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Nutritional quality of ensiled gamba grass (*Andropogon gayanus*) fortified with graded levels of Centro (*Centrosema pascourum*)

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Abstract

The study was conducted with the field grown gamba grass (Andropogon gayanus) and Centro (Centrosema pascourum) to examine the nutritional quality of gamba grass ensiled with graded levels of Centrosema pascourum. The forages were harvested separately chopped into 2-3cm length manually and mixed thoroughly as follows: (100:0, 90:10, 80:20,70:30, 60:40, 50:50 and 40:60% of Andropogon gayanus: Centrosema pascourum, respectively) and designated as T_1, T_2, T_3, T_4, T_5, T_6 and T_7 respectively. The treatments were ensiled in a laboratory using bottle silos in triplicates per treatments and kept for 30 days fermentation period. The silages were evaluated for quality characteristics, proximate composition, fibre fractions, volatile fatty acids composition and ammonia nitrogen concentration (NH_3-N) using standard procedure. The results obtained showed that the silages were adequately fermented with pleasant and fruity odour, greenish-yellow colour, firm and dry texture. The pH, ether extract (EE), nitrogen free extract (NFE), organic matter (OM) and Ash contents of the silages were similar across the treatments ($P<0.05$). However, the crude protein (CP) contents of silages (9.44-14.88%), varied significantly ($P<0.05$) across the treatments. The crude fibre (CF), cellulose, hemicellulose and fibre fractions (neutral detergent fibre (NDF) and acid detergent fibre (ADF) of the silages differed significantly ($P<0.05$) except for acid detergent lignin (ADL) which was similar across the treatments. Other parameters such as volatile fatty acids (VFAs), NH_3 concentration, temperature (^0C) and dry matter (DM) moisture content (MC) differed significantly across the board. The results of this study indicated that ensiled Andropogon gayanus with Centrosema pascourum at varied levels of inclusion improved physico chemical properties of the silages. The inclusion of Centrosema pascourum legume forage also improved the crude protein (CP) contents of ensiled gamba grass significantly. Thus, the study recommends the use of 60% Andropogon gayanus and 40% Centrosema pascourum, which is practicable and obtainable.

Keywords: Andropogon, Centrosema pascourum, Volatile fatty acids, Fermentation, Silage.

Introduction

Over the past four decades, the forage feed has received major focus across the tropics as a means of improving ruminant production and this was favoured by the discovery of many new forages species which offered required flexibility of growth in diverse agro-climatic condition. In the northern part of Nigeria where the grazing season is limited and pasture production fluctuates widely, silage making offers a means of improving the utilisation of pastures. As reported by Cowan *et al.* (1993) forage growth on tropical and subtropical perennial pastures often exceeds the feed requirements of dairy herds during summer and early autumn. This author estimated that the level of utilisation of available pasture was 30-50% leading to considerable wastage. Ensiling has been suggested as the preferred conservation option as climate condition during when surplus exist are considered unsuitable for hay making due to prevailing weather condition. Given the generally poor preservation of tropical pastures as silage, various compounds such as formaldehyde and acids have been used as additives in making silages from grasses (Thompson *et al.,* 1981). Silage can be defined as any plant material that has undergone fermentation or "pickling" in a silo and a silo is any storage structure in which green, moist forage is preserved (Stewart, 2011). The primary goals of making silage is to maximize the preservation of original nutrients in the forage crop for feeding of livestock at a later date in livestock feeding programs (Stewart, 2011). Silage production is one of the methods of storage conservation practiced in livestock production systems, although it is not a common practice among the livestock producers in Nigeria (Kallah *et al.,* 1997). Silage has been reported as a viable option for preservation of surplus forage during the growing season when yield and nutritional values are optimal. Silage can be used at any period of the season when it is required especially during the period of scarcity (Koon, 1993). Increasing trends of intensification of livestock production in Nigeria suggest the need for the development of feed conservation strategies which allows for stock-pilling fodders at the time of its abundance for use at the time of its shortage period (dry season). This redistributes the feed supply over the year to meet the requirements of livestock resources as reported by Muhammed *et al.* (2009). The addition of legume to grass forage during feeding increases productivity, profitability and also ensures long – term sustainability of livestock production system in tropics (Charmley, 2000). The current trend is, most of the grasses and cereal stovers used as silage materials are mainly energy value. This cannot meet the animal requirements, thereby resulting in loss of weight. The inclusion of legumes, therefore, is one of the methods that can be used to improve the protein content of grass silage. It is against this background, that this study was carried out to examine the nutritional quality of ensiled *Andropogon gayanus* (gamba grass) fortified with graded levels of *Centrosema pascourum* (Centro).

