IMPACT OF SUBSTITUTED MULBERRY (*MORUS ALBA*) LEAVES WITH GUINEA GRASS (*PANICUM MAXIMUM*) ON FEED INTAKE, MILK YIELD AND COMPOSITION OF LACTATING WEST AFRICAN DWARF DOES

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ABSTRACT

This study investigated the feed intake, milk yield and milk composition of lactating West African Dwarf (WAD) does fed fresh Panicum maximum which was substituted at five levels (0, 25, 50, 75 and 100 %) with fresh mulberry (Morus alba) leaves and concentrate diet was fed alongside the forages. Twenty-five lactating WAD does were used for the experiment for fifty-six days. The does were divided into five groups of five does per group in a completely randomized design and housed in individual pens. Dry matter (DM) intake, milk yield and feed efficiency (FE) for milk production of the goats were measured. There were significant differences (p<0.05) in feed intake, milk yield and FE of the goats. DM intake increased from 612.44 – 676.85 g/day and milk yield from 204.96 to 454.25 g/day with the inclusion of M. alba in the diet. The feed efficiency was 0.33, 0.57, 0.69, 0.74 and 0.48 for 0, 25, 50, 75 and 100 % M. alba diets respectively. Milk composition was not significantly influenced (p<0.05) by the level of M. alba leaves in the diet. Total solids in milk increased from 16.23 to 17.33 %; protein from 5.94 to 7.36 %; and fat from 4.03 to 4.71 %. In conclusion, supplementation of M. alba leaves in the diet enhanced feed intake and milk production in WAD does.

Keywords: Goat, Feed efficiency, Lactating does, *Panicum maximum, Morus alba*, Milk yield

INTRODUCTION

Goat raising has been seen as equally compensating under both intensive and semi-intensive systems of management (Kumar, 2007). In most situations, goats are however valued for their milk. Goat milk is sweet, nourishing, therapeutic and seen as exceptionally beneficial in consumptive cases (Ojoawo and Akinsoyinu, 2014). Goat milk can substitute cow milk for human consumption as it is more easily digested (Anya and Ozung, 2018) with finer fat particles that are more easily assimilated (Tona *et al*., 2015) by stomach intestinal walls. Generally, milk is an opaque white liquid produced by the mammary glands of mammals (Gonzalo, 2017) and contains essential nutrients necessary for the survival of young ones and promoting good health (Apata and Adewumi, 2011). The increased awareness of the nutritional and health benefits of milk in tropical areas has led to increased demand for milk and its products (Ahamefule *et al*., 2003).

Livestock production depends on the quantity and quality of feed provided to the animal (Kim *et al.,* 2012). One of the limiting factors for ruminant production in the tropics is the inadequate and low quality of feedstuff during the dry season especially in the semi-arid zone of Nigeria (Abdurrahaman *et al*., 2017).

For ruminant animals, grasses and legumes are the main feeds source to balance their nutritional requirements, either for maintenance, production or reproduction (Kim *et al.,* 2012). However, sufficient forage may not be available throughout the year due to low production during the dry season. Thus, providing an alternative feed resource is important for sustainable animal maintenance and milk production. *Panicum maximum* Jacq (Poales: Poaceae) is one of the main forages fed to ruminants during the wet season but becomes dry and lignified during the dry season. Going by animal physiology, pregnancy and lactation are energy demanding stages; it is of necessity to find an alternative to *P. maximum* to forestall energy deficit during the dry season (Adewumi *et al*., 2018). *Morus alba* Linnaeus, 1753 (Rosales: Moraceae) a drought resistant plant leaves has been reported by Benavides *et al*. (2000) and Milera *et al*. (2007) to contain high protein content of about 15 – 35 %, with minerals (2.42 – 4.71 % calcium, 0.23 – 0.97 % phosphorus), metabolizable energy (1,130 – 2,240 kcal/kg) with negligible anti-nutritional factors (Venkatesh *et al*., 2015) and characterized by high digestibility which makes it comparable to commercial concentrates for dairy cattle but there are scanty studies on its effect on milk production in lactating goats. This study evaluates the effect of substituting forage of *P. maximum* with leaves of *M. alba* on feed intake, milk yield and composition of West African Dwarf does.

