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Performance of Growing Yankasa Rams fed Ensiled *Sorghum almum (*Parodi) and *Lablab purpureus (*L. Sweet) forages and Concentrate Supplement

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Abstract

Silage making offers alternative means of fodder conservation during the rainy season while retaining nutrient quality of the fodder as feed for ruminants. An experiment was conducted at Feeds and Nutrition Research Programme, National Animal Production Research Institute, Shika, to assess the growth performance of Yankasa rams fed varying levels of ensiled sorghum (Sorghum almum) and lablab forages. The silage was prepared by harvesting sorghum and lablab forages at dough and flowering stages, respectively, chopped to 2 cm with a forage chopper, wilted for 12 hour and made into the following four dietary treatments containing forage sorghum and lablab at 100:0, 90:10, 80:20 and 70:30 mixed ratios. The silage materials were placed in polyethene bags and ensiled in a four partitioned pit silo measuring 10 m length x10 m width x 6 m height. The silages were opened after 21 days for physical inspection and chemical analysis. Twenty growing Yankasa rams aged between 10-12 months with average body weight of 21.00 ± 0.40 kg were randomly allotted to one of the silages produced and supplemented with concentrate. The rams were individually pen-fed at 3 % body weight (60% silage and 40% concentrate) with allowance of 200 g/day for a period of 12 weeks in a Completely Randomized Design (CRD) replicated five times. Silage composition at 70:30 ratio of sorghum and lablab forages was highly acidic pH (3.72) with yellow green colour, very sweet aroma and very soft texture; higher crude protein (10.10 %), calcium (0.45 %) and phosphorus (0.35 %) was observed. The total feed intake was significant (P<0.05) across treatments with the highest value (475.95 g/day) in rams fed 80:20 mixed ratios at par with (453.89 g/day) in rams fed 90:10 mixed silage. Average body weight gain and daily weight gain were significantly (P<0.05) higher (6.90 kg/ram) and (82.14 g/ram/day) in rams fed 70:30 mixed silage than other treatments. The feed conversion ratio (5.33) was significantly (P<0.05) better in rams fed 70:30 mixed silage. The coefficients of nutrient digestibility of DM, EE, CF and NFE were not significant (P>0.05) in all the treatments. The CP digestibility was better and range from (69.15-84.26 %), NDF and ADF were significantly (P<0.05) higher in all the treatments except in the control. mixed. The nitrogen absorbed (19.86 g/day), nitrogen retained (15.53 g/day) and nitrogen absorbed as percentage intake (80.67 %) were significantly (P<0.05) higher in rams fed 70:30 mixed silage ratio. Highest net cost-benefit of ₦4,114.48k was obtained for feeding rams with sorghum and lablab forage at 70:30 mixture ratio than the other treatments. It was concluded from this study that forage sorghum and lablab mixed silage at 70:30 ratios gave better nutritive quality silage and feeding Yankasa rams with the silage improved their performance, increased net cost-benefit of the farmer by 27.62 % % and consequently reduced the cost of feeding. Therefore, combination ensiled sorghum and lablab forages at 70:30 mixture ratio is recommended for improved performance of growing Yankasa rams.

Keywords: Performance, *Sorghum almum*, *Lablab purpureus*, Silage, Concentrate Yankasa rams

Performance des béliers Yankasa en croissance nourris avec des fourrages ensilés de *sorgho almum* (Parodi) et *Lablab purpureus* (L. Sweet) et un supplément de concentré

Résumé

L'ensilage offre des moyens alternatifs de conservation du fourrage pendant la saison des pluies tout en conservant la qualité nutritive du fourrage destiné à l'alimentation des ruminants. Une expérience a été menée

au Programme de recherche sur l'alimentation animale et la nutrition de l'Institut national de recherche sur la production animale, Shika, pour évaluer les performances de croissance des béliers Yankasa nourris à différents niveaux de sorgho ensilé (Sorghum almum) et de fourrages lablab. L'ensilage a été préparé en récoltant des fourrages de sorgho et de lablab aux stades pâteux et de floraison, respectivement, hachés à 2 cm avec un hachoir à fourrage, flétris pendant 12 heures et transformés en quatre traitements diététiques suivants contenant du sorgho fourrager et du lablab à 100:0, 90. Rapports mixtes :10, 80:20 et 70:30. Les matériaux d'ensilage ont été placés dans des sacs en polyéthylène et ensilés dans un silo à quatre fosses cloisonnées mesurant 10 m de longueur x 10 m de largeur x 6 m de hauteur. Les ensilages ont été ouverts après 21 jours pour inspection physique et analyse chimique. Vingt béliers Yankasa en croissance, âgés de 10 à 12 mois et pesant en moyenne 21,00 + 0,40 kg, ont été répartis au hasard dans l'un des ensilages produits et complétés par du concentré. Les béliers ont été nourris individuellement en enclos à raison de 3 % de leur poids corporel (60 % d'ensilage et 40 % de concentré) avec une allocation de 200 g/jour pendant une période de 12 semaines dans un plan complètement randomisé (PCR) répété cinq fois. La composition de l'ensilage dans un rapport de 70:30 de fourrages de sorgho et de lablab était d'un pH très acide (3,72) avec une couleur vert jaune, un arôme très sucré et une texture très douce ; des protéines brutes plus élevées (10,10 %), du calcium (0,45 %) et du phosphore (0,35 %) ont été observées. La consommation alimentaire totale était significative (P < 0,05) dans tous les traitements, avec la valeur la plus élevée (475,95 g/jour) chez les béliers nourris dans des proportions mélangées de 80 : 20, à égalité avec (453,89 g/jour) chez les béliers nourris avec de l'ensilage mélangé à 90 : 10. Le gain de poids corporel moyen et le gain de poids quotidien étaient significativement (P <0,05) plus élevés (6,90 kg/bélier) et (82,14 g/bélier/jour) chez les béliers nourris à 70:30 d'ensilage mélangé que les autres traitements. Le taux de conversion alimentaire (5,33) était significativement meilleur (P < 0,05) chez les béliers nourris à raison de 70 :30 d'ensilage mélangé. Les coefficients de digestibilité des nutriments DM, EE, CF et NFE n'étaient pas significatifs (P>0,05) dans tous les traitements. La digestibilité du CP était meilleure et allait de (69,15 à 84,26 %), le NDF et l'ADF étaient significativement (P < 0,05) plus élevés dans tous les traitements sauf dans le contrôle. mixte. L'azote absorbé (19,86 g/jour), l'azote retenu (15,53 g/jour) et l'azote absorbé en pourcentage d'absorption (80,67 %) étaient significativement plus élevés (P < 0,05) chez les béliers nourris avec un rapport d'ensilage mélangé de 70:30. Le rapport coût-bénéfice net le plus élevé, soit 4 114,48 kN, a été obtenu pour l'alimentation des béliers avec du fourrage de sorgho et de lablab dans un rapport de mélange de 70:30 par rapport aux autres traitements. Il a été conclu de cette étude que le sorgho fourrager et l'ensilage mélangé lablab dans des rapports de 70:30 donnaient un ensilage de meilleure qualité nutritive et que nourrir les béliers Yankasa avec l'ensilage améliorait leurs performances, augmentait le rapport coût-bénéfice net de l'agriculteur de 27,62 % % et par conséquent réduisait le coût de l'alimentation. Par conséquent, une combinaison de fourrages ensilés de sorgho et de lablab dans un rapport de mélange de 70:30 est recommandée pour améliorer les performances des béliers Yankasa en croissance.

