MILK YIELD, TOTAL SOLIDS AND BLOOD INDICES OF RED SOKOTO GOATS FED DIETS CONTAINING DRIED TIGERNUT (*Cyperus esculentus L.*)

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Abstract
The influence of diets containing graded levels of tiger nut *(Cyperus esculentus L)* on milk yield, milk total solids and blood indices of Red Sokoto goats were evaluated in this study. Four does in their mid-lactation stage were fed diets (A, B. C, D) containing 0, 10, 20 and 30% tiger nut (TGN) in a 4x4 Latin Square arrangement. Daily feed intake and milk yield were measured. Milk samples were also analyzed for total solids (%). Haematological profile and blood biochemical contents were evaluated. Data obtained was subjected to analysis of variance and means separated using Duncan's Multiple Range Test. The results showed that feed intake and milk yield of goats that were fed 10% and 20% tiger nut diets were higher ($P<0.05$) than those fed 0% and 30% tiger nut diets ($P<0.05$). Total solids (%) of milk was not influenced by tiger nut diets ($P>0.05$). Hematological profile was similar across the diets ($P>0.05$) except for total serum protein content which was higher in goats fed diets B and C and the serum albumin which was higher in those fed diet C ($P<0.05$). Feeding diets containing 30% tiger nut (diet D) resulted in significantly reduced serum cholesterol level ($P<0.05$). It was concluded that up to 20% tiger nut level can be included in the diet of lactating animals to improve milk yield and quality.

Keywords: Milk yield, Total solids, Blood indices, Red Sokoto goats, Tigernut

Introduction

The importance of milk in human nutrition cannot be over-emphasized as it provides proteins and other metabolites needed for growth, maintenance and repair of body tissues, reproduction, supply of energy and appetite satisfaction. As an animal product, milk is normally obtained from ruminant animals which include cattle, horses, buffalo, camels, sheep and goats; the dairy cow being the major milk producer. In some parts of the world however, goats serve as valuable animal for milk production. For instance, it has been reported that countries such as Libya and Iraq obtain half their total milk requirements from goats (Butswat *et al*., 2002). Presently, importance of goats as a source of milk has attracted global interest. Campbell *et al* (2003) postulated that goat milk industry will thrive and expand globally in the 21st century. In Nigeria, goats are rarely kept for milk production. The little data available on milk production from goats are largely from empirical research studies. Domestic milk supply is mainly obtained from indigenous cattle breeds kept primarily by pastoral and agro-pastoral Fulani cattle rearers. In this case, the amount of milk produced is too low when compared to the demand for milk and milk products. Moreover, organized dairy farms which consist of a few privately owned commercially oriented farms and experimental milk production farms operated by government agencies that utilize few imported breeds of cattle contribute little to domestic milk supply (Yahuza, 2001). These have resulted in high importation of dairy products every year. Since goats' population is high in Nigeria, using them as alternative source of milk will reduce excessive importation of dairy products and help the poor masses obtain milk at a cheaper rate since the prices of dairy products have skyrocketed in recent times.

Research studies carried out to investigate the milk production characteristics of most common local goat breeds revealed the Red Sokoto goat as a potential dairy goat (Akpan *et al*., 2002; Butswat *et al*., 2002; James and Osinowo, 2004; Zahradden *et al*., 2009). It was suggested that the breed can be selected to form the nucleus of dairy goat development in Nigeria (Butswat *et al*., 2002; Ochepo amd Mommoh, 2010). However, a major factor that can limit its dairy performance is inadequate nutrition. In arid and semi-arid regions where the Red Sokoto goat is found, intensive system of livestock production is rarely adopted. The goats depend only on available pasture and crop residues for their feed. But, high milk production is normally achieved by feeding dairy animals high quality feedstuffs. In dairy goat feeding, high concentrate-low forage diets have been used to improve milk yield without adverse effect on the content of milk (Min *et al*., 2005). Dietary fat sources have also been incorporated in the diets of lactating goats to increase the energy density of feeds or improve milk quality (Chillard *et al*., 2003; Kouakou *et al*., 2009; Pulina *et al*., 2008). Pigeon pea-cassava peel based diets have also been used in studies

involving lactating goats (Ahamefula and Ibeawuchi, 2005).