MATERIALS AND METHODS

Experimental Site, Preparation of Experimental Diets and Feed Formulation: The experiment was carried out at the Goat Unit, Teaching and Research Farm of the Federal University of Technology, Akure, (FUTA). Fresh mulberry (*M. alba*) leaves were collected from 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 from dried crushed cassava peel with other feed ingredients. Five diets (A, B, C, D and E) 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) for Diets A – E respectively.

Experimental Animal, Management and Experimental Design: Twenty-five (25) lactating WAD does age two years and weight of 15.00 – 19.00 kg were used in this study. The goats were randomly distributed into five treatment groups of five goats per replicate using the completely randomized experimental design and each experimental diet was offered *ad libitum* and the concentrate was given at a constant rate (350 g/day). Freshwater was offered a*d libitum.* Daily voluntary feed intake of goats was calculated as the difference between daily feed given and leftover.

Milk Production Study: Milk collection lasted for fifty-six days using twenty-five primiparous WAD does weighing between 15.00 – 19.00 kg. These animals were fed experimental diets containing *P. maximum* supplemented with varying levels of *M. alba*. Milking commenced 7 days post-partum to give kids access to sufficient colostrum. Thereafter, kids were separated from their dams. On the night preceding milk yield recording, kids were separated from their dams for 12 hours overnight (7 p.m. – 7 a.m.) and allowed to suckle for 10 minutes at 7.00 hours daily. Milk intake by kids was estimated using the weigh-suckle-weigh method according to Kouri *et al*. (2019). Animals were hand milked once daily between 7.00 and 8.00 hours. Milk off-take was measured daily using a measuring cylinder and, daily milk yield was estimated as a summation of milk off-take and intake by the kids for 8 weeks (56 days). The milk of each experimental animal was also stored in sterilized sample bottles and then taken to the laboratory for determination of milk proximate composition.

Laboratory Analysis of Diets and Milk Samples

Chemical composition of diets: The proximate compositions of feed samples were assayed for dry matter (DM), ash, crude protein

(CP) and ether extract (EE) according to AOAC (2005). The neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were assayed using the methods of Van Soest *et al*. (1991). Hemicellulose was calculated as NDF – ADF, while cellulose was calculated as ADF – ADL. The gross energy (GE) contents of the experimental diets were determined against thermo-chemical grade benzoic acid standard using a bomb calorimeter.

Proximate composition of milk samples: Milk samples were taken from each treatment group at 8 weeks intervals and analyzed for proximate composition by analyzing for total solids, fat (Gerber method), nitrogen and ash (AOAC, 2005). Milk protein was calculated as percentage protein (N X 6.38), and the percentage solids-not-fat (% SNF) was calculated by differences (% SNF = % TS - % Fat) described by Tona *et al*. (2015). Percentage lactose was determined by Fehling's solution technique described by Triebold (2013).

Statistical Analysis: Data collected were subjected to the one-way analysis of variance (ANOVA) procedure of SPSS (2017). Significant means were separated using Duncan's multiple range test of the same software. Simple correlation analysis was also carried out using SPSS (2017) statistical package.

RESULTS

Chemical Composition of Diets: 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 E having 100% *M. alba* leaves had the highest crude protein content (25.86 %) and gross energy (18.38 KJ/100gDM). Diet A 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 25 % substituted *M. alba* diet (7.78 % and 17.50 % respectively).

Feed Intake and Milk Yield of the Lactating West African Dwarf Does: The feed intake and daily milk yield of lactating WAD does were presented in Table 3. Forage and concentrate intakes for all treatment groups did not vary significantly ($p>0.05$) across the treatments. Total intake ranged from 1286.33 to 1391.73 g/day. The daily milk yield in WAD does vary significantly ($p<0.05$) across dietary treatments from 204.96 to 454.25 g/day. The lowest milk yield was recorded in the animals fed diet without *M. alba* (P100M0) and the highest value in the animals fed diet with 50 % level of *M. alba* (P50M50). Although yield was not significantly different ($p>0.05$) in diets with 25, 50 and 75 % *M. alba* inclusion, but it was higher than that of animals fed diet without *M. alba* (P100M0) inclusion.