Mots-clés : Performance, *Sorghum almum, Lablab purpureus*, Ensilage, Concentré de béliers Yankasa

Introduction

The rising world population, economic growth, and greater purchasing power in developing countries affect the dynamics of food production (Wheeler and Von Braun, 2013). In this scenario, the use of forages an important strategy to ensure the correct levels of supplementation to ruminants throughout the year. In order to ensure all year-round feed for livestock, research on fodder conservation in Shika, northern Guinea Savanna of Nigeria showed that there are inherent problems in conservation of forages as hay (Amodu *et al.,* 2004). The right climatic conditions suitable for hay

making coincide with time when forages are low in nutritive value while making of good quality hay during rainy season is practically impossible due to humid weather condition (Amodu *et al.,* 2004). Therefore, silage making offers alternative means of fodder conservation during the rainy season while retaining nutrient quality of the fodder. Also, silage production is not a common practice among the majority of the livestock producers in semi-arid zone of Nigeria. The conservation of forage as silage should be of particular interest and value to Nigerian livestock farmers, since it provides ample opportunity to harnessing wet season's excess forage growth for later use during the period of feed scarcity in the dry season (Amodu *et al*., 2008).This is a major challenge to livestock production in Nigeria as to ensuring adequate feed supply throughout the year in terms of quality and quantity. During the dry season forage quality declined to 3 % crude protein which is below the critical level of 7 % crude protein recommended (Alalade *et al*., 2014). *Sorghum almum* provides high quality fodder for silage preparation (Muhammad *et al.,* 2008). It is a short-lived perennial forage species which is easily established from seed with rapid growth and fodder yield accumulation within the year of establishment. Promising legume with high fodder and grain production on the Sub -humid

Savanna is Lablab (*Lablab purpureus* L. Sweet) and a multipurpose, late season herbaceous legume that can effectively fit into crop-livestock integration (Kato *et al.,* 2013). Small ruminants are usually reared with the aims of getting products such as meat, milk, wool and skin Musa *et al*., (2016). The four products assume varying degrees of importance in different countries, depending on the existing agro-ecological conditions, production system, choice or interest of the producers (Paez Lama *et al.,* 2013). A large percentage of the rural people satisfy their subsistence needs through livestock production which involves the rearing and marketing of livestock (Oladele, 2004). Musa (2016), reported that almost all households in the Sudano-Sahelian zones of Nigeria possess at least 1-5 small ruminants indicating a practice of crop-livestock integration and this indicate the potentials for livestock production especially for small ruminants. Ruminants rely heavily on low quality roughages (Thorpe *et al*., 2000) without supplementation. Consequently, this results in poor growth and low animal productivity. These feeds during the dry season become fibrous and devoid of most essential nutrients especially protein and energy, which are required for increased rumen microbial fermentation and performance of host animals (Lanyasunya *et al*., 2007a). Despite the availability of information on general feeding management of Yankasa rams, there is still little information on silage production and effective utilization of ensiled sorghum and lablab forages mixed in the feeding managements of Yankasa rams. Therefore, there is need to assess the use of these forages as dry season feed with concentrate supplementation for Yankasa rams.

The objective of these study was to determine the physico-chemical properties of silages made from ensiled sorghum and lablab forages at varying ratios and to assess the growth performance and cost-benefit analysis of the Yankasa rams offered the diets.

