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Comparative studies on the yield of some herbaceous legumes and effects of storage on the quality of their pellets

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Abstract

Dry matter yield of herbaceous legumes and effects of storage length of their pellets on the chemical composition were investigated. A two phased field and laboratory experiment were conducted. In the first experiment, the yield of the forage legumes using a 5 x 2 factorial experiment consisting of five herbaceous legumes (Lablab purpureus, Mucuna pruriens, Centrosema molle, Centrosema pascorum and Calopogonium mucunoides) and two harvesting ages (6 and 12 weeks after sowing) laid out in a split-plot design was determined. The second experiment was the selection of herbaceous legumes with higher yields from Experiment 1 using a 3 x 4 factorial experiment consisting of the three herbaceous legumes (L. purpureus, C. mucunoides and M. pruriens) used to make pellets and four storage lengths (0 i.e. fresh, 30, 60 and 90 days). Treatments in both experiments were replicated three times. Results showed that legumes harvested 12 weeks after sowing (WAS) had significantly ($P < 0.05$) higher dry matter yield (2.73 t ha^{-1}) than legumes at 6 WAS, while Lablab purpureus produced the highest ($P < 0.05$) dry matter yield (2.94 t ha^{-1}) of the legumes evaluated.. The physical characteristics of the herbaceous legumes pellets such as colour, odour and moldiness at different storage length showed that they were between fair and good pellets. The L. purpureus and M. pruriens had higher ($P < 0.05$) CP content than C. mucunoides. Differences in the CP content of pellets with the storage lengths employed was not significant ($P > 0.05$). Higher oxalate, phytate and saponin contents were found in C. mucunoides pellets than in other legumes pellets while the tannin content was in the order of M. pruriens (43.63 mg kg^{-1}) > L. purpureus (26.00 mg kg^{-1}) > C. mucunoides (20.31 mg kg^{-1}). In conclusion, increasing age at harvest increased the yield of the legumes, while increasing storage duration decreased the CP content but increased the NDF, ADF and saponin content of the pellets.

Keywords: Dry matter yield, Forage legumes, Nutritive value, pellets, storage length

Introduction

Forage serves as the cheapest feed resources for ruminant production. There are abundant natural forages which ruminants graze upon and are sufficient for feed supply during the wet season in Southwest Nigeria. There is however, a huge deficit in forage supply in terms of both the quantity and quality towards the end of the wet season and throughout the dry season. This leads to body weight losses and generally poor reproductive performance by the animals during these periods. Therefore, meeting the demand for meat and milk by the ever increasing human population will require sustainable production of more the higher quality feed (Delgado et al., 1999).

However, efforts have been made in the past to augment low quality feeds for ruminants by supplementing grasses with concentrate feeds and agro industrial by-products such as cotton cake and groundnut cake, but unfortunate, they are unavailable or in short supply and are expensive (Adjolohoun et al., 2008; Ososanya et al., 2013).

Insufficient protein during the dry season is one of the major constraints to ruminant production (Ngongoni and Manyuchi., 1993). Legumes are rich in nutrients which can augment quality of fibrous and coarse forages as well as high-fibre roughage that are available during dry season. Supplementation with legumes will provide high quality feed at reduced cost of feeding animals. However, forage legumes are poorly represented in the natural pasture since they are largely dominated by native grasses and weeds (Michiels et al., 2000) as a result contribution of fixed nitrogen is usually low to absent. To solve this problem, there is a need to grow forage legumes with potential for high dry matter accumulation which will enhance performance of animals.

However, the discrete rainfall pattern in the semi-arid and sub-humid zones of Nigeria results in variable forage supply for ruminants, with excessive amount during the wet, growing season and acute shortage in the late dry to early wet season (Kallah et al., 1999), this supply situation therefore makes a forage conservation imperative so that they can be fed to animals during dry season to ensure year round feed supply. Forage conservation is an attempt to redistribute the feed supply and fill the gaps within the feed year.

Examples of conservation include hay, silage and pellet which can be stored for animal feeding during the dry season. However, conservation as hay and silage have their attended problems. However, some advantages has been associated with preservation of feeds as pellets for ruminants. Pelleted feed has been noted to prevent selective feeding of palatable feedstuffs by animals, it prevents separation of constituents due to varying size and density, improves nutrient utilization and acceptability (Manasri et al., 2012). Furthermore, pellets have been reported to provide better feed efficiency, greater starch digestibility, reduced feed wastage, better handling and storage as well as increased income for the farmer due to a more efficient feeding of the ruminants (Orden et al., 2014). Legume pellets are also reported to be consumed much faster than long stemmed forages and this can increase the feed intake of animals and hence their productivity.