The Efficiency of Feed Utilization for Milk Production: The result of the efficiency of feed utilization for milk production is shown in Figure 1. After eight weeks of lactation, the result showed that 75 % *M. alba* inclusion level experimental diet gave the highest efficiency of feed utilization for milk production (0.74). This observed occurrence was closely followed by 50% *M. alba* inclusion level experimental (0.69) diet. Animals fed 0 % *M. alba* diet recorded the lowest (0.33) feed utilization efficiency for milk production.

Milk Composition: The mean composition of milk in lactating WAD does fed *P. maximum* substituted with *M. alba* in the diets after eight weeks is presented in Table 4. Protein content varied from 5.94 to 7.36 % while total solids varied from 16.23 to 17.33 %. The fat content of the milk ranged from 4.03 to 4.71 %. The result showed a numerical difference in all the milk proximate components.

Pearson Correlations among Milk Composition Variables of West African Dwarf Does: As shown in Table 5, there exist significant correlation ($p<0.05$) among milk composition variables of the does.

Table 1: Chemical composition of *Panicum maximum* grass, *Morus alba* leaves and concentrate (g/100g) fed to lactating West African Dwarf goats

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 fibre 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	26.65
Hemicellulose	39.39	4.84	11.30
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*

This indicated that the total solid had a positive and non-significant relationship with protein (r = 0.43), ash (r = 0.73), lactose (r = 0.41) and SNF (r = 0.72), but negative correlations between total solid and fat (r = - 0.94).

DISCUSSION

The proximate composition of *P. maximum* in this study was higher than the values reported by Tona *et al*. (2014) and Jiwuba *et al*. (2018) for the same tropical forage. Also, the proximate composition of *M. alba* leaves in this study was comparable with the value reported by Al-Kirshi *et al*. (2010) and also within the range reported by Simbaya *et al.* (2020) and Sun *et al.* (2020). The crude protein content of *M. alba* leaves obtained in this study was within the range of values obtained by Gebrekidan (2018) and also within the range of 13 – 21 % obtained by Omotoso and Fajemisin (2020) when the same forage was used in feeding growing WAD sheep. Fuglie (1999) attributed these observed variations in the nutrients to the age of cutting or harvesting, climatic conditions, edaphic factors, agronomic practices as well as methods of processing and analysis.

The range of values obtained for dietary crude protein as observed in this study (9.49 – 25.86 %) in the diets 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 sheep and goat production. This implied that the diets were adequate to meet the protein requirement for ruminant and 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 reticulorumen more slowly than other dietary constituents leading to a greater filling effect over time than non-fibrous feed components (Van Soest, 1994). The NDF content of sole mulberry leaf (Diet E) was in comparison with 31.1 % reported by Vu *et al*. (2011), whereas, its ADF content was within the range of 24.7 % reported by Habib *et al*. (2016). The fibre fraction contents of the diets suggested that the diets could be adequate to meet the fibre requirements of the animals for proper rumen function. The value of acid detergent fibre (ADF) content decreased with increased supplementation of *M. alba.* ADF values are inversely related to digestibility, so forages with low ADF concentrations are usually

Table 2: Chemical composition of experimental diets fed to lactating West African Dwarf does