Materials and methods

Experimental site

The study was conducted at National Animal Production Research Institute experimental farm at Shika Zaria Kaduna State located within the grid (11^0-11^0 13^1 N, $6^0 55^1 7^0 33$ ^{1}E,) in the sub-humid zone of Nigeria, mean annual rainfall varies from 700-1300mm with a long term of 1050mm. Approximately 95% of the rainfall occurs during May to October. The highest mean maximum temperature of $36^0{}_C$ is recorded in April while the lowest mean minimum temperature of about $11.5^o{}_C$ occurs in December to January as reported by (Kowal and Knabe, 1972).

Harvesting and silage production

The forages were harvested in established pasture unit of Teaching and Research farm of National Animal Production Research Institute at Shika Zaria, Kaduna State. The *Andropogon gayanus* (northern gamba grass) was harvested at full inflorescence stage, while *Centrosema pascourum* (centro) was harvested at flowering to early podding stage on 10^{th} October 2018. Intact whole plants were harvested at 5cm above ground level using sickle. The forage materials (Gamba grass and centro) were chopped separately into smaller pieces of about 2-3cm length (for easy compaction, consolidation and good fermentation) with cutlass. The materials were wilted on a concrete floor under shade for 12hours to reduce the moisture content for good fermentation. Thereafter forages were mixed thoroughly, weighed and divided into equal portions of 500g each. The silage was divided into seven treatments to obtain the following silages: T_1 = 100% sole Gamba grass, ensiled without *Centrosema pascourum*, T_2 = 90% Gamba grass ensiled with 10% *C. pascourum,* T_3 = 80% Gamba grass ensiled with 20% *C. pascourum,* T_4 = 70% Gamba grass ensiled with 30% *C. pascourum,* T_5 = 60% Gamba grass ensiled with 40% *C. pascourum,* T_6 = 50% Gamba grass ensiled with 50% *C. pascourum* and T_7 = 40% Gamba grass ensiled with 60% *C. pascourum.* The control forage was ensiled without legume forage. All were replicated three times in a completely randomised design. Fermentation period was 30 days as reported by Babayemi (2009) and Amuda *et al*. (2017).

Experimental silos

Each of the treatments was ensiled in Bama labelled bottles, each capable of holding a 500g of wilted mixture of Gamba grass (*Andropogon gayanus*) and *Centrosema pascourum.* The Bama bottles were used as silos. Ensiling was done by rapid compaction of the material (to eliminate air) into the silos. The bottles (silos) were covered tightly and firmly. Sealing of the silos was done by tapped up the bottle's cover to ensure anaerobic condition for good fermentation. Each of the treatments combination was compressed and ensiled on the same day. The jars/bama bottles were stored at ambient temperature (25^0C-27^0C) for 30 days in order to provide condition and environment suitable for microbial fermentation.