Therefore, sowing of forage legumes (Lablab purpureus, Mucuna pruriens and Calopogonium mucunoides) and preserving them as pellets for feeding animals during food shortage particularly dry season, will help ameliorate nutrition problems in ruminants production thereby boosting the livestock production to contribute more to gross domestic product and to meet up with high demand of animal protein by the increasing human population.

Materials and methods

Experimental site

The experiment was conducted at the Pasture unit of the Directorate of University Farms, while the chemical analysis was carried out at the Laboratory of the Department of Pasture and Range Management. Both sites are situated within the premises of the Federal University of Agriculture, Abeokuta (FUNAAB) farm, Ogun State Nigeria (7°58'N; 3°20'E; 75 m above sea level). FUNAAB is situated in the derived savannah agro-ecological zone of South West Nigeria with average annual rainfall of 1037 mm. Mean monthly temperature range from 25.70 °C in July to 30.20ºC in February (Google Earth, 2015).

Land preparation and sowing of legume seeds

A total land area measuring 1600 m^2 was cleared manually, ploughed and allowed to rest for a period of two weeks before harrowing, following conventional tillage operations. After harrowing, fine seed beds measuring 4 m x 6 m were prepared. The land area was divided into three blocks, with each block representing a replicate. Prior to sowing, soil samples were randomly collected from the plots at the depth of 0 -15 cm using soil auger to determine the pre-planting nutrient status of the soil. Analysis of the soil from the site indicated that it was sandy silt with pH of 6.75; organic carbon 1.27 %, available phosphorus 30.40 mg kg^{-1}, potassium 0.79 cmol/kg, calcium 3.36 cmol/kg, magnesium 2.42 cmol/kg, sodium 1.51 cmol/kg and total nitrogen 0.11%. Five herbaceous forage legume species (Lablab purpureus, Calopogonium mucunoides, Mucuna pruriens, Centrosema molle and Centrosema pascorum) obtained from National Animal Production Research Institute, Zaria, Nigeria, were used for this study. Lablab purpureus and Mucuna pruriens were sown using spot planting method at a seed rate of 20 (FAO, 2012) and 40 kg ha^{-1} (Oudhia, 2001) with spacing of 0.5 m^2 respectively. Centrosema molle, Centrosema pascuorum and Calopogonium mucunoides were sown by drilling method at the rate of 10 kg ha^{-1} in August 2015. The inter-plot and intra-plot spaces were kept weed-free as much as possible throughout the experimental period by weeding manually.

Samples were harvested from the cropping field at 6 and 12 weeks after sowing to determine the dry matter yield. This was done with the use of 1 m^2 quadrat. Sub samples weighing 500 g were taken, weighed and oven – dried at 65 ^{0}C until a constant weight was attained. The dry matter percentage was estimated as:

$$\text{Dry matter percentage} = \frac{\text{Weight of dry sample}}{\text{Weight of fresh sample}} \times 100$$

While dry matter yield was estimated as:

Dry matter yield = dry matter percentage x fresh sample from 1 m^2 which afterwards was extrapolated in tonnes per hectare.

Based on the result of the dry matter yield of the herbaceous legumes from first experiment, three legumes with higher yields abve others were selected to make pellets.

Procedures for making pellets

The forage legumes were harvested at 12 weeks after sowing (WAS) and chopped to length of 50-60 mm using reel cutter after which they were sun dried for three days. The dried legumes were milled and pelletized using a 6 mm die size to produce pelleted forage of average length of 40 mm. Cassava flour was used as binder (proportion of 1 kg of cassava flour to 100 kg of the milled sample) with addition of water to moisten it. Moist warm pellets were produced by the mill which was spread out on the trampoline to facilitate drying and hardening. The produced pellets were stored in white polyethylene bags and kept in cool dry containers (25 – 28 °C).

Fresh and stored sub-samples of the pellets stored for 30, 60 and 90 days were collected to determine their physical (colour and moldiness) and sensory (odour) properties as well as their chemical compositions. The physical and sensory characteristics of the pellets were determined using questionnaires, while three hundred grams (300 g) of the collected samples were oven dried at 65 °C to a constant weight, milled and allowed to pass through a 1 mm sieve screen for chemical composition determination.

Proximate composition and mineral contents were determined according to the standard methods of AOAC (2000). Fibre fraction analysis was determined according to Van Soest et al. (1991). Mineral composition was determined according to Fritz and Schenk (1979). Anti-nutritional factors such as tannin content (as described by Price and Betler., 1977), phytate content (according to Latta and Eskin, 1980), oxalate (analysed using the methods of Munro, 2000) and saponin content (according to the methods of Obdoni and Ochuko, 2001) were all determined.