Parameters	Diets (g/100 g)				
	A	B	C	D	E
Dry matter	88.03 ± 0.01^{d}	90.75 ± 0.01^{a}	89.68 ± 0.01^{b}	89.14 ± 0.02^{c}	89.18 ± 0.02^{c}
Crude protein	9.49 ± 0.01^{e}	12.97 ± 0.02^{d}	16.44 ± 0.02^{c}	16.55 ± 0.02^{b}	25.86 ± 0.03^{a}
Crude fibre	25.76 ± 0.01^{a}	20.63 ± 0.01^{b}	18.08 ± 0.01^{c}	15.09 ± 0.01^{d}	9.78 ± 0.01^{e}
Ether extract	3.57 ± 0.01^{e}	7.78 ± 0.01^{a}	3.85 ± 0.01^{d}	5.50 ± 0.12^{c}	6.50 ± 0.12^{b}
Ash	6.42 ± 0.01^{e}	17.50 ± 0.01^{a}	9.67 ± 0.01^{c}	7.57 ± 0.01^{d}	10.33 ± 0.01^{b}
Nitrogen free extract	54.76 ± 0.01^{b}	41.12 ± 0.01^{e}	51.96 ± 0.01^{c}	55.29 ± 0.01^{a}	47.53 ± 0.01^{d}
Neutral detergent fibre	75.52 ± 0.01^{a}	48.32 ± 0.01^{b}	37.93 ± 0.01^{c}	35.84 ± 0.01^{d}	30.57 ± 0.01^{e}
Acid detergent fibre	38.00 ± 0.01^{a}	35.18 ± 0.01^{b}	34.36 ± 0.01^{c}	32.04 ± 0.01^{d}	26.98 ± 0.01^{e}
Acid detergent lignin	28.78 ± 0.01^{a}	25.09 ± 0.01^{c}	25.16 ± 0.01^{b}	23.67 ± 0.01^{d}	21.93 ± 0.01^{e}
Hemicellulose	37.52 ± 0.01^{a}	13.14 ± 0.01^{b}	3.57 ± 0.01^{d}	3.80 ± 0.01^{c}	3.59 ± 0.01^{d}
Cellulose	9.22 ± 0.01^{b}	10.09 ± 0.01^{a}	9.20 ± 0.01^{b}	8.37 ± 0.01^{c}	5.05 ± 0.01^{d}

abcde = Means on the same row with different superscripts are significantly different ($p<0.05$). n = 3, A = 100 % Panicum maximum (P100M0), B = 75 % Panicum maximum + 25 % Morus alba (P75M25), C = 50 % Panicum maximum + 50 % Morus alba (P50M50), D = 25 % Panicum maximum + 75 % Morus alba (P25M75), E = 100 % Morus alba (P0M100)

Table 3: Feed intake and milk yield of lactating West African Dwarf does fed experimental diets

Parameters	Diets				
	A	B	C	D	E
Forage Intake (g/day)	959.16 ± 38.30	1047.25 ± 22.53	970.15 ± 48.64	975.60 ± 10.41	1051.10 ± 31.40
Concentrate Intake (g/day)	327.17 ± 8.36	344.48 ± 3.58	339.24 ± 8.11	337.40 ± 7.35	332.55 ± 5.31
Total Feed Intake (g/day)	1286.33 ± 37.86	1391.73 ± 23.53	1309.39 ± 55.98	1312.99 ± 13.63	1383.64 ± 36.35
Dry Matter Intake (g/day)	621.48 ± 14.06^{b}	645.13 ± 8.53^{ab}	657.16 ± 24.46^{ab}	612.44 ± 7.78^{b}	676.85 ± 15.84^{a}
Average Daily Milk Yield (g/day)	204.96 ± 14.77^{b}	364.94 ± 18.08^{a}	454.25 ± 53.69^{a}	454.13 ± 61.59^{a}	324.52 ± 53.52^{ab}
Crude Protein intake (g/day)	131.53 ± 3.62^{d}	178.48 ± 3.04^{c}	201.49 ± 8.90^{b}	203.23 ± 2.07^{b}	312.98 ± 8.73^{a}

abc = Means on the same row with different superscripts are significantly different ($p<0.05$). n = 3, A = 100 % Panicum maximum (P100M0), B = 75 % Panicum maximum + 25 % Morus alba (P75M25), C = 50 % Panicum maximum + 50 % Morus alba (P50M50), D = 25 % Panicum maximum + 75 % Morus alba (P25M75), E = 100 % Morus alba (P0M100)

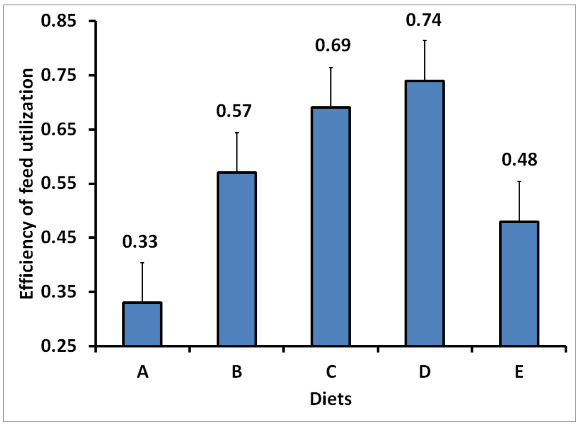

Figure 1: Efficiency of feed utilization for milk production of lactating WAD does fed *Panicum maximum* substituted with *Morus alba*. *Key: A=100% Panicum maximum (P100M0), B = 75 % Panicum maximum + 25 % Morus alba (P75M25), C = 50 % Panicum maximum + 50 % Morus alba (P50M50), D = 25 % Panicum maximum + 75 % Morus alba (P25M75), E = 100 % Morus alba (P0M100)*

higher in energy, hence, the increase in the gross energy of the diets, with increased supplementation of *M. alba.* The obtained gross energy values were favourable compared to the energy values reported by Fajemisin *et al.* (2017).