Silage quality determination

Following the 30 days fermentation period, each glass jar/bottle was opened and the contents were visually examined for color, texture, pH, temperature and odour was recorded by four independence scorer, to avoid the bias of a single man assessor since the attribute to access are on normal scale, each assessor recorded his observations and submitted them for final collection which was based on the frequency and consistency of observation. Laboratory thermometer was inserted into the silage, immediately it was opened for 3 minutes and temperature was taken. The pH content of the silages were determined by taking 25g of the sample from each treatment, mixing it with 100ml of distilled water in the beaker and leaving to stand for one hour. It was then agitated for about two minutes before inserting a calibrated pH meter glass electrode into the mixture for 3 to 5 seconds and pH was determined according to Babayemi (2009), Amuda and Nuhu (2019). Furthermore, sub-samples were taking from the prepared silages and oven dried at 65^oC for 48 hours for chemical analysis.

Chemical and statistical analysis

The samples were ground in the laboratory with hammer mill of 1mm sieve and subjected to chemical analysis in triplicate for determination of dry matter, crude protein, crude fibre, ether extract, organic matter, and nitrogen free extract as described by AOAC (2005). Ammonia nitrogen was determined according to Weatherburn (1967) while volatile fatty acids (VFA) were determined as described by Bhatt *et al*. (2014), Neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were assayed by the method of Van Soest *et al*. (1991). Hemicellulose was calculated as the difference between NDF and ADF and cellulose as the difference between ADL and ADF (Rinne *et al*., 1997) while neutral detergent soluble (NDS) was determined according to Bhatt *et al.* (2014). Data obtained were subjected to one-way analysis of variance (ANOVA) using SPSS (Version 23.0.2018). The treatments means were compared using the Duncan's Multiple Range Test (Duncan, 1955)

Results and discussion

Physical characteristics of the silage

Presented in Table 1 are the physical characteristics of the silage as reflected in terms of colour, texture, odour and mouldness. All the ensiled materials exhibited similar properties in terms of colour, odour, texture and mouldness. The ensiled *Andropogon gayanus* with graded levels of *Centrosema pascourum* was characterised by greenish-yellow colour, pleasant and fruity odour, firm and dry in texture and not mouldy. The physical characteristics of silage types indicated that the forages are well-preserved. Good silage must retain its original colour as (Amuda and Tsekaa, 2019). The greenish–yellow colour obtained in this study suggests that the silage is well preserved. The pleasant and fruity odour, firm and dry texture couple with absent of mould in the silage suggests that the silage is well preserved and lactic acid producing bacteria dominated fermentation process (Kung and Shaver, 2002; Amuda and Tsekaa, 2019).

Table 1: Physical characteristics of ensiled *Andropogon gayanus* with graded Levels of *Centrosema pascourum*

		Parameters		
Silage Type	**Colour**	**Texture**	**Odour**	**Mouldness**
T_1	Greenish-yellow	Firm and Dry	Pleasant and Fruity	Not Mouldy
T_2	Greenish-yellow	Firm and Dry	Pleasant and Fruity	Not Mouldy
T_3	Greenish-yellow	Firm and Dry	PleasanRt and Fruity	Not Mouldy
T_4	Greenish-yellow	Firm and Dry	Pleasant and Fruity	Not Mouldy
T_5	Greenish-yellow	Firm and Dry	Pleasant and Fruity	Not Mouldy
T_6	Greenish-yellow	Firm and Dry	Pleasant and Fruity	Not Mouldy
T_7	Greenish-yellow	Firm and Dry	Pleasant and Fruity	Not Mouldy

T_1=*Andropogon gayanus* only, T_2 = 90% *Andropogon gayanus* + *10%Centrosema pascourum*, T_3 = 80%*Andropogon gayanus* + 20% *Centrosema pascourum*, T_4 = 70% *Andropogon gayanus* + 30% *Centrosema pascourum,* T_5 = 60% *Andropogon gayanus* + 40% *Centrosema pascourum*, T_6 = 50% *Andropogon gayanus* + 50% *Centrosema pascourum*, T_7 = 40% *Andropogon gayanus* + 60% *Centrosema pascourum*