Materials and method

Description of experimental site

The study was conducted at the Experimental Farm of the Feeds and Nutrition Research Programme, National Animal Production Research Institute (NAPRI), Shika, Zaria. Shika is located on Latitude 11^0 12'W. Longitude 07^0 33'E with an altitude of 660 m above sea level, along Zaria-Funtua Road in the Northern Guinea Savannah zone of Nigeria (Ovimap, 2018). The climate of the study area is characterised by a defined wet and dry season. Wet season starts from April to early May and ends in late September to early October while the dry season last from October to April. The total annual rainfall ranges from 748.6 – 1156.7 mm with a long-term average of 1058.60 mm, with a maximum air temperature of 37^0C in May and minimum air temperature of 11.5^0C recorded in December/January and relative humidity of approximately 70% (IAR, 2018).

Preparation of ensiled sorghum and lablab forage mixtures

Sorghum and Lablab forages were harvested at 84 days after sowing, then chopped to 2 cm with a forage chopper. The chopped forage materials were allowed to wilt for 24 hours and ensiled in a four partitioned pit silo measuring 10m x 10m x 6m properly covered with blue polyethene and compressed with sand bags to allow exit

of gasses. Silage treatments were mixed according to the following proportions of sorghum and Lablab at 100:0, 90:10, 80:20 and 70:30. The silage treatments were made on the same day and laid in a Completely Randomized Design with 3 replicates each.

Silage sampling

The silages were opened after 21 days for physical and chemical analysis (colour, aroma and texture) by visual examination and rated by independent scorers as described by Amodu *et al*. (2005); and Olusola (2011). The pH of the silage was measured with pH meter. Composite sample (450g) was obtained by selecting materials (150g) from the top, middle and bottom of each jar and then bulk immediately and mix thoroughly before it is being stored in the refrigerator at (-5^0C) until required for proximate analysis is presented in Table 2. Composition of the concentrate supplement was prepared to contain; maize, wheat offal, cotton seed cake, bone meal and salt as presented in Table 1.

Experimental animals and their management

The experiment was conducted at the Small Ruminant Research Programme experimental unit of the National Animal Production Research Institute (NAPRI) Shika, Ahmadu Bello University, Zaria. Twenty (20) growing Yankasa rams aged between 10-12 months with average body weight of 21.0 $\pm$ 0.4 kg were used in the study. The animals were initially prophylactically treated against internal and external parasites during the acclimatization period of 14 days. All animals received 0.1ml/10kg body weight of *Ivermectin* (10ml) injection and 0.1mg/kg body weight of *Tetranor* (*Oxytetracycline Dehydrate*, 20 % weight/volume injectable solution). Other routine management practices carried out was deworming against intestinal parasites using *Albendazole*® 10% solution administered orally; *Amitics*® solution was also sprayed on the animals using knapsack sprayer against external parasites twice a week prior to the commencement of the study.

Experimental design and animals feeding

The rams were initially balanced for their weights and allotted to four dietary treatments with five rams per treatment in a Completely Randomized Design experiment (CRD). The experimental treatments contain sorghum and lablab forage silage mixtures in the ratios of (100:0, 90:10, 80:20 and 70:30) which were fed as basal diets respectively, with concentrate as supplement. The rams were pen-fed separately with the silage treatment diets and concentrate supplement at 3 % body weight (BW) (60 % silage mixture and 40% concentrate) for a period of 12 weeks. During the feeding trial, concentrate diet was offered once in the morning (8.00am) then the forage sorghum and lablab silage mixtures immediately after they finish the concentrate. Daily records of feeds offered (concentrate and silage) and left over were recorded to determine the voluntary feed intake. Water and mineral salt-licks were provided *ad libitum* to the rams. During the experiment the rams were also weighed fortnightly to determine their live weight changes and to adjust for the feed offered.

Digestibility and Nitrogen balance study

At the end of the feeding trial, three rams from each of the four treatment groups were randomly selected and housed in individual metabolism crates ideal for easy collection of urine and faeces as described by Osuji *et al.* (1993). The rams were maintained on the same treatment diets used in the feeding trial. The animals were allowed 14 days adjustment period to the crates and 7 days collection period for urine and faeces. The residues of previous day's feed were collected and weighed each morning at 8:00am. The total faecal output from individual animals was collected daily in the morning, weighed, mixed thoroughly and 10% sub sample taken for dry matter determination. The total faecal sample collected over the 7 days period was bulked and sub sampled (40g) and oven dried after treating with 20 % formaldehyde to prevent further bacterial activity in polyethene bags until required for laboratory analysis. The total urine output for 24 hours was collected from individual animals for a period of 7 days. This was done by using graduated plastic containers containing 10mls 0.1N H_2SO_4 which was placed under the metabolism crates. 10 % of the daily urine output (aliquot) was taken from each ram bulked and stored in a deep freezer at (0^0C) until required for analysis.

Chemical analysis

Samples of the forages harvested, feed offered and faeces were analysed for dry matter (DM), crude protein (N x

6.25), crude fibre (CF), Ether extract (EE) and Ash contents according to the procedure described by AOAC (2005). Nitrogen Free Extract was calculated by difference NFE = 100 - (CF + CP + EE + Ash). Acid detergent fiber (ADF) and neutral detergent fiber (NDF) were determined according to the method of Van-Soest (1991). Mineral contents (Calcium and Phosphorus) were determined by the standard laboratory procedure of AOAC (2005) using the Atomic Absorption Spectrophotometer. Urine was analysed for nitrogen using Kjeldahl Procedure (AOAC, 2005). Samples of experimental diets, orts and faeces were burnt to ash by charring in Muffled furnace at 500^0 C for 6 hours. Organic matter (OM) was obtained as the difference between the dry matter and ash content. Metabolizable energy of the diets was calculated by the equation of Alderman, (1985) as: ME (MJ/Kg DM) = 11.78 + 0.0064 CP + $(0.00065EE)^2$ – CF (0.00414EE) – 0.0118A. Where ME = Metabolizable energy, DM= dry matter, CF = crude fiber, CP = crude protein, EE= ether extract and A = Ash.