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 stimulates 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, however; goats fed Diet E had the highest crude protein intake. 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.

The result showed that the range of 204.96 to 454.25 ml daily milk yield by the lactating WAD does obtain in this study was significantly higher than the amount of milk yield in previous research findings (Agbede *et al.*, 1997; Adewumi *et al.*, 2012). This increase can be attributed to the inclusion of *M. alba* forage leaves in the experimental diet which contributed significantly to the lactation performance of the does after eight weeks. The mean daily milk yield (204.96 to 454.25 g/day) obtained for the experimental WAD goats are higher when compared with 185.30 to 340.05 g/day and 40.00 and 205.00 g day-1 obtained by Bawala *et al.* (2006) and Tona *et al.* (2015) for the same breed. Makun *et al.* (2013) observed a huge impact of breed and protein supplementation on milk yield of indigenous goats in Nigeria. Thus the high milk yield of the WAD goats used in this research could be due to the crude protein in the diets of the WAD goats. The goats fed with diets containing 50 and 75 % *M. alba* inclusion levels respectively had the highest daily milk yield due to the high protein content of the diets. Generally, the difference observed in milk yield of does in this study with other researchers could be due to nutritional factors, management system adopted parity and the live weight of the animal.

The efficiency of feed utilization values of 0.33, 0.57, 0.69, 0.74 and 0.48 obtained in this study was lower than the range of 1.29 to 1.40 reported by Okunlola and Olorunnisomo (2016) for Red Sokoto goats. However, the values obtained in this study were higher than the range 0.237, 0.412 and 0.431 reported by Williams *et al.* (2012). The efficient utilization of feed by the lactating does could be attributed to the breed, physiological status of the animals and the quality of the feed offered. This observation was in agreement with the findings of Blake and Custodio (1984) as reported by Williams *et al.* (2012) that feed efficiency for milk production depends on diet, environmental factors and on the genetic ability of the animal to utilize these inputs to produce milk. The mean chemical composition of the raw milk collected from the WAD does indicate that the crude protein range values (5.94 – 7.36 %) obtained in this study were higher than values 4.34 – 4.89 % obtained by Anya and Ozung (2018) for milk of lactating WAD does. The crude protein content of the milk increased with higher levels of *M. alba* in the diet. Ogunbosoye and Babayemi (2010) and Ahamefule *et al.* (2012) also recorded higher milk protein for goats fed browse based diets. This was influenced by the higher protein intake of goats as the level of *M. alba* leaves increased in the diet although the protein content in the milk of does fed diet containing 75 % mulberry supplementation was lower but it is still within

Table 4: Chemical composition of milk of West African Dwarf does fed *Panicum maximum* substituted with *Morus alba* leaves

Parameters	Diets				
	A	B	C	D	E
Protein (%)	6.26 ± 0.90	6.91 ± 0.43	6.87 ± 0.83	5.94 ± 0.85	7.36 ± 1.03
Fat (%)	4.23 ± 0.31	4.03 ± 0.36	4.71 ± 0.31	4.57 ± 0.30	4.36 ± 0.31
Ash (%)	0.98 ± 0.31	0.74 ± 0.23	0.53 ± 0.06	0.53 ± 0.03	0.77 ± 0.24
Lactose (%)	5.90 ± 1.0168	5.23 ± 0.64	4.85 ± 1.38	5.20 ± 0.79	5.08 ± 0.98
SNF (%)	12.76 ± 1.06	12.65 ± 0.81	10.07 ± 1.45	11.66 ± 0.72	12.57 ± 0.83
Total solid (%)	16.99 ± 0.91	17.33 ± 0.90	16.41 ± 1.35	16.23 ± 0.64	16.86 ± 0.75
Gross Energy (MJ/kg)	4.02 ± 0.41	4.18 ± 0.22	3.98 ± 0.28	3.95 ± 0.20	4.01 ± 0.18