The quality characteristics (pH, NH_3-N concentration, temperature (^{0}C), moisture content (MC %) and dry matter (DM %)) of ensiled *A. gayanus* fortified with grade levels of *C. pascourum* is showed in Table 2. The pH values ranged from 3.75 in treatment 5 (60% *A. gayanus* + 40% *C. pascourum*) to 4.02 in treatment 2 (90% *A. gayanus* + 10% *C. pascourum*) and similar across the treatments. However, ammonia nitrogen concentration (NH_3-N), temperature (^{o}C), moisture content (MC %) and dry matter (DM %) varied significantly ($P<0.05$) across the treatments. The values ranged from 8.83% in T_1 (100% *A. gayanus)* to 11.57% in T_6 (50% *A. gayanus* + 50% *C. pascourum)*. The temperature, percentage moisture content (MC %) and DM of the ensiled materials ranged from 24.02-25.70^{o}C, 66.17-70.07% and 29.95–34.02% respectively. The highest (25.70^{o}C) and the least (24.02^{o}C) temperature were observed in T_1 (100% *A. gayanus*) and T_5 (60% *A. gayanus* + 40% *C. pascourum)*. The dry matter content of the silages was significantly ($P<0.05$) highest (34.02%) in T_2 (90% *A. gayanus* + 10% *C. pascourum)* and lowest (29.95%) in T_7 (40% *A. gayanus* + 60% *C. pascourum*). The pH value is one of the simplest and quickest ways of evaluating silage quality; the lower the pH, the better the preserved and more stable is the silage. Silage that is properly fermented will have a much lower pH (more acidic to slightly acidic) than the original forage. The low pH range value (3.75 – 4.02) obtained in this work indicates that the silage is stable. This further justified the absence of mould growth on surface of the silage. The pH value of good silage below 4.1 has been considered as an index of good quality (Harrison *et al*., 1995). The pH values of all the silage types are in agreement with the report of Eweedah *et al*. (2005) for well-preserved and good silage quality.

Silage is a process of forage conservation in which some chemical reactions catalysed either, by plant microbiological enzymes present in the anaerobic environment cause the breakdown of proteins and amino acids and subsequent production of several nitrogen compounds like amines and ammonia (Muck, 1988). Increased levels of these soluble nitrogen compounds usually decrease ruminal microbial growth efficiency and amino acids absorption by animals consuming silage (Givens and Rulquin, 2004). Ammonia is an essential nutrient for cell wall fermenter microorganisms (Russel *et al.,* 1992), but its utilisation is related to the amount of carbohydrate available inside the microbial cell. If excess of ammonia is available into the rumen most of them will be absorbed and lost in urine as urea (Harmeyer and Martens, 1980). Ammonia N in silage has long been associated with reduced silage intake (Wright *et al.,* 2000). Belewu (2019) categorised the silage based on the level of NH_3-N concentration into four groups: as very good (<10%), good (10-15%), fair (15-20%) and poor (>20%). Based on this assertion, the silage obtained in this study fall within very good and good. The ammonia NH_3-N concentration of the ensiled materials is moderate and within the normal range of good and well fermented silage. High level of NH_3 concentration (>15 +0.15% of CP) are result of excessive protein breakdown in the silo caused by a slow drop in pH or excessive growth by *Clostridia* or *Enterobacteria*.

The temperature range of 24.02-25.70 obtained for the silages was within the range of normal fermenting forage as observed by Bolsen *et al.* (1996). Any excessive heat production can result in Maillard or Browning reactions which can reduce the digestibility of both protein and fibre constituent. Although "heat damaged" may be palatable, but part of the protein and some of the energy, it may contain will be unavailable to livestock (Adesogan and Newman, 2010). Furthermore, temperature is one of the essential factors affecting silage colour. The lower the temperature during ensiling, the less will be the colour change as excessive heat owing to high temperature do affect silage colour (Adesogan and Newman 2010). However, in this study, the range of temperature (24.2-25.70^{0}C) obtained during the fermentation period of 30 days was in agreement with the temperature 26.0-26.30^{0}C reported by Amuda *et al.* (2017) for ensiled maize stover with and without additive.