Cost benefit analysis of the experimental diets

The value of gain and net benefit for each treatment was calculated based on the value of weight gain by each ram and cost of feed consumed during the experimental period of 12 weeks. The total cost of feed per kilogramme (kg) was determined by addition of costs of concentrate and silage mixtures per kg. Total feed consumed was recorded as the total feed intake from each treatment for silage and concentrate. Cost of feeding each ram was calculated as total cost of feed multiplied by total feed consumed divide by 5 (number of rams). The value of gain was determined as live weight gain of each ram multiplied by N750.00 (cost per kg of live weight experimental period). Cost per kg gain was calculated as cost of feeding divided by live weight gain. Net benefit was determined as value of gain minus cost of feeding each ram, using the procedure of Hassan *et al.* (2016).

Statistical analysis

Data collected on daily voluntary and nutrient intake, average daily gain, initial and final weights, coefficients of digestibility and cost benefit analysis were analysed by ANOVA using the General Linear Model Procedure of (SAS, 2005). Significant treatment means were compared using the Post Hoc Test (Dunnet's test).

Results

Physical properties of silage produced

The physical properties of forage sorghum and lablab mixed silages is shown in Table 3. The pH value of 3.72 was significantly (P>0.05) lower and better in 70:30 mixed silages compared to other treatments. The silage temperature fell within the range of 36.33-37.30^{0}C. In terms of colour, aroma and texture, 70:30 mixed silage had yellowish green, very sweet and very soft physical properties respectively.

Chemical properties of concentrate, sorghum and lablab forages

The chemical composition, Metabolizable energy and relative feed values of concentrate, fresh sorghum and lablab forages harvested before ensiling is presented in Table 1. The concentrate supplement given to Yankasa rams had a DM, OM, CP, CF, EE, Ash, NFE, ME, RFV, ADF, NDF, ADL of 92.68%, 86.02%, 15.75%, 5.09%, 6.66%, 64.92%, 11.67MJ/Kg, 105.45, 28.68%, 58.69% and 30.01% respectively. The DM and CP of sorghum and lablab forages obtained are (92.50%, 9.62%) and (94.47%, 22.53%) respectively. The CF of lablab forage was 22.14% and greater than 19.01% for sorghum. The relative feed values of both crops are above 100% and ME are within 12.13-12.17MJ/Kg.

Chemical properties of the silages

Chemical properties of the ensiled sorghum and lablab at the varying ratios are presented in Table 5. The dry matter content ranged from 60.10 - 44.74%. The organic matter was significantly (P>0.05) high (53.92 %) in 90:10 silage, followed by 100:0 silage (50.89%). The lowest (36.96%) was recorded in 80:20 silage. The crude protein content was significantly (P>0.05) higher (10.10%) in 70:30 mixed silage than all other treatments. The crude fiber contents were not significant (P<0.05) except in 80:20 mixed silage. Ash content (9.21%) was significantly higher in the control (100:0) than other treatments. However, nitrogen free extract ranged from 16.77 – 32.55%. The metabolizable energy and relative feed values were not significantly (P<0.05) different among treatments. The acid detergent fibre and neutral detergent fibre ranged from 33.29 – 38.21% and 44.64 – 50.11% respectively. The calcium (0.35%) and

phosphorus (0.45%) contents are significantly (P>0.05) higher in 70:30 mixed silage than other treatments and the lowest values (0.25% and 032%) were obtained in the control (100:0) respectively (See figure 1).

Growth performance of growing Yankasa rams fed varying levels of ensiled sorghum and lablab forages with concentrate supplementation

The result on performance characteristics of growing Yankasa rams fed forage sorghum and lablab mixed silages are presented in Table 4. The voluntary silage dry matter (DM) intakes are significant (P<0.05) across the treatments except in 90:10 and 70:30 silage mixtures. Silage DM intake of (164.52 g/day) for rams fed 80:20 mixed silage was significantly (P<0.05) higher than other treatment groups, the control had the least DM intake of the silage (118.81 g/day). The concentrate DM intake was not significantly different across all the treatments. However, the total dry matter intake (475.95 g/day) was significantly (P>0.05) higher in rams fed 80:20 mixed silage compared to other treatments. The initial and final body weight of the rams were not significantly (P<0.05) difference. The average body weight gain and daily weight gain of rams fed with 90:10, 80:10 and 70:30 diets differed significantly (P<0.05) from the control (100:0). The highest average body weight gain (6.90 kg) and daily weight gain (82.14 g/day) was observed in rams fed with 70:30 mixed silage while the lowest average body weight gain of 4.30 kg and daily weight gain of 51.19 g/ram/day was obtained in rams fed the control diet. The feed conversion ratio was significantly (P<0.05) better (5.33) in rams fed 70:30 diet compared to the control (8.39).

Nutrient digestibility coefficient of growing Yankasa rams fed varying levels of ensiled sorghum and lablab forages with concentrate supplementation

The nutrient digestibility of growing Yankasa rams fed varying levels of ensiled sorghum and lablab forages with concentrate supplementation is presented in Table 5. The digestibility coefficients of dry matter were not significant (P>0.05) across all the treatment groups with a range between 82.22 – 88.74%. The crude protein digestibility coefficients of 84.26%, 78.94% and 77.91% obtained from rams fed 70:30, 100:0 and 80:20 respectively and are significantly (P<0.05) different from 69.15% fed 90:10 mixed silages. The ether extract, crude fibre and Nitrogen free extract digestibilities were not significantly (P>0.05) different across all the treatment groups. The neutral detergent fiber and acid detergent lignin were significantly (P<0.05) higher (85.08% and 84.80%) respectively in Yankasa rams fed 70:30 silage compared to rams fed the control (78.65% and 75.99%) silage, respectively.