Experimental design

Following the selection of legumes with high forage yield, the experiment was split into a field phase (dry matter yield experiment) and a laboratory phase (physical, sensory and chemical composition). The field phase was as a 5 x 2 factorial experiment consisting of five herbaceous legumes (Lablab purpureus, Mucuna pruriens, Centrosema molle, Centrosema pascorum and Calopogonium mucunoides) as the main plot and two harvesting ages (6 and 12 weeks after sowing) as the sub-plot, laid out in a split-plot design. Blocking was used to account for variations in the soil, and each block served as a replicate. The laboratory phase was a 3 x 4 factorial experiment consisting of the three herbaceous legumes selected for higher yield (L. purpureus, C. mucunoides and M. pruriens) and four storage lengths (0 i.e. fresh, 30, 60 and 90 days). The data obtained were analysed using the general linear model procedure (GLM) and treatment means were separated using Duncan multiple range test (Duncan, 1955).

Results and discussion

Dry matter yield of the forage legumes was measured at different age at harvest (Table 1). The dry matter yield increased significantly ($P < 0.05$) with increasing age at harvest. Differences in the dry matter yield of the legumes were significant ($P < 0.05$) when compared. The dry matter yield was in the order of Lablab purpureus > *Calopogonium mucunoides* > *Mucuna pruriens* > *Centrosema pascorum* > *Centrosema molle*. *Lablab purpureus* produced the highest dry matter yield, while both species of Centrosema produced significantly ($P < 0.05$) lower yields. Differences in yield values between *C. mucunoides* and *M. pruriens* were not significant ($P > 0.05$). Higher dry matter yield reported at higher harvest age (i.e. 12 WAS) could be attributed to the fact that as the forage plants increase in age, the nodes of the plants are elongated, leading to an increase in the production of leaves and stem component. The present observation corroborates the findings of Omokanye et al. (1996) who also reported that plant dry matter increases with maturity of the plant from an increase in stem proportions at the expense of leaf production leading to more dry matter yield produced by the plants.

Higher dry matter yield produced than L. purpureus and the other legumes evaluated may imply the superiority of the legumes. Perhaps the plants had better morphometric plants than the other legumes planted in the present study. Dry matter yield produced by the legumes in the present study were higher than the value of 1.48 t ha^{-1} reported by Muir (2002) for some herbaceous legumes and browse plants compared. Higher dry matter yield is desirable in forage production since it will provide sufficient quantity of feeds for animals.

The observed linear increase in dry matter yield with increasing age at harvest corroborates earlier report that extended harvesting time of tropical forages encourages high DM yield (Chheda and Akinola, 1971). The dry matter yield obtained in the present study for L. purpureus was within the range of 1.4 to 7.07 t ha^{-1} reported in previous studies (Omokanye et al., 2004; Amodu et al., 2004; Anthony and John, 2007). Though previously higher values (8.15 to 14.85 t ha^{-1}) than obtained in the present study had been reported by Ojo et al. (2017) some dual-purpose cowpea cultivars. The differences between the yield values obtained in the present study and the reports of those studies could be due to differences in the species used, soil nutrients status, season of harvest and age of harvest.

Table 1: Effect of legume species and age at harvest on dry matter yield of herbaceous legumes

Factors	Dry matter yield t ha^{-1}
Age at harvest	
6	1.41^{b}
12	2.73^{a}
SEM	0.16
Legume species	
Calopogonium ***mucunoides***	2.29^{b}
Centrosema molle	1.42^{c}
Centrosema pascorum	1.49^{c}
Lablab purpureus	2.94^{a}
Mucuna pruriens	2.21^{b}
SEM	0.30
P value	
Age at harvest	<.0001
Legume species	<.0001

$^{a, b, c:}$ Means on the same column with different superscripts are significantly different ($P<0.05$)
SEM = standard error of means.

Table 3 shows the effects of storage of forage legume pellets on their physical characteristics. Good physical characteristics are indicative of pellets of excellent qualities. Production of pellets for livestock demands a good process of production so as to have acceptable and high quality products for utilization. There is need to pay particular attention to physical quality of pellets for transportation for effective feed delivery. Khater *et al*. (2014) reported that the physical properties of pellets should be high to be able to withstand handling, transportation and pneumatic conveying, without generation of excessive amount of dust and fine particles. Although, there are lack of standardization of equipment and measurements for describing physical properties of pellets (Khater *et al*., 2014), observation by inviting judges that have been briefed helped them to document their findings in this study. Odour is an important physical characteristic in terms of pellets acceptability. The pellets were characterized by pleasant odour with no indication of putrefaction as they all had favourable odour when they were freshly prepared. This will make the pellets acceptable animals. Meanwhile, as the storage period increased, the pellets were affected except in *Mucuna pruriens.* There could be reason to enhance the odour by addition of feed additives. The mould-free of pellets in this study was a clear indication that the pellets were well preserved. It was noticed that the colour of pellets were affected as the storage duration increased except in *Mucuna pruriens.* The physical characteristics of the pellets showed that they were between fair and good pellets.