The moisture content range of 66.17-70.07% obtained in this study is inclined to range values of 64.7-68.7% reported by Amuda *et al.* (2017) for ensiled maize stovers with or without additive for, easy fermentation. The dry matter (DM) of silages ranged from 29.95-33.83 % as compared to that without legume inclusion having 33.83%T_1, (sole *A. gayanus*). Dry matter of silage with or without legume was consistent with 30.65-35.26% reported by FAO (2010) and lower than 37.02% obtained by Elkholy *et al.* (2009). However, it was higher than range of 21.2-28.46% reported by Moran (2005); Ashbell and Weingberg (2002).

Table 2: Quality characteristics of ensiled *Andropogon gayanus* with graded levels of *Centrosema pascourum*

	TREATMENTS							
Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**SEM**
pH	4.01	4.02	3.76	3.78	3.75	3.83	3.89	0.64
NH_3-N %	8.83^{d}	8.83^{d}	10.04^{c}	11.53^{b}	13.04^{a}	11.57^{b}	10.05^{b}	0.03
Temp(°C)	25.70^{a}	25.34^{a}	25.08^{ab}	25.03^{abc}	24.02^{c}	24.04^{c}	24.15^{bc}	0.68
MC (%)	66.17^{b}	66.32^{b}	67.06^{b}	68.63^{a}	69.05^{a}	69.90^{a}	70.07^{a}	1.08
DM (%)	33.83^{a}	34.02^{a}	32.94^{a}	31.37^{b}	30.95^{b}	30.10^{b}	29.95^{b}	0.97

a,b,c= means on the same row with different superscripts are significantly ($P<0.05$) different

T_1 = *Andropogon gayanus* only, T_2 = 90% *Andropogon gayanus* + *10%Centrosema pascourum*, T_3 = 80%*Andropogon gayanus* + 20% *Centrosema pascourum*, T_4 = 70% *Andropogon gayanus* + 30% *Centrosema pascourum,* T_5 = 60% *Andropogon gayanus* + 40% *Centrosema pascourum*, T_6 = 50% *Andropogon gayanus* + 50% *Centrosema pascourum*, T_7 = 40% *Andropogon gayanus* + 60% *Centrosema pascourum,* TRTS = Treatments, SEM = Standard Error of Means

The volatile fatty acids (lactic, butyric and acetic acid) composition of the ensiled forages is shown in Table 3. All the volatile fatty acids were significantly ($P<0.05$) different from each other. The lactic acid composition of the silages was higher than other volatile fatty acids (acetic and butyric acids). Lactic acid composition of the ensiled materials ranged from 6.63 -7.51% which was high compared to acetic and butyric acids suggests that the silage is of good quality. Bad silage with high levels of butyric acid is characterised by foul odour. Belewu, (2019) classified silage with nil butyric acid as very good while the one with traces value is termed good silage. However, silage that has little and high butyric acid are classified as fair and poor silage (Belewu, 2019). Furthermore, the ranged values (6.63 to 7.51%) of lactic acid composition of this silage suggests that the fermentation is dominated by lactic acid producing bacteria (LAB). Lactate silages are characterised by having a low pH (3.7 – 4.2) and a high concentration of lactic acid as reported by Mc Donald *et al. (*2010). Lactate silages have a pleasant, acidic and sometimes sweet smells which was characterised by this silage.

