravid West African Dwarf (WAD) goat; *Panicum maximum*; *Morus alba*; udder

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INTRODUCTION

Small ruminants are very important in the farming system of southern Nigeria because of their unique ability to adapt to the prevailing conditions of weather and the available range of grasses with browse plants (Onyeonagu and Asiegbu, 2008). Goats constitute a very important part of the rural economy in Nigeria, with more than 95% of the rural households keeping goats (Ukpabi *et al.,* 2000). Moreover, goats are produced in Nigeria mainly for meat, skin and milk (Alikwe *et al*., 2011). Small ruminants suffer a shortage of feed supply and pasture quality in the humid region of West Africa, especially in the dry season when the natural vegetation is of poor nutritive value (Aye, 2007). The effects of these challenges resulted in poor productivity of livestock and lower quantity of animal protein available for human consumption in the third world (Adebisi *et al*., 2016). Thus, providing alternative herbage such as *Morus alba* Linn. 1753 (Rosales: Moraceae) with high feeding value to supplement the *Panicum maximum* Jacq. (Poales: Poaceae) grass which is an important fodder in ruminant nutrition and maintenance, and to avoid competition between the animals and human food sources. Mulberry (*M. alba*) leaves have been reported to be rich in protein (15 – 35%), minerals (2.42 – 4.71% Calcium, 0.23 – 0.97 % Phosphorus) and metabolizable energy (1130 – 2240 kcal/kg) (Venkatesh *et al*., 2015). The leaf has been reported to contain many bioactive constituents such as flavonoid, polyphenol, and 1-deoxynojirimycin (Hassan *et al*., 2020) which are rich in crude protein and are highly digestible. 1-deoxynojirimycin (DNJ) compound is a natural alkaloid and has been found to have a positive activity in primary breast epithelial cell growth of dairy goats (Hassan *et al*., 2020). Guinea grass (*P. maximum*) is one of the most important grasses in the tropics and is highly palatable to ruminant animals (Lawal-Adebowale, 2012) but becomes dry and lignified during the dry season (Adewumi *et al*., 2018).

This study thus evaluates the feed intake and reproductive performance of gravid WAD does-fed guinea grass substitute with mulberry leaves

MATERIALS AND METHODS

Experimental Site: The experiment was carried out at the Sheep and Goat Unit of the Teaching and Research Farm of the Federal University of Technology, Akure, Ondo State, Nigeria. Akure is located at longitude 4.944055ºE and 5.82864ºE, and latitude 7.491780ºN with annual rainfall ranging between 1300 and 1650mm and annual daily temperature ranging between 27ºC and 38º C (Daniel, 2015).

Collection and Preparation of Experimental Diet

Fresh mulberry (*M. alba*) leaves were collected from the Ondo State Ministry of Agriculture Sericulture Centre, Akure while fresh *P. maximum* was sourced from the pasture within the FUTA campus. The experimental concentrate was formulated using dried crushed cassava peel with other feed ingredients such as wheat offal, brewer-dried grains, palm kernel cake (PKC), bone meal, premix and salt. Five diets T_1, T_2, T_3, T_4 and T_5 were made to contain 100 % *P. maximum* (P100M0), 75 % *P. maximum* + 25% *M. alba* (P75M25), 50 % *P. maximum* + 50 % *M. alba* (P50M50), 25 % *P. maximum* + 75 % *M. alba* (P25M75) and 100 % *M. alba* (P0M100) respectively.

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Experimental Layout and Animal Management: Twenty-five (25) pregnant WAD does aged two years and weighing between 10 – 13 kg were used in this study. The goats were randomly distributed into five treatment groups replicated five times with one goat per replicate using the completely randomised experimental design, Experimental diets and water were offered *ad libitum* and the concentrate was given at a constant rate (350 g/day). The goats were synchronised using prostaglandin (PGF2) at 1 Ml/10kg intramuscularly to bring all the animals to oestrous and were then exposed to a proven buck for mating.

Data collection

The reproductive data collection commenced when animals did not return to oestrous. Parameters investigated were; feed intake, weight of doe at mating, before parturition, after parturition (kg), gestation length, weight gain in pregnancy, kid average daily weight gain (g/day), sex ratio, and mortality at birth.