Nitrogen balance of growing Yankasa rams fed varying levels of ensiled sorghum and lablab forages with concentrate supplementation

The result of nitrogen balance study is presented in Table 8: The result showed that there was a significant (P<0.05) difference in nitrogen balance parameters across all the treatments. The nitrogen intake was significantly (P<0.05) higher (24.58 g/day) in rams fed 70:30 mixed silages compared to the other treatments. The faecal nitrogen loss was not significant (P>0.05) across treatment groups except in rams fed 90:10 mixed silages. The highest value of urinary nitrogen loss (4.33 g/day) observed for rams fed 70:30 was significantly (P<0.05) higher than those fed the other treatments. But the total nitrogen out go was not significantly different across all the treatment groups. However, the highest amount of Nitrogen absorbed (19.86 g/day), Nitrogen retained (15.53 g/day), Nitrogen absorbed as percentage intake (80.67 g/day) and Nitrogen retained as percentage intake was highest (62.76 g/day) were obtained in rams fed 70:30 mixed silages compared to other silage mixtures. But not significantly (P>0.05) different from the control except in nitrogen retained.

Cost benefit analysis of growing Yankasa rams fed ensiled sorghum and lablab forages with concentrate supplementation

Table 7: Shows the cost benefit analysis of feeding varying levels of forage sorghum and lablab mixed silages to growing Yankasa rams. The cost/kg of concentrate was the same for all treatments (50.80 ₦/kg). The cost /kg of silage increased with increase in quantity of lablab in the mixture from (40.40 – 47.60 ₦/kg). The cost of concentrate consumed was statistically similar across treatments. The cost of silage consumed by rams fed 80:20 (7.52 ₦/day) and 70:30 (6.41 ₦/day) are significantly (P<0.05) higher than those fed 90:10 (21.95 ₦/day) and 100:0 (20.63 ₦/day) respectively. The cost of feed consumed per ram per day was significantly (P<0.05) higher in rams fed forage sorghum and lablab mixed silage compared to the control. The value of gain (weight gain x prevailing market price of 750 per kg).

The value of gain was higher (₦ 4,425.00k) in rams fed 70:30 and lowest (₦ 3,225.00k) in rams fed 100:0 silage mixtures. However, the net benefit derived from feeding Yankasa rams with forage sorghum and lablab mixed silages were higher (₦ 4,114.48k) in 70:30 diet compared to the values obtained in the other treatment groups. This represents 27.62 % higher net benefits obtained when 70:30 was fed to the rams compared to the treatment groups.

DISCUSSION

The combination of gramineae grasses with legumes is one of the effective methods for the preparation of high quality silage (Ridwan *et al.*, 2015; Li *et al.*, 2019). The chemical composition of concentrate, fresh forage and lablab before ensiling were adequate to meet the nutritional requirements of ruminants due to crude protein content of above 9.0%, metabolizable energy was above 11.67MJ/kg and more than 100% relative feed value. The physical properties of silage obtained in this study showed that 70:30 mixed silage produced the lowest (3.72) pH, yellow green colour, very sweet aroma and very soft texture. pH value was reported as one of the simplest ways of evaluating silage quality. Silage that has been properly fermented will have a much lower pH (moderately acidic to slightly acidic). Abdulrahman *et al.* (2018), reported that a good quality grass and legume silage pH values in the tropics range between 4.3 – 4.7. The silage DM was above 44.0% classified as haylage or low moisture silage (Ishiaku *et al.*, 2020). The crude protein (CP) ranged from 6.43 – 10.10 %. This increase could be associated with increased levels of lablab in the silage mixture. The crude protein is one of the quality parameters used in pasture evaluation (Muhammad and Halim, 2014). However, The CP value of all the treatments except in the control, were greater than the bench mark recommended for efficient rumen function in matured beef cattle 7 % but fell short of the requirement of high producing dairy cows 19 % as reported by Sebahattin *et al*. (2011). The CP values reported in this study was slightly below the requirement of 10 – 12 % CP for sheep and goats (Wada *et al*., 2016). In a previous study, Muhammad *et al*. (2008) reported that inclusion of lablab improved the nutritive value of pear millet-based silage from 10.2 – 11.8%. The crude fibre contents obtained in this study was within 29.90% - 35.60% reported by Abubakar *et al*. (2015) for millet ensiled with tropical legumes. The nutrient detergent fibre (NDF) was below 60.0 % suggested by Muia, (2000) as critical limit for efficient utilization of roughages. The metabolizable energy obtained ranged from 10.07 – 10.51 MJ/kg below the range of values 10.85 – 11.16 MJ/kg reported by Sani *et al.* (2015) for fattening bulls. The RFV index is used to rank cool season legumes, grasses and mixtures by potential digestible dry matter intake and it enables allocation of forages to the proper livestock class with a given level of expected performance (Lanyasunya *et al*., 2007c). The relative feed value (RFV) obtained in this study is above 100 and it indicated a good quality silage (Agric- fact, 2006).