Table 3: Volatile fatty acids composition of ensiled *Andropogon gayanus* with graded levels of *Centrosema pascourum*

		Parameters	
Silage Type	**Lactic Acid (%)**	**Butyric Acid (%)**	**Acetic Acid (%)**
T_1	6.49^{ab}	0.08^{a}	2.52^{ab}
T_2	6.06^{b}	0.10^{a}	2.55^{a}
T_3	6.90^{ab}	0.05^{b}	2.47^{b}
T_4	6.81^{ab}	0.08^{a}	2.26^{c}
T_5	7.50^{a}	0.06^{b}	2.10^{d}
T_6	7.27^{a}	0.03^{c}	2.08^{d}
T_7	7.39^{a}	0.01^{c}	2.00^{e}
SEM	6.83	0.04	0.05

abcde = values bearing different superscripts in a column differs significantly ($P<0.05$)

T_1 = *Andropogon gayanus* only, T_2 = 90% *Andropogon gayanus* + *10%Centrosema pascourum*, T_3 = 80%*Andropogon gayanus* + 20% *Centrosema pascourum*, T_4 = 70% *Andropogon gayanus* + 30% *Centrosema pascourum,* T_5 = 60% *Andropogon gayanus* + 40% *Centrosema pascourum*, T_6 = 50% *Andropogon gayanus* + 50% *Centrosema pascourum*, T_7 = 40% *Andropogon gayanus* + 60% *Centrosema pascourum,* SEM = Standard Error of Means

Table 4 shows the proximate composition of ensiled *Andropogon gayanus* fortified with graded levels of *Centrosema pascourum*. All the parameters evaluated were similar except for CP, CF and CHO that were significantly (P<0.05) different. T_1 (sole *Andropogon gayanus*) had the lowest CP value (9.44%) and the highest CF value (36.73%) while the treatments 7 (40% *Andropogon gayanus* + 60% *Centrosema pascourum*) had the highest CP value (14.88%) and lowest CF value (33.10%) across the treatments.

The crude protein content of the silages ranged from 9.44 in T_1 and 14.88% in T_7. This result agrees with the findings of Kallah *et al.* (2008) that high CP content in silages was obtained from high levels of legume inclusion. Silage made with 60% inclusion of legume forage T_7 (40% *Andropogon gayanus*) + 60% *Centrosema pascourum)* had highest CP (14.88%) with corresponding decline in CF, NFE, OM and CHO. The result is in line with the report of Muhammed *et al.* (2008) that the use of legumes (centro and stylo) improved silage quality of Columbus grass. The geometric increasing in crude protein (CP) contents of the silages observed was in agreement with the reports of Muhammed *et al.* (2008). The crude protein (CP) contents of all the silage types were higher than minimum protein requirement of 10 – 12% recommended by ARC (1985) except for the control T_1(100% *Andropogon gayanus*) that has CP value of 9.44%. However, the CP content of the sole ensiled *Andropogon gayanus* is higher than critical value of 7% threshold recommended for small ruminants by NRC (1981). This suggest that the inclusion of tropical legumes improves the nutrient (protein) quality of *Andropogon gayanus* as reported by Muhammed *et al.* (2008; 2009). The higher the level of legume inclusion the higher the crude protein (CP) and conversely, the lower the crude fibre content of the silage. This is an indication that legume had significant effect on protein level of ensiled gamba grass.