Chemical composition of diets

The feed samples were analysed for their proximate compositions: dry matter (DM), ash, crude protein calculated (N x 6.25), and ether extract (EE) using the methods of AOAC (2012). The neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were analysed according to Hindrichsen *et al*. (2006). Hemicellulose was calculated as NDF – ADF, while cellulose was calculated as ADF – ADL. The experimental diets' gross energy (GE) contents were determined against thermo-chemical grade benzoic acid standard using a bomb calorimeter.

Experimental Design and Statistical Analysis

Data obtained were analysed using one-way analysis of variance (ANOVA) in a completely randomized design using statistical analysis software (SPSS, 2017) and means were separated using the Duncan Multiple Range Test of the same package.

RESULTS

Chemical composition of Diets

The percentage chemical composition of the chemical composition of the *P. maximum* grass, *M. alba* leaves, concentrate and that of the experimental diets is presented in Tables 1 and 2. The crude protein, ether extract and crude fibre of the diets ranged from 9.49 to 25.86%, 3.57 to 7.78% and 9.78 to 25.76% respectively. The dry matter content, ash and neutral detergent fibre ranged between 88.03 and 90.75%, 6.42 and 17.50% and 30.57 to 75.52% respectively. The Diet T_5 having 100 % *M. alba* leaves had the highest crude protein content (25.86%) and gross energy (18.38 KJ/100gDM). Diet T_1 with 0% *M. alba* leaves had the highest crude fibre (25.76%), neutral detergent fibre (75.52%) and acid detergent fibre content of 38.00%. Ether extract and ash contents were highest in the T_2 diet containing 25% substituted *M. alba* diet (7.78% and 17.50% respectively).

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Feed Intake of WAD Does-fed Experimental Diets

The feed intake of gravid WAD does-fed *Panicum maximum* substituted with mulberry leaves is presented in Table 4. There was a significant ($p<0.05$) difference in the total dry matter intake (TDMI) throughout the three trimesters with animals on diet T_3 having the highest values. At early gestation, TDMI ranged from 324.96-356.63g/day, at mid-pregnancy, values were 457.38-488.69g/day while at late gestation, values ranged from 497.07-539.63g/day.

Reproductive Performance of Gravid WAD Does-fed Experimental Diets

The reproductive performance presented in Table 5 shows the mean weight of does at mating which ranged from 10.80-13.67kg with does on diet T_1 having the highest weight of 13.67kg and does on diet T_3 having the least mean weight of 10.80kg. No significant ($P>0.05$) difference was observed between the weight of does at mating. Also, the weight of does at parturition ranged from 18.93-21.80kg. The does on diet T_5 had a superior mean weight of 21.80kg while those on diet T_4 had the least mean weight of 18.93kg. The weight gain during gestation was highest for animals on diet T_5.

DISCUSSION

Chemical composition of Diets

The range of values obtained for dietary crude protein in this study (9.49 – 25.86%) and that of the formulated concentrate (12.38%) were above 8% crude protein required by ruminants for optimum microbial activities in the rumen (Asaolu *et al.*, 2012). The crude protein in this study was also higher than the values of 10 and 14% reported by Abdu *et al*. (2012) and Okafor *et al.* (2012) respectively, for optimum goat production. This implied that the diets were adequate to meet the protein requirement of the ruminant and provided effective rumen function (Ibhaze *et al*., 2016).

P. maximum used in this study contained high NDF and ADF. Feeds with higher NDF (more than 35%) have lower digestibility because NDF generally ferments and passes from the reticulo-rumen more slowly than other dietary constituents leading to a greater filling effect over time than non-fibrous feed components (Beauchemin, 2018). The NDF content of sole mulberry leaf (Diet T_5) was in comparison with the 31.10% reported by Vu *et al.* (2011), whereas, its ADF content was within the 24.7% reported by Habib *et al.* (2016). The dry matter intake by all the goats was high and this may be due to the protein quality and acceptability of the diets. High crude protein enhances dry matter intake and provides rumen-degradable nitrogen for micro-organisms to build their body protein (Ibhaze *et al.*, 2014). The crude protein intake was adequate for all the goats. Crude protein intake increased with an increase in protein quality. High crude protein in the diets has been considered an important factor that enables a high intake of the feed.