Dry matter intake is an important factor in the utilization of feeds and a critical determinant of energy and performance in small ruminant (Abdu *et al*., 2015). It appears that the mixed silage of 70:30 was probably more absorbed and utilized by the rams. The variations observed in feed intakes could be as a result of improvement in the protein status of the feed which enhances rumen micro-organism profile and encourage a more rapid and thorough digestion of ingesta leading to assimilation. Hassan *et al*. (2016) reported that inclusion of lablab in the diet can help to increase the efficiency of utilization of roughages by the rumen microbes which resulted in improved weight gain. Lanyasunya *et al*. (2007b) in a study in China, reported that increase in intake is attributed to increase in nitrogen in the diet and available fermentable fiber. They further suggested that beneficial effect of the incorporation of highly digestible legume in an otherwise low digestible basal diet could be that, it exert a large effect on digestibility by providing a highly colonised fiber source to "seed" bacterial onto the less digestible fibre. The result of this study indicated an increase in body weight (6.90kg) and a daily weight gain (82.14 g/day) when the rams were fed ensiled sorghum and lablab forages at the ratio of 70:30. This could be as a result of better feed conversion ratio by the rams to have consumed more nutrients and energy available for tissue development. This was in agreement with the report of Njidda, (2008) and Wada *et al*. (2016) that efficient utilization of feed supply adequate energy and protein is required for optimum growth and performance in ruminants. The feed conversion ratio (FCR) obtained

in this study (5.33) for 70:30 of ensiled sorghum and lablab forages was better than (10.72) report by Hassan *et al.* (2016) for lablab hay mixture. Better FCR observed in 70:30 silage mixtures might be attributed to better utilization of feed and hence improved body weight gain.

The dry matter digestibility of Yankasa rams fed forage sorghum and lablab mixed silage obtained in this study followed an increasing trend as the inclusion level of lablab increased. The dry matter values (82.22 – 88.74%) were higher than the range of values for dry matter (77.74 - 80.65 %) when *Panicum maximum*: Centrosema basal diet was fed to Yankasa rams reported by Abdu *et al*. (2015). The digestibility of crude protein, crude fibre, ether extract, ash and nitrogen free extract was found to increase with increase in the ratio of lablab silage in the forage mixtures when compared with the control (100:0). This could be attributed to the fact that increasing the ratio of lablab silage in the basal diet improves the digestibility of the forage mixtures. In earlier report by Hassan *et al*. (2016) stated that lablab improves the digestibility of poor-quality roughages, increase passage rate in the rumen, maintain stable rumen environment and facilitate growth of rumen microbes. Also, Lanyasunya *et al.* (2007d) in a study in china reported that forage legumes are relatively good sources of digestible nitrogen and fermentable energy so their inclusion in low quality diets is likely to increase the rumen population of cellulolytic microbes, thereby improve the rumen concentration of fermentable products and nitrogen utilization. Several studies have been reported on decreased digestibility as a result of high levels of NDF and ADL and depress dry matter intake and dry matter digestibility (Njidda *et al*., 2014).

Nitrogen retention is the major indicator for assessing the protein nutritional status of ruminant livestock (Abdu *et al.*, 2012). It is also the proportion of nitrogen utilized by farm animals from the total nitrogen intake for the body process, hence the more nitrogen consumed and digested the more nitrogen retained and vice versa (Okeniyi *et al*., 2010). The higher nitrogen absorbed and retained in rams fed (70:30) of ensiled sorghum and lablab forages could be attributed to higher nitrogen intake of (24.58 g/day) and low (4.72 g/day) faecal nitrogen loss. It is therefore logical to infer that superior nitrogen absorbed and retained in the 70:30 silage mixture compared to the control (100:0) is due to efficient nitrogen utilization. However, nitrogen utilization and rumen fermentation characteristics observed quiet agreed with the fact that lablab has a potential to improve the performance of ruminant on poor quality diet (Cooks *et al*., 2005). Also, higher nitrogen retention (15.53 g/day) observed from rams fed 70:30 silage mixture indicates the favourable role of lablab in post ruminal nitrogen metabolism and utilization compared to the control (9.81 g/day). This provide the fermentable nitrogen required for efficient synthesis of essential amino acids and positive nitrogen balance in Yankasa rams. The nitrogen retained and absorbed as percentage intakes were above 42.47 % similar to 47.98 % reported by Yashim *et al*. (2014) but lower than 95.84 % reported by Wada *et al*. (2016). Generally, the supplementation of protein sources improves microbial nitrogen yield and retention with subsequent increase in the performance of growing animals.

It was observed from the result of this study that, the combination of forage sorghum and lablab mixed silage in the diet of Yankasa rams resulted in a positive net benefit and income. Higher economic returns of N4, 114.48k (1US$ = N 365.00k) generated from rams fed 70:30 mixed silage compared to the control (N 2,822.00k) resulted from the addition of lablab. This is in agreement with previous reports by Yusufali, (2005) and Kabirizi *et al.* (2006) that inclusion of lablab in the diet of Yankasa rams resulted into high profit margin compared to other forage legumes and Sani *et al*. (2015) also reported a positive net benefit derived from fattening bulls with rice offal up to 30%. The study showed that a mixture of forage sorghum and lablab silage at 70:30 can increase the income of a smallholder farmers by 27.62 % compared to when sole forage sorghum was fed to Yankasa rams.

Conclusions

It could be concluded from the results of this study that, ensiled sorghum and lablab forages at 70:30 was observed to be highly acidic pH (3.72), yellow green colour, very sweet aroma with better crude protein (10.10%), higher calcium (0.45%) and phosphorus (0.35%) which was most preferred by the rams. In the growth study, ensiled sorghum and lablab forages at 70:30 gave a highest weight gain (6.90kg) better FCR

(5.33), highest nutrient digestibility above 80.0%, N retained and absorbed above 60.0% and generated 27.62 % higher net cost-benefit for the growing Yankasa rams.