Table 2: Physical characteristics of herbaceous forage legume pellets during storage

Day	Parameters	*Lablab purpureus*	*Calopogonium mucunoides*	*Mucuna pruriens*
0 day	Colour	Greenish brown	Light brown	Black
	Odour	Favourable	Favourable	Favourable
	Mouldiness	Absent	Absent	Absent
30 days	Colour	Light brown	Dark brown	Black
	Odour	Fair	Unfavourable	Favourable
	Mouldiness	Absent	Absent	Absent
60 days	Colour	Light brown	Dark brown	Black
	Odour	Fair	Unfavourable	Favourable
	Mouldiness	Absent	Absent	Absent
90 days	Colour	Light brown	Dark brown	Black
	Odour	Fair	Unfavourable	Favourable
	Mouldiness	Absent	Absent	Absent

There were significant ($P < 0.05$) differences in the dry matter content of legumes when compared (Table 3). *Calopogonium mucunoides* had significantly ($P < 0.05$) higher dry matter content than *L. purpureus*. Both plants had statistically similar ($P > 0.05$) DM content when compared with *M. pruriens*. Crude protein content obtained from *L. purpureus* and *M. pruriens* did not differ significantly ($P > 0.05$) from each other, however the CP content obtained from both plants were significantly ($P < 0.05$) higher than obtained from *C. mucunoides*. Ether extract content obtained from the legumes were statistically similar ($P > 0.05$) when compared. Ash and non-fibre carbohydrate content obtained was in the order of *L. purpureus* < *M. pruriens* < *C. mucunoides*.

Differences in the dry matter content with the storage lengths of the pellets were significant ($P < 0.05$). Dry matter content ranged from 896.68 g kg^{-1} obtained from pellets stored for 90 days to 930.67 g kg^{-1} obtained from pellets stored for 60 days. Differences in the CP content with the storage lengths were not significant ($P > 0.05$). The least EE and ash contents were obtained from pellets stored for 60 and 90 days respectively. Contents obtained at other storage durations did not differ significantly ($P > 0.05$) from each other. Non-fibre carbohydrates ranged from 223.67 g kg^{-1} obtained from pellets stored for 90 days to 232.90 g kg^{-1} obtained from pellets stored for 30 days. Lower CP content obtained for *C. mucunoides* than *L. purpureus* and *M. pruriens* in the present study may imply the efficiency/superiority of *L. purpureus* and *M. pruriens* in terms of protein accumulation over *C. mucunoides*. We hypothesized that *L. purpureus* and *M. pruriens* might have had better soil nutrient intake capacity and larger nutrient storage reserved than *C. mucunoides*, or *C. mucunoides* might have a faster rate at attaining maturity than the other legumes which could have resulted in the accumulation of more structural constituents. This implies that *C. mucunoides* might have sacrificed more CP contents for the build-up of fibre constituents. This is because plant maturity has been associated with the structural build-up of fibre constituents in plants (Omokanye *et al*., 1996). This might be particularly true because of the higher NDF and ADF content recorded for *C. mucunoides* which was at significantly higher levels when compared with *L. purpureus* and *M. pruriens*. This suggest that the association of *C. mucunoides* with more structural fibre contents might be the reason for the decline in CP content obtained in the present study. Albeit, the CP content of the forage legumes, *C. mucunoides* inclusive in the present study were well above the value of 8 % suggested by Norton (1994) for ruminal function. There was no significant influence of storage lengths on the CP content, though a numerical decrease up to 4.78 % by the 90th day of storage was observed. In addition, the CP contents of the stored pellets fell within the range of 110–130 g CP kg^{-1} DM, recommended by NRC (1996) as adequate for maintenance and growth of beef cattle.

The highest ($P < 0.05$) NDF and ADF content were obtained from *Calopogonium mucunoides*, while the least was obtained from *L. purpureus*. The latter also had the least ADL content while *M. pruriens* had the highest. Differences in the hemicellulose content with the legumes was not significant ($P > 0.05$), while cellulose content was in the order of *C. mucunoides* < *L. purpureus* < *M. pruriens*.