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Feed Intake of WAD Does-fed Experimental Diets

The high daily dry matter intake observed here is in agreement with the report of Osakwe and Udeogu (2007). It was observed in this present study that dietary supplementation of *Panicum maximum* and *Morus alba* resulted in higher digestibility of dry matter. The differences in the nature of browse plants and the conditions of the experiment could be responsible for this. This finding was in line with Okoruwa *et al.* (2018) who asserted that there is better efficient utilisation of feed and production outcomes of some browse and forage mixtures than solely browse or forage. The high intake observed in all the animals fed the experimental diets might be attributed to the palatability, higher dry matter intake, crude protein intake and better digestibility of the diets which is to the report of Ibeawuchi *et al*. (2002) who opined that beyond nutritional composition, animals tend to consume more of palatable diets. The mean total dry matter intake (TDMI) of does increased linearly with the advancement of the gestation period which is in agreement with the findings of Rastogi *et al*. (2003). Feed intake trend showed that at mid-pregnancy, animals in all the treatment groups had increased TDMI. This observation could also be due to the increased need for nutrients by the foetus for rapid growth and development at this stage. This report corroborates with that of Ibhaze *et al*. (2016). The increase in TDMI among goats at a later stage of pregnancy is in agreement with the reports of Rastogi *et al.* (2003) and Shalu *et al*. (1995) who attributed the increase to the changes in the fractional passage rate of digesta from the rumen by a decline in mean retention time of particulate matter as gestation progress. However, this contradicts the findings of Ibhaze *et al*. (2016) and Forbes (1995).

Reproductive performance of Gravid WAD Does-fed Experimental Diets

All the does on dietary treatments gained weight during the gestation period which shows that the feed intake and nutritional quality were adequate both for maintenance and production following the report of Ibhaze (2016). However, the mean weight gain during gestation which was highest for does on diet T_3 (50% *Panicum maximum*+ 50% *Morus alba* (P50M50)), could be attributed to higher feed intake while the lowest for those on diet T_1 (100% *Panicum maximum* (P100M0)), could be as a result of lower feed intake by the does. Values obtained show an increase in does' body weight due to pregnancy and not total weight gain. The usual changes in the live weight of dam during gestation are often assumed to be indicative of the prenatal development of the foetus(es) (Amoah *et a*l., 1996 as cited by Rastogi *et al*., (2003). Likewise, it has also been suggested that the live weight of pregnant does during gestation affects the amount of available energy for foetal growth (Issac *et a*l., 1991; Rastogi *et al*., 2003). Therefore, changes in the weight of gravid does can be used to monitor foetal development (Akingbade *et al*., 2001).

A similar observation was reported by Ososanya (2016) for West African dwarf ewe-fed broiler litter. Orr and Treacher (1989), cited by Ososanya (2016) reported that the level of concentrate-feeding during pregnancy significantly affects all aspects of performance. Weight gain in pregnancy observed in this study is higher than the values reported by Okunlola *et al.* (2018) for Red Sokoto goats fed a Baobab fruit meal-based diet but higher than the values obtained by Ibhaze (2016) for WAD goats. Although no significant ($P>0.05$) difference was observed in the kids' birth weight, a higher value (1.92kg) was obtained for kids of does-fed 100% *Morus alba* (P0M100) and least (1.30kg) for those on 100% *Panicum maximum* (P100M0). This observation could have been influenced by the does' weight during pregnancy. These present results agree with the report of Peart (1967), cited by Oderinwale *et al*. (2016) who opined that

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the dam's weight during pregnancy influenced a kid's weight at birth. The birth weights were lower than the 3.16-3.20kg obtained for Kalahari goats by Oderinwale *et al*. (2016) and lower than the values obtained by Okunlola *et al.* (2018) for Red Sokoto goats fed Baobab fruit meal-based diet. This variation might be due to breed differences, the mother's age and birth type (Ince, 2010). The results from the present study on kid weight at birth are higher than the one reported by Ibhaze (2016) for the same WAD goat. It may be pointed out that the least birth weight, weaning weight, and daily weight gain of kids of does on 100% *Panicum maximum* (P100M0) is a reflection of the lower feed intake by the animals. The significant difference ($P<0.05$) in kid weight at weaning and daily weight gain could also be attributed to the sex ratio of kids at birth. *Morus alba* was reported to contain high nutritional values required for good health (Gebrekidan, 2018; Omotoso & Fajemisin, 2020; Trabi *et al.*, 2017).