Recommendation

It could be recommended from the perspective of animal nutrition and feed utilization that smallholder farmers and stock owners should conserve sorghum and lablab forages at 70:30 mixed silage as a remedy for feed scarcity during the dry season and also feed Yankasa rams with forage sorghum and lablab at 70:30 mixed silage for better performance, higher net benefit and income.

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Conflict of Interest

The Authors declare no conflict of interest

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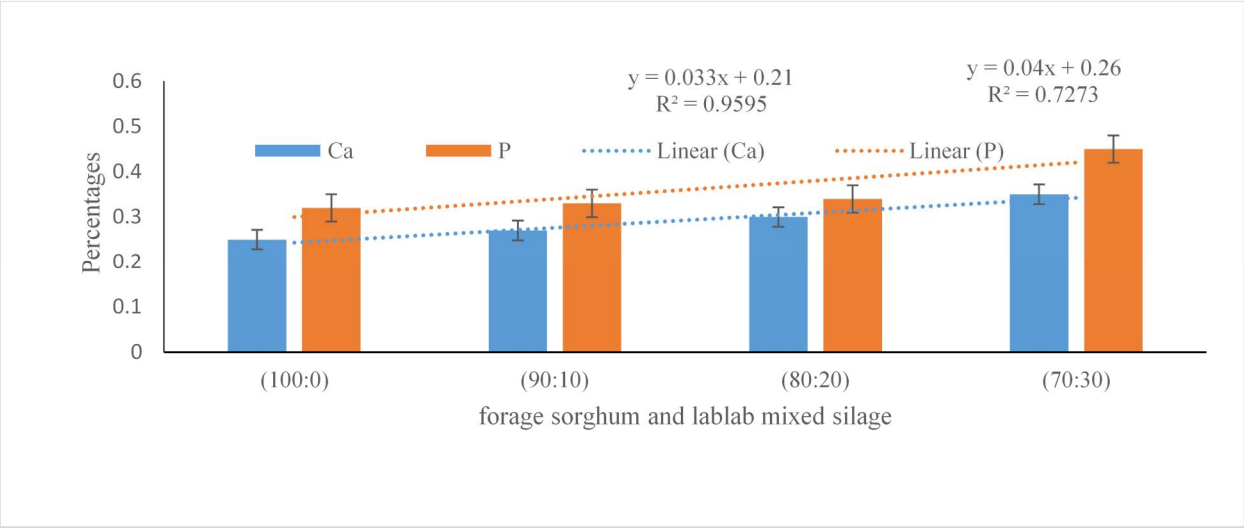

Figure 1. Shows the linear relationships of calcium and phosphorus (Ca and P) as affected by silage mixture ratios respectively

Table 1. Composition of concentrate supplement fed to growing Yankasa rams

Ingredients	**Percentage (%)**
Maize	40.0
Wheat offal	31.5
Cotton seed cake	25.0
Bone meal	2.5
Common salt	1.0
Total	100.0
Calculated analysis (%)	
Crude protein	13.63
Ether extract	17.53
Crude fibre	10.28
Ca	0.74
Available P	0.81
Ca:P	0.90
Metabolizable energy (kcal/kg)	2679.0
Cost/(₦)	50.80

1$= NGN480 (2018)

Table 2. Chemical composition of concentrate, fresh forage sorghum and lablab harvested before ensiling

Parameter (%)	Concentrate	sorghum forage	Lablab forage
Dry matter (DM)	92.68	92.50	94.47
Organic matter (OM)	86.02	87.60	83.15
Crude protein (CP)	15.75	9.62	22.53
Crude fibre (CF)	17.58	19.01	22.14
Either extract (EE)	5.09	2.03	6.37
Ash content (A)	6.66	4.9	10.32
Nitrogen free extract (NFE)	64.92	63.44	38.64
ME (MJ/kg)	11.67	12.17	12.13
Relative feed Value (RFV)	105.45	129.35	120.03
Acid detergent fiber (ADF)	28.68	26.66	27.82
Neutral detergent fiber (NDF)	58.69	48.98	52.08
Acid detergent lignin (ADL)	30.01	9.8	14.22
Hemicellulose	ND	22.32	24.26
Cellulose	ND	16.86	13.60

RFV= {88.9-(0.78 x ADF%)) x (120/NDF%)}/1.29) (Agric –facts 2006), ME (MJ/kg DM) = 11.78 + 0.00654CP + $(0.000665EE)^2$ – CF (0.00414EE) – 0.0118A.

Table 3. Physical properties of ensiled sorghum and lablab forage mixtures

Parameters	Ensiled sorghum and lablab forage mixtures				
(%)	100:0	90:10	80:20	70:30	SEM
pH	4.39^{c}	4.12^{b}	4.86^{d}	3.72^{a}	0.12
Temperature	36.33	37.30	36.70	37.0	0.40
Colour	Dark or deep brown	Light brown	Pale yellow	Yellow green	Nil
Aroma	Putrid or rancid	Pleasant	Sweet	Very sweet	Nil
Texture	Soft and wet	Soft	Very soft	Very soft	Nil

^{abc}Means with different superscripts within rows differed significantly (p>0.05).