Tiger nut (*Cyperus esculentus*) is one of the two major species of the nutsedge found as weed in the tropics and subtropics and has been grown in Florida in the past as livestock feed (Mason, 2010). It belongs to the group of plants known as Magnoliophyta, class Liliopsida, Order – Cyperale and Family Cyperaceae (The Columbia Electronic Encyclopedia, 2004). *Cyperus esculentus* is a good source of dietary fiber, carbohydrate, fat and minerals especially phosphorus, potassium and vitamins C and E (Ekeanyanwu and Ononogbu, 2009; Ekeanyanwu, 2010). It has a high content of soluble glucose, about 21% (Mason, 2010). It can be eaten raw, used as hog feed or pressed for its juice to make a beverage (The Columbia Electronic Encyclopedia, 2004). Belewu *et al*. (2007) reported higher weight gain and feed efficiency when tiger nut meal was used to substitute wheat offal at 0, 10 and 20 percent levels in the diets of West African Dwarf (WAD) goats. Also, better carcass yield was reported when it was used to replace 33.3% maize in the diets of cockerel (Bamigbose *et al*., 2003). There is paucity of information on its utilization in the diet of lactating animals hence this study.

Materials and Methods

The study was carried out at the Livestock Unit of the Teaching and Research farm, Michael Okpara University of Agriculture Umudike (MOAU) as a collaborative work between the Department of Animal Science and Technology, FUTO and that of MOAU. Umudike is located at about eight kilometers from Umuahia, the Abia State capital and lies on latitudes 5°28[1] north, longitude 7° 32[1] east and at an altitude of 122m above sea level. It is situated in the tropical rain forest zone, which is characterized by an annual rainfall of about 2177mm**.**The relative humidity ranges from 50 to 95%. Average monthly ambient temperature is 26°C with maximum and minimum of 32°C and 22°C, respectively (Ahamefule *et al*., 2004).

Dry tiger nut tubers were purchased from vendors in Owerri main market. The tubers were sorted, milled and sundried for three days to improve the keeping quality. The basal feed was formulated with cassava peels, brewer's dried grains, palm kernel cake, molasses, bone meal and common salt. Cassava peels were collected from garri processing sites and sundried for a period of 6-8 days. The sundried peels were milled and stored in sacks before incorporation into the basal ration**.** The other feed ingredients were obtained from reputable feed vendors in Owerri and Umuahia. The tiger nut meal was used to replace cassava peel at 10, 20 and 30% (w/w) in diets, B, C and D while diet A (control) had no tiger nut meal. Other feed ingredients were of fixed proportion. The ingredient composition of the experimental diets is shown in Table 1. The proximate compositions were determined according to AOAC (2000) procedure.

Table 1: Ingredients composition of experimental diets containing tiger nut meal

Ingredients (%)	A	B	C	D
Tiger nut meal	0.00	10.00	20.00	30.00
Dried cassava peel meal	30.00	20.00	10.00	0.00
Brewers' Dried grains	34.00	34.00	34.00	34.00
Palm kernel cake	30.00	30.00	30.00	30.00
Molasses	3.00	3.00	3.00	3.00
Bone meal	2.00	2.00	2.00	2.00
Common salt	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00

Four Red Sokoto does in mid-lactation averaging 20 kg body weight were selected from among the flock reared in the MOAU Farm and used for the experiment. The animals were managed intensively in separate pens. The does were assigned to four dietary treatments in a 4 x 4 Latin Square arrangement. An average of 800g of the treatment diets were offered to each doe. Each animal received one of the diets for 14 days. The first 7 days was allowed for adjustment to the feed, whilst data collection was carried out during the second 7 days. Thereafter the next ration in the sequence was introduced. Water was provided liberally. Feed intake was determined as the difference between daily feed offered and refusal.

Milk sampling, measurement and analysis

Each animal was hand-milked once daily in the morning hours between 6.30 and 7.30am. The volume of milk harvested was measured using a graduated 100 ml capacity glass cylinder and then weighed to the nearest gram on an electronic laboratory scale (Citizen Electronic Weighing Balance). Prior to each day's milking, kids were separated from their dams on the evening preceding the day of milking and returned in the morning after milking. Samples from the daily milk yield for each doe was analyzed three times per week for lactose content before being bulked and stored in a refrigerator (-5°c) until required for analysis. The milk samples were analyzed for total solids (TS). A known weight of milk sample was weighed into a clean dried moisture can and placed on a water bath for moisture evaporation. This was transferred into an electric oven at 105°C and allowed to dry. The dry sample

was removed and placed in a dessicator to cool, and then weighed again. The process was continued until a constant dry weight was reached. The TS content was calculated and expressed as percentage of fresh milk.