In this study, more males were produced than females; however, the cause of this observation is difficult to explain. Sex of the kids was another factor accountable for the significant difference ($P<0.05$) in kid weight at weaning and daily weight gain. The heavier weight ($P<0.05$) of the males weaning compared to the females could be associated with the hormonal differences between sexes regarding the anabolic effect of the male hormone (Androgen). Unlike the depressing effect of oestrogen on female animals. Nwakalor and Obochi (2000) reported heavier birth weights for male lambs while Okunlola *et al.* (2018) reported heavier birth weights for male kids for Red Sokoto goats. The heavier weight for males implies that sex effects are pronounced even at birth. The zero mortality rate when *Morus alba* was used to supplement *Panicum maximum* leaves could be attributed to its analgesic and immunostimulant potential of *Morus alba* (Aditya *et al*., 2013; Manda *et al*., 2019). The healthy appearance and stability of the West Africa Dwarf goats fed *Morus alba* leaves supplementation in this study was attributed to the analgesic potential of the experimental diets. In addition to good health management procedures which include proper cleaning and sanitation of the experimental unit and its surroundings, provision of good water and feeding of good quality feed also contributed to zero mortality in this study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

CONCLUSION

From the results of this study, it can be concluded that feeding *M. alba* leaves up to 50% substitution level to WAD goat has no deleterious effect on pregnancy development. There is a need to encourage farmers to plant the *M. alba* plant for improved performance in WAD goats in terms of udder development and reproductive performance as its use as a substitution in the diets of goats is a means of alleviating the adverse effect of poor forage quality during dry season on both the animals and the livestock farmers in Nigeria.

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Table 1. Chemical composition of *Panicum maximum* grass, *Morus alba* leaves and concentrate

Parameters	***Panicum maximum****	***Morus alba****	**Concentrate**
Dry Matter	11.69	11.00	88.99
Crude Protein	8.02	24.46	12.38
Crude Fibre	26.67	8.59	9.91
Ether Extract	3.17	6.01	5.53
Ash	5.96	8.89	8.47
Neutral Free Extract	56.18	52.05	63.71
Neutral Detergent Fibre	75.97	29.92	57.00
Acid Detergent Fibre	36.58	25.08	30.35
Acid Detergent Lignin	25.61	20.33	19.05
Cellulose	10.97	4.75	11.30
Hemicellulose	39.39	4.84	26.65
Organic Matter	82.35	80.11	80.52
Carbohydrate	44.49	41.05	52.70
Gross Energy (KJ/100gDM)	14.26	18.00	13.23

Dry matter of fresh *Panicum maximum and Morus alba

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Table 2. Chemical composition of Experimental Diets fed to Gravid WAD Does

Parameters (%)	DIETS					
	T_1	T_2	T_3	T_4	T_5	±SEM
Dry matter	88.03^{d}	90.75^{a}	89.68^{b}	89.14^{c}	89.18^{c}	0.01
Crude protein	9.49^{e}	12.97^{d}	16.44^{c}	16.55^{b}	25.86^{a}	0.05
Crude fiber	25.76^{a}	20.63^{b}	18.08^{c}	15.09^{d}	9.78^{e}	0.01
Ether extract	3.57^{e}	7.78^{a}	3.85^{d}	5.50^{c}	6.50^{b}	0.05
Ash	6.42^{e}	17.50^{a}	9.67^{c}	7.57^{d}	10.33^{b}	0.01
NFE	54.76^{b}	41.12^{e}	51.96^{c}	55.29^{a}	47.53^{d}	0.01
NDF	75.52^{a}	48.32^{b}	37.93^{c}	35.84^{d}	30.57^{e}	0.01
ADF	38.00^{a}	35.18^{b}	34.36^{c}	32.04^{d}	26.98^{e}	0.01
ADL	28.78^{a}	25.09^{c}	25.16^{b}	23.67^{d}	21.93^{e}	0.01
Hemicellulose	37.52^{a}	13.14^{b}	3.57^{d}	3.80^{c}	3.59^{d}	0.01
Cellulose	9.22^{b}	10.09^{a}	9.20^{b}	8.37^{c}	5.05^{d}	0.01
GE	14.86^{e}	15.00^{d}	15.32^{c}	15.93^{b}	18.38^{a}	0.01

a,b,c,d = means within the same row with different superscripts are significantly (P<0.05) different. ***T_1****=100% Panicum maximum (P100M0),* ***T_2****=75% Panicum maximum + 25% Morus alba (P75M25),* ***T_3****=50% Panicum maximum + 50% Morus alba (P50M50),* ***T_4****=25% Panicum maximum + 75% Morus alba (P25M75),* ***T_5****=100% Morus alba (P0M100); NDF= Neutral detergent fiber; ADF= Acid detergent fiber; ADL= Acid detergent lignin; GE= Gross Energy (KJ/100gDM)*