The NDF and ADF content increased with increasing duration of storage. The ADL content ranged from 43.33 g kg^{-1} obtained from the fresh pellets to 78.33 g kg^{-1} obtained from pellets stored for 60 days. The highest hemicellulose content was obtained from pellets stored for 90 days, while differences in the hemicellulose content at other storage days were statistically similar ($P > 0.05$). Pellets stored for 30 days had the least cellulose content, while higher ($P < 0.05$) contents were obtained from the fresh pellets. The observed increase in the NDF, and ADF content could be due to the observed decline in the CP content. Though the differences in the CP content were not significant, it might be partially responsible for the observed increase in the fibre content. Other factors that could be responsible for the increase in the fibre constituents could be the degradation of carbon fractions within the pellets over storage. Albeit, the values recorded in the present study were within the range reported by Anele *et al*. (2008) to be digestible by animals and also below the threshold of 65 % suggested as the level by which intake of tropical feeds by ruminants would be limited (Eastridge, 2006). Though West (1998) reported that a major factor which could enhance intake of forages by cattle is to simply lower cell wall content, it would seem that increasing storage of the pellets increased rather than caused a decline in the fibre contents. This suggests that fibre levels might be higher if pellets are stored for longer durations.

The highest Ca and P content were obtained from *C. mucunoides* and *L. purpureus* respectively, while the least of the contents were produced by *Mucuna pruriens*. The latter also produced the highest Ca:P ratio.

Increase in the Ca content with increasing storage duration up to 60 days was observed but significantly (P <0.05) lower Ca content was obtained at 90 days of storage. The least P content was obtained from pellets stored for 30 days, while Ca:P ratio ranged from 1.58 g kg^{-1} obtained from pellets stored for 90 days to 1.90 g kg^{-1} obtained from pellets stored for 60 days. Calcium and phosphorus make up to 70% of the total mineral elements in the body and have vital functions in almost all tissues in the body and must be available to livestock in proper quantities and ratio (Anele *et al*., 2011). The values recorded for Ca in the present study was above the critical level of 3 g kg^{-1} DM recommended for ruminant needs in the warm wet climates (McDowell *et al*., 1993). The range of P in this study fell within the normal requirements reported for growing cattle (1.1-4.8g/kg) (Begum *et al*., 2001).

Table 3: Effects of storage length and legume species on chemical composition (g kg^{-1} DM) of pellets

Treatment	Legume			SEM	P-value	Storage Length				SEM	P-value
	Lablab purpureus	*Calopogonium mucunoides*	*Mucuna pruriens*			0	30	60	90		
Proximate composition											
Dry matter	899.25^{b}	921.25^{a}	907.50^{ab}	7.67	0.1024	896.67^{b}	913.33^{ab}	930.67^{a}	896.68^{b}	8.14	0.0188
Crude protein	121.00^{a}	106.00^{b}	122.45^{a}	2.77	0.0010	120.67	118.77	115.17	115.17	3.98	0.2555
Ether extract	67.50	71.25	71.00	3.50	0.6143	74.67^{a}	71.66^{a}	58.33^{b}	75.00^{a}	3.47	0.0063
Ash	87.50^{a}	71.25^{b}	63.75^{c}	5.42	<.0001	83.33^{a}	73.33^{a}	83.33^{a}	56.67^{b}	5.99	<.0001
Non fibre carbohydrate	229.00^{a}	224.00^{c}	227.80^{b}	4.37	<.0001	224.67^{c}	232.90^{a}	226.50^{b}	223.67^{c}	5.12	<.0001
Fibre fraction											
Neutral detergent fibre	495.00^{c}	527.50^{a}	515.00^{b}	5.15	<.0001	496.67^{c}	503.33^{c}	516.67^{b}	533.33^{a}	5.95	<.0001
Acid detergent fibre	270.00^{c}	317.50^{a}	290.00^{b}	4.76	<.0001	280.00^{b}	283.33^{b}	306.67^{a}	300.00^{a}	7.67	<.0007
Acid detergent lignin	52.50^{c}	66.25^{b}	82.50^{a}	4.34	<.0001	43.33^{d}	76.67^{b}	78.33^{a}	70.00^{c}	4.53	<.0001
Hemicellulose	225.00	210.00	225.00	4.96	0.0016	216.67^{b}	220.00^{b}	210.00^{b}	233.33^{a}	5.78	0.0006
Cellulose	230.00^{b}	251.25^{a}	207.50^{c}	4.61	<.0001	236.67^{a}	223.33^{b}	228.33^{ab}	230.00^{ab}	7.93	0.0777
Minerals											
Calcium	3.33^{b}	3.43^{a}	3.25^{c}	0.07	0.0002	3.39^{b}	3.30^{b}	3.60^{a}	3.06^{c}	0.07	<.0001
Phosphorus	2.35^{a}	2.05^{b}	1.67^{c}	0.05	<.0001	2.05^{a}	1.98^{b}	2.03^{ab}	2.05^{a}	0.12	0.0231
Ca:P	1.45^{c}	1.71^{b}	1.95^{a}	0.06	<.0001	1.70^{b}	1.74^{ab}	1.80^{a}	1.58^{c}	0.10	<.0001

a, b, c: Means on the same row with different superscripts are significantly different (P<0.05)
SEM = standard error of means