Blood collection and analysis

Blood samples were collected from the jugular vein of the experimental animals with syringes and needles at the end of each period. Blood samples were placed in ethylene diamine tetra-acetic acid (EDTA) containing bottles for haematological analysis. Other samples were placed in bottles without anticoagulant for biochemical analysis. Blood samples were analyzed for haemoglobin (Hb), red blood cells (RBC), white blood cells (WBC), packed cell volume (PCV), glucose, total protein, albumin, urea, creatinine, cholesterol and total bilirubin. Mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated. Haematological parameters were analyzed with the procedures described by Seiverd (1975). The biochemical indices: glucose, total protein, albumin, urea, creatinine, cholesterol and total bilirubin were determined using the RANDOX KITS (Randox, 2009). The data obtained were subjected to analysis of variance (ANOVA) and differences between means were established using Duncan's Multiple Range Test as outlined in Obi (1990). Analysis was carried out using SPSS statistical software (SPSS, 2008).

Results and Discussion

The proximate composition of tigernut and the experimental diets were shown in Tables 2 and 3. The values obtained for crude protein, crude fibre and ash contents of tigernut in this study are comparable to the values reported by Ekeanyanwu and Ononogbo (2009). However, the fat content (21.5%) reported here is lower than 24.3% recorded by these authors. The crude protein content of the experimented diets (11.20 - 12.17%) is within the range of 9 - 14% recommended for goats (Aduku, 1993). The energy contents of the diets are comparable, ranging from 2290 Kcal/kg in diet A to 2330 Kcal/kg in diet C. Increase in tiger nut meal level increased the crude protein and crude fibre contents of the experiment diets. This is similar to the report of Belewu *et al.* (2007) which showed increase in crude protein and crude fibre contents of diets as the level of tiger nut increased in the diets. Also, there was an increase in the ether extracts of the diets as tigernut level increased. This, however, not in line with the report of the same authors which showed a decrease in ether extract of diets as the level of tiger nut increased.

Table 2: Proximate composition of dried tigernut

Nutrient	Content (%)
Moisture content	10.20
Crude protein	6.94
Crude fibre	23.43
Ether extract	21.50
Ash	2.19
NFE	35.74
Energy (ME, Kcal/kg)	3550

Table 3: Proximate composition of experimental diets containing tigernut meal

Parameters	A	B	C	D
Dry matter	88.14	86.31	88.26	87.29
Crude protein	11.20	11.54	12.01	12.17
Crude fibre	21.20	24.10	27.50	29.25
Ether extract	3.01	4.47	6.63	7.79
Ash	10.87	8.02	8.75	8.55
NFE	41.86	38.18	33.37	29.53
Energy (ME, kcal/kg)	2290	2300	2330	2300

NFE = nitrogen free extract. Energy calculated as in MAFF (1977)

The feed intake, milk yield and milk constituents of the experimental goats are summarized in Table 4. Both the average daily feed intake (g/d) and feed intake on metabolic weight basis (Wkg $^{0.75}$) were significantly higher ($P<0.05$) for diets B and C than in diets A and D. Average milk yield (g/day) increased in tigernut-containing diets. However, the average milk yield (g/d) obtained from goats fed the 30% tigernut diet was similar to that of goats fed the control diet; but lower than those fed diets with 10% and 20% tigernut diets ($P<0.05$). Results indicate that diets B and C which were consumed more than the other diets promoted higher milk yields. The low milk yield, ranging from 48.74-67.05 (g/d) obtained in this study

may be due to once a-day milking practiced. Earlier observations (Steele, 1996; Winters, 1997) revealed that milk yields are higher when animals are milked twice or thrice a day. Also the present results were obtained with does in their mid-lactation. Studies with Red Sokoto goats showed that high milk yields were obtained in early lactation (Butswat *et al.,* 2002; Zahraddeen *et al.,* 2009). The total solids of milk ranged from 14.89% in diet B to 16.38% in diet D. The values obtained for diets A, C and D are comparable to the values of 15.85% recorded for Red Sokoto goats elsewhere (Mba *et al.,* 1975) but higher than the value of 15.37% recorded by Malau- Aduli and Anlade (2002). Although the total solids value of the 10% tigernut diet was numerically lower than the other diets, differences in total solids were not significant (P>0.05) across the dietary treatments.

Table 4: Intake, milk yield and milk total solids of goats fed diets containing tigernut

Parameter	A	B	C	D	SEM
Feed intake (g/d)	497.68^{b}	609.64^{a}	593.93^{a}	456.43^{b}	31.78
Feed intake($Wkg^{0.75}$)	104.34^{b}	122.48^{a}	120.28^{a}	98.20^{b}	5.09
Milk yield (g/d)	48.74^{b}	66.51^{a}	67.05^{a}	51.10^{b}	5.04
Total solids (%)	15.70	14.89	15.77	16.38	0.61

^{ab} means on the same row with the same superscripts are not significantly different (P>0.05), SEM: standard error of mean.