The crude fibre content of ensiled gamba grass with centro decreased from 36.73% (sole gamba) to 33.10%. This may be due to the degradation action of microbes especially fungi on fibre component of the ensiled materials during fermentation process. The crude fibre value of 33.10 to 36.73% in this study is similar to 36.30 – 36.65% reported by Ajayi *et al*. (2012) but higher than 26.4% and 25.03% reported by Moran (2005) and Elkholy *et al*. (2009), respectively. However, the value obtained in this study was within the range value of 28 – 46% reported by Fomunyan and Meffeja (1986) and similar to 32.1% value obtained by Nour *et al*. (1987). Generally, the crude fibre level obtained in this study is within the ranged values of tropical grasses and cereal stovers characterised by C_4. Mean ash represents inorganic matter which mainly includes plant minerals. The ash content of the silages ranged from 6.43 – 7.25%. The level of ash in the ensiled forage plant is within the range 3.05 – 7.70 obtained by Ajayi *et al*. (2012). Fomunyan and Meffeja (1986) reported 8.69%, and 9 to 15%, respectively. Whatever variation reported in the literature as values might be connected with the age of the plants, period of the year of collection, the nutrient level of each maize stover, fermentation length of the silage and the different levels inclusion of centro used for fermentation. Grass and centro may differ in chemical constituents from one period to another and from one place to another in a year due to variation in weather, soil nutrient composition which has a direct correlation or relationship with the plant nutrient composition. The ash obtained in this study compared favourably with normal ash of legume and grass forage of 7 – 9%. The organic matter (OM) and carbohydrate (CHO) levels of the silages suggests that the silages will supply more energy if feed to ruminant animals. The ether extract (EE) measured the fat components of the silage. The EE in gamba grass ranged from 1.70 to 2.27% in the silages. Analysing samples of maize stover, Elkholy *et al*. (2009) and Fomunyan and Meffeja (1986), reported 2.4 and 1.0 – 2.0 and 1.43 % respectively. The range value obtained in this study generally agreed with those authors. Nitrogen free extract (NFE) indicates the soluble carbohydrate of forage plant. The values obtained for NFE (43.40 – 44.97%) in ensiled gamba grass with graded level of centro, was within the range of 35–53% obtained in maize stover silages (Fomunyan and Meffeja, 1986). The nitrogen free extract level of the silages in this study is within the range of common grasses.

Table 4: Nutrients composition of ensiled *Andropogon gayanus* with graded levels of *Centrosema pascourum*

	TREATMENTS							
Nutrients	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**SEM**
CP	9.44^{g}	10.35^{f}	11.25^{e}	12.08^{d}	13.17^{c}	13.89^{b}	14.88^{a}	0.13
CF	36.73^{a}	36.18^{b}	35.97^{b}	34.75^{c}	34.62^{cd}	34.32^{d}	33.10^{e}	0.27
EE	1.76	2.16	2.14	2.27	1.86	1.70	1.82	0.79
ASH	7.25	6.34	6.43	6.49	6.45	6.48	6.81	1.40
NFE	44.97	44.81	44.20	44.08	43.90	43.60	43.40	1.83
OM	93.41	93.66	93.23	93.51	93.55	88.56	93.19	3.74
CHO	81.54^{a}	81.15^{ab}	80.17^{abc}	79.16^{abcd}	78.52^{bcd}	77.93^{cd}	76.49^{d}	1.84

abcd = means on the same row with different superscripts are significantly (P<0.05) different

T_1 = *Andropogon gayanus* only, T_2 = 90% *Andropogon gayanus + 10%Centrosema pascourum*, T_3 = 80%*Andropogon gayanus* + 20% *Centrosema pascourum*, T_4 = 70% *Andropogon gayanus* + 30% *Centrosema pascourum,* T_5 = 60% *Andropogon gayanus* + 40% *Centrosema pascourum*, T_6 = 50% *Andropogon gayanus* + 50% *Centrosema pascourum*, T_7 = 40% *Andropogon gayanus* + 60% *Centrosema pascourum,* CP = Crude Protein, CF = Crude Fibre, EE= Ether Extract, NFE = Nitrogen Free Extract, OM = Organic Matter, CHO = Carbohydrate, SEM = Standard Error of Means

The fibre fractions of the ensiled *Andropogon gayanus* with graded levels of *Centrosema pascourum* is shown in Table 5. All the parameters considered were significantly (P0<0.05) different except for acid detergent lignin (ADL). The neutral detergent fibre NDF, acid detergent fibre (ADF), neutral detergent soluble (NDS), (ADL), cellulose and hemicellulose range from 60.67–70.23, 38.17– 42.70, 3.93–15.34, 6.36–7.27, 31.69 –35.11 and 22.50 –27.53% respectively.