Table 4. Chemical properties of ensiled sorghum and lablab forages

Parameter (%)	Silage diets				SEM
	100:0	90:10	80:20	70:30	
Dry matter	60.10[a]	58.82[a]	49.51[b]	44.75[c]	2.15
Organic matter	50.89[a]	53.92[a]	36.96[c]	45.10[b]	2.50
Crude protein	6.43[c]	7.01[b]	8.50[b]	10.10[a]	0.78
Crude fibre	34.64[a]	39.55[a]	24.75[b]	36.91[a]	5.40
Either extract	9.95	8.69	10.15	8.80	1.56
Ash content	9.21[a]	4.90[b]	4.05[b]	4.54[b]	2.06
Nitrogen free extract	16.77[c]	19.84[b]	32.55[a]	19.65[b]	2.42
ME (MJ/kg)	10.07	10.11	10.51	10.21	1.52
Relative Feed Value	116.83	117.60	124.87	112.05	2.64
Acid detergent fiber	33.29[b]	33.52[b]	37.15[a]	38.21[a]	2.20
Neutral detergent fiber	50.11[a]	49.64[a]	44.64[b]	49.06[a]	2.21

Relative feed value, RFV= {88.9-(0.78 x ADF%)) x (120/NDF%)}/1.29) (Agric –facts, 2006), Metabolizable energy, ME (MJ/kg DM) = 11.78 + 0.00654CP + $(0.000665EE)^2$ – CF (0.00414EE) – 0.0118A (Van Dyke and Anderson, 2002). [abc]Means with different superscripts within rows differed significantly (p>0.05).

Table 5. Growth performance of growing Yankasa rams fed ensiled sorghum and Lablab forages with concentrate supplementation

Parameters	Ensiled sorghum and lablab forages				SEM
	100:0	90:10	80:20	70:30	
Concentrate DM intake g/day	310.95	315.56	311.43	303.21	12.52
Silage DM intake g/day	118.81[c]	138.33[b]	164.52[a]	134.76[b]	9.25*
Total DM intake g/day	429.76[b]	453.89[ab]	475.95[a]	437.97[b]	14.78*
Initial body weight (kg)	21.00	21.00	21.40	21.00	0.00
Final body weight (kg)	25.30	26.80	27.10	26.90	2.48
Body weight gain (kg/ram)	4.30[c]	5.80[b]	5.70[b]	6.90[a]	0.43*
Daily weight gain (g/ram/day)	51.19[c]	69.05[b]	67.86[b]	82.14[a]	8.89*
Feed conversion ratio	8.39[c]	6.57[b]	7.01[b]	5.33[a]	0.45*

[abc]Means with different superscripts within rows differed significantly (P>0.05). SEM= Standard Error of Mean.

Table 6. Nutrient digestibility of growing Yankasa rams fed ensiled sorghum and Lablab forages with concentrate supplementation.

Parameter (%)	Ensiled sorghum and Lablab forages				SEM
	100:0	90:10	80:20	70:30	
Dry matter	82.22	84.77	86.76	88.74	5.06
Crude protein	78.94[a]	69.15[b]	77.91[a]	84.26[a]	5.60*
Ether extract	89.10	86.38	81.94	90.21	9.89
Crude fibre	78.87	80.17	72.79	83.40	8.88
Nitrogen free extract (NFE)	77.09	77.60	74.61	80.20	11.02
Neutral detergent fiber (NDF)	78.65[b]	82.86[a]	80.59[a]	85.08[a]	6.25*
Acid detergent fiber (ADF)	75.99[b]	84.14[a]	79.01[a]	84.80[a]	4.20*

[abc]Means with different superscripts within rows differed significantly (p>0.05).

Table 7. Nitrogen balance of growing Yankasa rams fed ensiled sorghum and lablab forages with concentrate supplementation.

Parameter (g/day)	Ensiled sorghum and Lablab forages				SEM
	100:0	90:10	80:20	70:30	
Nitrogen intake	15.78[b]	13.54[c]	19.09[ab]	24.58[a]	2.90*
Faecal nitrogen loss	4.11[a]	3.87[b]	6.67[a]	4.72[a]	1.36*
Urinary nitrogen loss	1.87[c]	3.92[b]	2.79[c]	4.33[a]	0.52*
Total N outgo	5.97	7.79	9.46	9.05	2.14
Nitrogen absorbed	11.67[b]	8.67[c]	12.42[b]	19.86[a]	2.28*
Nitrogen retained	9.81[b]	5.75[b]	9.63[b]	15.53[a]	2.18*
N retained as % intake	62.16[a]	42.47[b]	49.82[b]	63.18[a]	4.78*
N absorbed as % intake	73.70[b]	64.03[b]	64.84[b]	80.67[a]	4.04*

*abc Means with different superscripts within rows differed significantly (P>0.05), SEM= standard error of mean.
N = nitrogen.

Table 8. Cost benefit analysis of growing Yankasa rams fed ensiled sorghum and lablab forages with concentrate supplementation

Parameters (on dry basis)	Ensiled sorghum and Lablab forages				SEM
	100:0	90:10	80:20	70:30	
Cost/kg of concentrate (₦/kg)	50.80	50.80	50.80	50.80	0.00
Cost/kg of silage (₦/kg)	40.40[b]	42.80[b]	45.72[a]	47.60[a]	2.28*
Cost of conc. consumed (₦/day)	15.83	16.03	15.82	15.40	0.82
Cost of silage consumed (₦/day)	4.80[c]	5.92[b]	7.52[a]	6.41[a]	0.56*
cost of feed consumed (₦ /ram/day)	20.63[b]	21.95[a]	23.34[a]	21.81[a]	0.97*
Value of gain (₦)	3,225.00[c]	4,350.00[ab]	4,275.00[b]	4,425.00[a]	56.02*
Cost/kg gain (₦)	403.00[c]	317.90[a]	343.96[b]	310.52[a]	10.41*
Net benefit (₦)	2,822.00[d]	4,032.10[b]	3,931.04[c]	4,114.48[a]	35.02*

abc*Means with different superscripts within rows differed significantly (P>0.05), SEM= standard error of mean
1$= NGN480 (2018)