abc = Means on the same row with different superscripts are significantly different (p<0.05). n = 3, A = 100 % Panicum maximum (P100M0), B = 75 % Panicum maximum + 25 % Morus alba (P75M25), C = 50 % Panicum maximum + 50 % Morus alba (P50M50), D = 25 % Panicum maximum + 75 % Morus alba (P25M75), E = 100 % Morus alba (P0M100)

Table 5: Pearson correlations among milk composition variables of West African Dwarf does

Parameters	Protein	Fat	Ash	Lactose	SNF	Total solid
Protein	1					
Fat	-0.18	1				
Ash	-0.08	-0.17	1			
Lactose	-0.49	-0.54	0.83	1		
SNF	0.04	-0.86	0.78	0.66	1	
Total solid	0.43	-0.94*	0.73	0.41	0.72	1

**= p<0.05*

the range of protein content in WAD does milk but confirms earlier reports that increasing the crude protein of diets does not necessarily increase the protein content of milk (Sutton, 1981). The variation in the crude protein value obtained in this study compared to others could be as a result of differences in the diet, breed, individual, season, feeding, management, environmental condition, locality, and stage of lactation (Park, 2007). The fat content of goat milk in this study ranged from 4.03 to 4.71%. This was lower than values of 4.44 to 5.49 % reported by Anya and Ozung (2018) for WAD goats. However, the percentage fat content obtained in this study compared favourably with the fat content of 4.72 % reported by Ahamefule *et al*. (2012). The fat content values in this study were higher than those obtained by Odoemelam *et al*. (2013). There is good evidence that in small ruminants about 75 % of the fat in milk arise from dietary fat. Thus, for many feeding systems in the tropics, the level of fat in the diet could be a primary constraint to milk production (Anya and Ozung, 2018).

Total solids constituents which ranged between 16.23 – 17.33 % were lower than the value reported by Adewumi *et al*. (2017) but higher than the values obtained by Odoemelam *et al*. (2013). Butterfat and total solid, like most other milk constituents, are generally influenced by the type of diet of lactating animals Williams *et al*. (2010). The range values of 0.53 – 0.98 % of the milk ash obtained in this study compared favourably with the values of 0.80 – 0.90 % reported by Okunlola and Olorunnisomo (2016).

The values obtained for SNF in this study were lower than 13.16 % reported by Ahamefule *et al*. (2012) but considerably higher than the values reported by Olaniyi *et al*. (2018). Odoemelam *et al.* (2013) reported that the higher the SNF in the milk, the higher the buffer value of the milk and therefore the better its keeping quality. The difference in dietary plans and composition has been reported to be responsible for variations in the milk yield and compositions observed within the same breed Williams *et al*. (2010). Meanwhile, the mean milk energy value (3.95 – 4.18 MJ/Kg) obtained in this study was higher than (1.73 – 2.17 MJ/Kg) values reported by Odoemelam *et al*. (2013) and Anya and Ozung (2018), but favourably compared with 3.93 – 4.21 MJ/Kg reported by Ukpabi (2007) for lactating WAD does.

The total solid of milk had a positive but not significant relationship with protein, ash, lactose and SNF. This indicated that these constituents depend on each other, thus selection in one of these traits may lead to an increase in the other. It was observed that protein had a negative and non-significant relationship with ash, lactose and fat which indicates that as the protein increases, the ash, lactose and fat decrease, but SNF had a positive relationship with protein. It also indicated that as ash increases, the lactose and fat increase, but SNF decrease. This was in disagreement with the report of Malau-Adali *et al*. (2001). The negative correlation between protein, ash, lactose and fat indicates an unfavourable relationship whereby selection for an increase in protein content of milk may lead to a decrease in ash, lactose and fat of the milk.

Conclusion: The results of the study suggest that the supplementation of the *M. alba* forage leaves in the experimental diets had a positive effect on goat production in terms of milk yield as well as milk composition. There is a need to encourage farmers to plant *the M. alba* plant for improved lactation performance in WAD goats.

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