There were significant (P < 0.05) differences in the anti-nutritional factors of the legume pellets when compared. *Mucuna pruriens* had the highest (P < 0.05) tannin content, while the least was obtained from *C. mucunoides*. Oxalate, phytate and saponin concentration was in the order of *C. mucunoides* > *L. purpureus* > *M. pruriens*. The duration of storage also significantly affected the anti-nutritional contents of the legumes. Tannin content ranged from 26.00 mg kg^{-1} obtained from the fresh un-stored pellets to 33.17 obtained for pellets stored at 30 and 60 days. The highest oxalate content was obtained from pellets stored for 30 days, while phytate content decreased significantly (P < 0.05) with storage up to 30 days, but increased by 60 and 90 days of storage, while saponin content increased significantly (P < 0.05) with increasing duration of storage. No regular trend/patterns in anti-nutritional factors were observed with the duration of the storage except saponin contents. Anti-nutritional factors are compounds which reduce the nutrient utilization and or food intake of plants or plants products used as human foods or animal feeds. Diagayete and Huss (1983) reported that sheep and cattle can tolerate 2-5 % dietary tannin while goats can tolerate about 9% tannin in their diets (Nastis and Malecheck 1981). The tannin contents obtained in this study were lower compared than the value of 1.24 % reported for *C. mucunoides* by Obua *et al.* (2012). The reason for decrease in tannin contents obtained in the present study than the reports of Obua *et al.* (2012) could be as a result of the processing by pelletizing employed in the present study. Tannin concentration recorded for the pellets in the present study was moderate and suggest an advantage of by-pass protein for ruminants (Barry and McNabb, 1999). The authors further reported that by-pass protein improved the nitrogen availability in the gut with consequent improvement in weight gain. Kumar and Vaithiyanathan (1990) and Barry and McNabb, (1999) reported that high level of tannin generally depresses voluntary feed intake but a low content is beneficial to ruminants as it produces a by-pass protein effect (Babayemi *et al*., 2004), hence it would mean that levels obtained in the present study were at levels tolerable for consumption if fed to ruminants.

Table 4: Effects of storage length and legume pellets on anti-nutritional factors

Factors	Tannin mg kg^{-1}	Oxalate mg kg^{-1}	Phytate mg kg^{-1}	Saponin %
Legumes species				
L. purpureus	26.00^{b}	6.93^{b}	0.47^{b}	5.75^{c}
C. mucunoides	20.31^{c}	8.03^{a}	0.56^{a}	6.63^{a}
M. pruriens	43.63^{a}	5.12^{c}	0.37^{c}	6.38^{b}
SEM	1.31	0.42	0.02	0.34
Storage length (Days)				
0	26.00^{c}	6.09^{b}	0.49^{a}	5.33^{d}
30	33.17^{a}	7.48^{a}	0.43^{b}	5.83^{c}
60	33.17^{a}	6.60^{b}	0.47^{ab}	6.83^{b}
90	27.58^{b}	6.60^{b}	0.47^{ab}	7.00^{a}
SEM	3.13	0.58	0.03	0.34
P-value				
Legume	<.0001	<.0001	<.0001	<.0001
Storage length	<.0001	0.0010	0.0618	<.0001

[a, b, c:] Means on the same column with different superscripts are significantly different ($P<0.05$) SEM = standard error of means

Conclusion

The study showed that harvesting of legumes at 12 weeks after sowing increased the yield of forage legumes evaluated. Pellets made from selected legumes had decreasing CP content as the storage duration increased while there was increase in NDF, ADF and saponin content of the pellets. Storing the pellets for longer durations should be discouraged because of its relative effects with decreasing quality components, hence the pellets are better stored for lesser durations. This will provide high quality supplement to ruminants especially during the dry season for improved animal performance and productivity.

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References

Adjolohoun, S., Buldgen, A., Adandedjan, C., Decruyenaere, V. and Dardenne, P. 2008. Yield and nutritive value of herbaceous and browse forage legumes in the Borgou region of Benin. *Tropical Grasslands* 42:104–111.

Allen 1996. Physical constraints on voluntary intake of forages by ruminant. *Journal of Animal Science*, 74:3063-3075.

Amodu, J. T., Kallah, M. S., Adeyinka, I.

A. and Lakpini, C. A. M. 2004. Response of lablab varieties to farmyard manure in the northern quinea savanna of Nigeria. In: Sustaining livestock production under changing economic fortunes. Proceedings of the 29th Annual Conference of the Nigerian Society for Animal Production held in Sokoto, 21- 25 March, 2004. Pp 293 - 297.