Effect of tigernut diets on blood parameters

The effect of tigernut on haematological and biochemical parameters of blood are shown in Table 5. There were no significant differences among the diets on hematological parameters (P>0.05). However, serum total protein, albumin and blood cholesterol levels were influenced by diets (P<0.05). The values for haemoglobin and red blood cells ranged from 8.17- 8.41 g/dl and 9.58 ($x10^3$/ml) respectively. These values are within the normal range (8.0 - 12 g/dl) for Hb and (8.0- 18.0 ($x10^6$/ml)) for RBC recorded for goats (Administrator, 2009). White blood cell values decreased slightly across the dietary treatments, whilst the packed cell volume (PCV) values were lower than the normal range (22-28%) for goats (Administrator, 2009). Reduction in PCV values have been observed in lactating goats and cows (Mbassa and Poulsen, 2002; Radostitis *et al.,* 2000). The range for MCV was 21.31-22.65(fl) while the MCH and MCHC range of values were 8.59-9.29(pg) and 39.35-41.49% respectively. The mean MCHC value of 40.64% obtained in this study is less than 44.7+ 8.2% reported by Tambuwal *et al.* (2002) for Red Sokoto goats.

Serum total protein was lowest for animals on the control diet but highest for those on 10% and 20% tigernut diets (P<0.05). It decreased slightly for the animals on 30% tigernut diet. This could be as a result of lower absorption of protein in diet due to reduced feed intake (Eggum, 1970). The mean values for total protein obtained in this study: 6.96g/dl, 7.56g/dl, 7.44g/dl for diets A, B, C and D respectively are comparable to the values of 71.19+ 0.89g/L recorded for lactating goats in Khaled *et al* (1999). Serum albumin was significantly higher (P<0.05) in goats fed diets A and B than in diet C or D. However, the range of serum albumin reported in this study is within normal range stated by Administrator (2009) for goats.

Table 5: Haematological and biochemical profile of lactating goats fed tigernut diets

Parameter	A	B	C	D	SEM
Haemoglobin (g/dl)	8.18	8.17	8.41	8.26	0.14
Red Blood Cell ($x10^6$/ml)	9.58	9.29	9.39	9.00	0.25
Leucocytes ($x10^3$/ml)	7.38	7.34	7.31	7.27	0.13
Packed Cell Volume (%)	20.30	20.73	20.08	20.13	0.34
Mean Corpuscular Volume (fL)	21.31	22.54	21.60	22.65	0.65
Mean Corpuscular Haemoglobin (pg)	8.59	8.88	9.05	9.29	0.27
MCHC (%)	40.50	39.35	41.49	41.21	0.82
Total protein (g/dl)	6.96^{b}	7.56^{a}	7.44^{a}	7.29^{ab}	0.13
Albumin(g/dl)	3.15^{a}	3.06^{a}	2.65^{b}	2.91^{ab}	0.12
Glucose(mg/dl)	47.50	47.75	47.83	47.63	0.34
Urea(mg/dl)	8.80	8.50	8.94	8.50	0.41
Creatinine (mg/dl)	0.84	0.81	0.73	0.81	0.04

Cholesterol (mg/dl)	70.13[a]	71.38[a]	70.45[a]	67.73[b]	0.85
Total bilirubin (mg/dl)	0.06	0.11	0.10	0.07	0.02

[ab] means on the same row with the same superscripts are not significantly different (P>0.05).
MCHC - Mean corpuscular haemoglobin concentration

There were no significant differences in blood glucose values across the dietary treatments (P>0.05). It was however observed that diets B and C which produced higher milk yields and a similar trend for blood glucose level was observed. There were no significant differences in the values of blood urea and creatinine among the dietary treatments (P>0.05). The low values obtained for both parameters indicate that the diets were of good protein quality (Eggum, 1970). The blood cholesterol values of 70.13mg/dl; 71 38mg/dl and 70.45mg/dl obtained in goats fed diets A, B and C were similar but significantly higher (P<0.05) than 67.73 mg/dl obtained with diet D. The low level of blood cholesterol obtained with diet D could be as a result of high fibre content of the diet due to increased level of tigernut inclusion. Previous reports (Belewu and Belewu, 2007; Ekeanyanwu, 2010; Idowu *et al*, 2002) showed that high fibre intake causes a reduction in blood cholesterol level.

Conclusion

The results of this study have shown that up to 20% level of tigernut can be included in the diet of lactating does to improve milk production without adverse effect on the health of the animals. Further studies should be directed towards investigation of milk production of does fed diets containing tigernut in late lactation. Also, there is need for extensive laboratory analysis in order to acquire more information on fatty acid profile, mineral and vitamin contents of milk of lactating animals fed tigernut diets.

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