The levels of fibre fractions (NDF, ADF ADL, Cellulose and Hemicellulose) of ensiled gamba grass with graded levels of Centrosema pascourum levels decreased significantly (P<0.05) as the level of inclusion centro increased. Sing and Oosting (1992) reported that roughage feeds containing values of less than 45% could be classified as high quality, those with values ranging from 45-65% as medium with values and those with higher than 65% as low quality. High NDF values can be a limiting factor to dry matter intake, as dry matter and NDF content are negatively corrected (Van Soest, 1994). Consequently, the silage types can be categorised as medium and low quality forage in terms of their NDF ranged values (60.67-70.23%) which fall within the two categories. Forage with high ADF value is classified as low quality roughage (Rusdy, 2016). According to Kellems and Church (1998), roughage with less than 40% ADF are classified as high quality and those that are greater than 40% as poor quality. Based on this assertion, the silages can be categorised as high quality feed forage except for treatments 1, 2 and 3 that have 42.70%, 41.61% and 40.93% respectively. Hemicellulose and cellulose levels of ensiled forages are within the levels in which the ruminants' animal can accommodate due to the presence microbes in their rumen. Lignin is virtually indigestible and is the major non-polysaccharide compound of plant cell wall (Van Soest, 1994). It is implicated in limiting the digestion of cell wall polysaccharides by its close association and formation of covalent bounds with cellulose and hemicelluloses (Van Soest, 1994). Tropical forages exhibit higher rates of lignifications than temperate and this partly explains the low degradability. The amount influence the plant digestibility as reported by Gillespie (1998). However, the ADL of ensiled forages were relatively low, indicating that about 85% of the silages can be digested and utilised by ruminant animals.

Table 5: Fibre fractions of ensiled *Andropogon gayanus* with graded levels of *Centrosema pascourum*

	TREATMENTS							
NUTRIENTS	T1	T2	T3	T4	T5	T6	T7	SEM
NDF	70.23^{a}	68.63^{b}	67.04^{c}	65.44^{d}	63.86^{e}	62.27^{f}	60.67^{g}	0.03
ADF	42.70^{a}	41.61^{b}	40.93^{c}	40.24^{d}	39.55^{e}	38.86^{f}	38.17^{g}	0.33
NDS	3.93^{b}	10.80^{a}	9.99^{a}	10.46^{a}	11.10^{a}	13.84^{a}	15.34^{a}	3.44
ADL	7.27	6.87	6.61	6.61	6.36	6.40	6.48	0.60
Cellulose	35.11^{a}	34.74^{a}	34.41^{ab}	33.62^{ab}	33.91^{ab}	34.28^{ab}	31.69^{b}	1.88
Hemicellulose	27.53^{a}	27.03^{b}	26.11^{c}	25.20^{d}	24.31^{e}	23.40^{e}	22.50^{g}	0.30

abcde = means on the same row with different superscripts are significantly ($P<0.05$) different
T_1 = *Andropogon gayanus* only, T_2 = 90% *Andropogon gayanus* + *10%Centrosema pascourum*, T_3 = 80%*Andropogon gayanus* + 20% *Centrosema pascourum*, T_4 = 70% *Andropogon gayanus* + 30% *Centrosema pascourum,* T_5 = 60% *Andropogon gayanus* + 40% *Centrosema pascourum*, T_6 = 50% *Andropogon gayanus* + 50% *Centrosema pascourum*, T_7 = 40% *Andropogon gayanus* + 60% *Centrosema pascourum,* NDF = Neutral Detergent Fibre, ADF = Acid Detergent Fibre, NDS = Neutral Detergent Soluble, SEM = Standard Error of Means

Conclusion

The use of *Centrosema pascourum* and *Andropogon gayanus* (Northern Gamba grass) for silage production has beneficial effect on silage quality characteristics and nutrients composition. The present study showed that crude protein (CP) contents of the silages increased significantly as the level of inclusion of *Centrosema pascourum* ensiled with *Andropogon gayanus* increased. This indicates that inclusion of centro at graded level improved nutritional quality of northern gamba grass. Therefore, this study recommends the use of 60% *A. gayanus* and 40% *C. pascourum* which is practicable and obtainable.

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