Anele, U. Y., Südekum, K.-H., Arigbede, O. M., Welp, G., Oni, A. O., Olanite, J. A. and Ojo, V. O. A. 2011. Agronomic performance and nutritive quality of some commercial and improved dual purpose cowpea (*Vigna unguiculata* L. Walp) varieties on marginal land in southwest Nigeria. ***Grassland Science*** **57:** 211 - 218.

Anthony, W. and John, L. 2007. Lablab fact sheet for Grain and Graze. Tropical forages-An Interactive Selection Tool. *CSIRO Sustainable Ecosystems* pp. 5.

AOAC, 2000. *Official Methods of Analysis*. 16th edn. Association of Official Analytical Chemists, Arlington, VA, USA.

Babayemi, O. J., Demeyer, D. and Fievez, V. 2004. *In vitro* rumen fermentation of tropical browse seeds in relation to their content of secondary metabolites. *Journal of Animal Science,* 13 suppl 1: 31 - 34

Barry, T. N. and McNabb, W. C. 1999. The implications of condensed tannins on the nutritive value of temperate forages fed to ruminants. *Br. J. Nutri.,* 81:263-272.

Begum, S. M. M., Rahman, M. J., Abedin, M., Islam, M. R., Uddin, M. 2001. Effects of nitrogen supplied from manure and fertilizer on the growth, yield and nutrient uptake of rice. *Journal of Biological Science* **18**,708-710.

Chheda, H. R. and Akinola, J. O. 1971. Effects of cutting frequency and level of applied nitrogen on productivity, chemical composition, growth components and regrowth potential of three *Cynodon* strains. 1. Yield, chemical composition and weed competition. *Nigerian Agricultural Journal* 8(1): 44-62.

Delgado, C., Rosegrant, M., Steinfeld, H. Ehui, S. and Courbois, C. 1999. Livestock to 2020. *Food, Agriculture and the Environment Discussion Paper* 28. International Food Policy Research Institute, Washington DC, Food and Agriculture Organization of the United Nations, Rome and International Livestock Research Institute, Nairobi.

Diagayete, M. and Huss W. 1983. Tannin contents of African pasture plants: Effects on analytical data and *in vitro* digestibility. *Animal Research and Development*, 15: 79-80.

Duncan, D. B. 1955. Multiple Range and Multiple F-Test *Biometrics*. 11:1-42

Eastridge, M. L. 2006. Major Advances in Applied Dairy Cattle Nutrition. *Journal of Dairy Science* 89 (4): 1311-1323.

FAO, 2012. Grassland species index. *Lablab purpureus*.

Fritz, J. S. and Schenk, G. H. 1979. Quantitative Analytical Chemistry, 4th edition. Allyn and Bacon, Boston. 661pp.

Google Earth 2015.

http//www.google.earth

Kallah, M. S., Muhammad, I. R., Baba, M. and Lawal, R. 1999. The effect of maturity on the composition of hay and silage made from Columbus grass (*Sorghum almum*) grown in Nigeria. *Tropical Grasslands*, 33, 46-50.

Khater E. G., Bahnasawy A. H. and Ali S. A. 2014. Physical and Mechanical Properties of Fish Feeds Pellets. *Journal of Food Processing and Technology,* 5:378.

Kumar, R. and Vaithiyanathan, S. 1990. Occurrence of nutritional significance and effect on animal productivity of tannins in tree leaves. *Animal feed science and technology*, 30: 21 – 23

Lamidi, A. A. and Aina, A. B. J. 2013. Presowing treatment, agronomic parameters and nutritive potential of *Tephrosia bracteolata* (Guill. Et Perr.) at four different stages of growth. *African Journal of Livestock Extension,* 11: 31-36.

Lamidi, A. A. and Ogunkunle, T. 2016. Nutritional potential of poultry dropping meal as feed resources for ruminant production in Niger Delta, Nigeria. *Global Agricultural Science & Technology*, 1:1-11.

Latta, M. and Eskin, A. 1980. A simple and rapid colorimetric method for phytate determination. *Journal of Agriculture and Food Chemistry* 28: 1313-1315.

Manasri, N., Wanapat, M. and Navanukraw, C. 2012. Improving rumen fermentation and feed digestibility in cattle by mangosteen peel and garlic pellet supplementation. *Livest Sci.* 148:291–295.

McDowell, L. R., Conrad, J. H. and Humbry, F. G. 1993. Minerals for grazing ruminants in tropical regions. Bulletin: The US Agency for Literature Development and Caribbean Basin Adversary Group (CBAG) USA.

Michiels, B., Babatunde, S., Dahouda, M., Chabi, S. L. W. and Buldgen, A. 2000. Botanical composition and nutritive value of forage consumed by sheep during the rainy season in a Sudano-guinean savanna (central Benin). *Tropical Grasslands* 34: 48–55.