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Table 4. Feed Intake (g/day) of pregnant WAD Does fed Guinea grass (*Pannicum maximum*) substituted with Mulberry (*Morus alba*) leaves for the three trimesters

Parameters		DIETS					
		A	B	C	D	E	±SEM
Early Pregnancy	FOI	352.06^{d}	363.03^{bc}	373.44^{a}	370.31^{ab}	360.41^{cd}	2.63
	CONI	244.07^{a}	241.16^{ab}	247.08^{a}	232.01^{b}	238.18^{ab}	2.70
	TFI	596.13^{b}	604.19^{b}	620.52^{a}	602.31^{b}	598.59^{b}	4.01
	TDMI	338.45^{b}	331.98^{bc}	356.63^{a}	324.96^{c}	342.57^{b}	2.75
Mid Pregnancy	FOI	604.81^{a}	603.84^{a}	617.80^{a}	609.99^{a}	599.80^{b}	5.09
	CONI	297.59	295.36	294.92	294.62	289.74	4.58
	TFI	902.40^{ab}	899.20^{ab}	912.72^{a}	904.61^{ab}	889.54^{b}	5.35
	TDMI	473.12^{b}	458.06^{c}	488.69^{a}	457.38^{c}	475.21^{b}	2.03
Late Pregnancy	FOI	714.74	728.26	752.38	755.67	738.83	14.28
	CONI	298.19	293.99	296.78	289.94	290.24	4.69
	TFI	1012.93	1022.25	1049.17	1045.60	1029.06	12.73
	TDMI	511.51^{ab}	497.07^{b}	539.63^{a}	499.83^{b}	526.03^{ab}	12.40

abc= means within the same row with different superscripts are significantly different (P < 0.05).

***T₁**=100% Panicum maximum (P100M0), **T₂**=75% Panicum maximum + 25% Morus alba (P75M25),*

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T_3=50% Panicum maximum + 50% Morus alba (P50M50), T_4=25% Panicum maximum + 75% Morus alba (P25M75), T_5=100% Morus alba (P0M100).

Table 5. Reproductive Performance of WAD does fed Guinea grass (*Pannicum maximum*) substituted with Mulberry (*Morus alba*) leaves

Parameters	DIETS					
	A	B	C	D	E	±SEM
WM(kg)	13.67	12.13	10.80	11.20	13.20	1.63
WP (kg)	19.03	19.67	19.47	18.93	21.80	1.47
WAP(kg)	15.07^{b}	16.87^{ab}	17.41^{ab}	16.80^{ab}	19.07^{a}	0.93
GL(days)	143.00	143.33	143.33	143.00	144.67	0.43
WGP(kg)	5.37	7.53	8.67	7.73	8.60	1.36
BWK(kg)	1.30	1.91	1.31	1.70	1.92	0.23
WKW(kg)	3.30^{b}	5.10^{ab}	4.74^{ab}	5.39±^{a}	4.61±^{ab}	0.51
DWGK	35.66^{b}	57.08^{ab}	61.31^{ab}	65.83^{a}	48.10^{ab}	6.64
KMB	1	0	0	0	0	
SR (%)	20:80	60:40	100:0	50:50	100:0	

abc= means within the same row with different superscripts are significantly different (P < 0.05).

T_1=100% Panicum maximum (P100M0), T_2=75% Panicum maximum + 25% Morus alba (P75M25), T_3=50% Panicum maximum + 50% Morus alba (P50M50), T_4=25% Panicum maximum + 75% Morus alba (P25M75), T_5=100% Morus alba (P0M100); P= Parameters; WM= weight at mating; WP= weight at parturition; WAP= weight after parturition GL= gestation length; WGP= weight gain in pregnancy; BWK= birth weight of kid; WKW= weight of kid at weaning; DWGK= daily weight gain of kid 0-8 weeks(g/day); KMB= kid mortality at birth; SR= sex ratio

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