Muir, J.P. 2002. Hand-picked forage yield and quality and seed production from annual and short-lived perennial warm season legumes fertilized with composed manure. *Crop Sci.*, 42: 897-904.

Munro, A. B. 2000. Oxalate in Nigerian vegetables. ***West African Journal of Biological Applied Chemistry,*** 12(1): 14 18.

Nastis, A. S. and Matechek, J. C. 1981. Digestion and utilization of nutrients in Oak browse by goats. *Journal of Animal Science*, 52: 283- 288.

Ngongoni, N. T. and Manyuchi, B. 1993. A note on the flow of nitrogen to the abomasum in ewes given a basal diet of milled star grass hay supplemented with graded levels of deep litter poultry manure. *Zimbabwe Journal of Agricultural Research* 31(2): 135-140.

Norton, B. W. 1994. *Anti-nutritive and toxic factors in forage tree legumes. In: Forage Tree Legumes in Tropical Agriculture, 202-215*

NRC. 1996. *Nutrient Requirements of Beef Cattle*, 7th edn. National Academy of Science, Washington, DC, USA.

Obdoni, B. and Ochuko, P. 2001. Phytochemical studies and comparative efficacy of the crude extracts of some homostatic plants in Edo and Delta States of Nigeria. *Global Journal of Pure and Applied Science*, 8: 203–208.

Obua, B. E., Okocha, C. N. and Nwaoha, L. E. 2012. Proximate composition and anti-nutritional factors of some forage species used in feeding rabbits in Umudike, humid South Eastern Nigeria. *Journal of Agricultural and Rural Development,* 15 (3):1275-1286.

Ojo, V. O. A., Olufemi, S. J., Adetokunbo, G. A., Odunaye, B. T., Bakare, B. A. nd Adeyemi, T. A. 2017. Growth components and chemical composition of some improved dual-purpose cowpea (*Vigna unguiculata* L. Walp) varieties as influenced by manure application. *Nigerian Journal of Animal Production* 44: (2) *299-310*.

Omokanye, A. T., Amodu, J. T. and Onifade, O. S. 1996. Effects of Phosphorus and Harvest Time on Dry Matter Yield, Nitrogen and Phosphorus Contents of Horsegram (*Macrotyloma uniflorum*). *Tropicultura* 14(2): 73-76.

Omokanye, A. T., Amodu, J. T., and Onifade, O. S. 2004. Influence of intra-row plant spacing, phosphorus application and growth stage on the forage, seed yields and quality of Phasey bean (*Macroptilium lathyroides*) in sub-humid area of Nigeria. *Nigerian Journal of Animal Production, 31*(1), 45-50.

Orden, E. A., Cruz, E. M., Espino, A. N., Battad, Z. M., Reyes, R. G., Orden, M. E. M., Frias, N. O., Gibe, G., Del Rosario, N. A. and Villar, E. C. 2014. Pelletized forage-based rations as alternative feeds for improving goat productivity. *Tropical Grasslands* 2:108- 110.

Ososanya, T. O., Odubola, O. T. and Shuaib – Rahim, A. 2013. Intake, nutrient digestibility and rumen ecology of West African Dwarf Sheep fed palm kernel oil and wheat offal supplemented diets. *International Journal of Agricultural Science* 3(5): 380 – 386.

Oudhia, P. 2001. My experiences with world's top ten Indian medicinal plants: Glimpses of research at farmers field in Chhattisgarh (India). In: Abstract Workshop - cum-Seminar on sustainable agriculture for 21st Century, IGAU, Raipur, India.20-21 January.

Price, M. L. and Butler, L. G. 1977. Rapid visual estimation and spectrophotometric determination of tannin content of sorghum grains. *J. Agric. Food Chem*. 25:1268-1273.

Trevaskis, L. M., W. J Fulkerson. and J. M Gooden. 2001. Provision of Certain Carbohydrate based Supplement to Pasture fed Sheep, As Well as Time of Harvesting of The Pasture, Influences pH, Ammonia Concentration and Microbial Protein Synthesis in The Rumen. ***Australia Journal Experimental Agriculture,*** 41: 21-27.

Uku, E. J. 2000. The performance of Rabbits on Neem leaf-based diet in the growing period and digestibility of same at the end of the grower phase. A B.Sc. Project, University of Ibadan, Dept. Animal Science.

Van Soest, P. J., Robertson, J. B. and Lewis, B. A. 1991. Methods for dietary fibre, neutral detergent fibre and non-starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science* **74** (10), 3583-3597. http://jds.fass.org/cgi/reprint/74/10/3583.pdf

West, J. W. 1998. Factors which influence forage quality and effectiveness in dairy rations. Animal and dairy science department, University of Georgia - Coastal Plain Experiment Station, Tifton, GA 31793-0748 USA.

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