ASSESSMENT OF PELLETING TECHNIQUE ON THE CONSUMPTION, DIGESTIBILITY, AND CARCASS TRAITS OF MALE GOATS GIVEN VARIED AMOUNTS OF RICE BRAN IN PELLETED FEED

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Abstract

The necessity for enhancing goat intake and performance, particularly in cases where they exhibit selectivity towards non-palatable and unconventional feed ingredients during feeding, led to the adoption of pelleting techniques. A study was undertaken employing sixteen growing West African Dwarf (WAD) goats in a complete randomized design to assess the impact of pelleting on the efficient utilization of rice bran in pelleted diets. Grinded dry cassava peel (GDCP) was substituted by rice bran (Rb) in diets 1 through 4 at levels of 0%, 15%, 25%, and 35%, respectively. The consumption of Rb increased significantly ($p<0.05$) as GDCP was replaced. While there was no significant change in total feed intake ($p>0.05$), total weight gain increased ($p>0.05$) from 0.34 to 1.18 kg, as did the feed conversion ratio ($p>0.05$). Goats on Diet 4 exhibited the highest feed conversion ratio (12.97%). The nutrient digestibility of the diets showed a significant increase ($p<0.05$) in crude protein (CP) and nitrogen-free extract (NFE) as the proportion of rice bran in the diet increased. Across all criteria pertaining to carcass characteristics (fasted live weight, carcass weight, dressed weights, dressing percentage, and whole or pieces), the results were comparable ($p>0.05$). The high feed conversion efficiency, elevated digestibility coefficient CP level, and comparable value ($p>0.05$) of different carcass parts at 35% replacement of GDCP with Rb affirmed the efficacy of pelleting methods for incorporating non-palatable and unconventional feed materials alongside other feedstuffs for goats, without selective feeding behavior.

Keywords

Intake and performance of goats, Selective picking, Non-conventional feedstuffs, Feeding, Pelleting technique method

Introduction

The expense of supplementary feeding and the absence of forage during the dry season pose significant challenges to efficient livestock feeding and management in tropical regions (Animashahun, et al., 2023) . Recognizing the crucial need for adequate nutrition, it's estimated that approximately 75-80% of the cost of livestock production is allocated to feeding. This financial burden exacerbates the difficulties faced by many impoverished livestock farmers, compounded by poor marketing opportunities for farm animals, making it exceedingly challenging for them to afford supplementary feeding (Olawale et al., 2024). Consequently, there's a prevailing preference among farmers for extensive and semi-intensive rearing systems (Adamu et al., 2016). Additionally, forage scarcity during the dry season further compounds the issue, as ruminants lack access to grazing land due to its conversion for arable cropping, necessitating alternative feed sources. Rice bran, a by-product of the rice processing industry, constitutes 5 to 8% of the entire grain and boasts a rich array of chemical compositions. Compared to other feed products, it contains approximately 11-14% crude protein (CP) and 12-18% ether extract (EE), rendering it an affordable and practical feed component (Elfiana, 2020). However, goats typically exhibit low intake of rice by-products, particularly during the dry season, owing to their tough texture, low palatability, and poor digestibility. Therefore, adopting technical methods for its presentation to facilitate proper consumption becomes imperative. The pelleting technique offers a means to improve the presentation of less palatable feed ingredients to animals. It increases bulk density and enhances palatability, thereby boosting animal intake (Fasae, 2014). Additionally, pelleting ensures even distribution of nutrients (Reese, Foltz & Moritz, 2017) and enhances the ability to utilize these nutrients (Oyewole & Aderinola, 2019). Despite these benefits, there remains a lack of information regarding the extent to which rice bran can be effectively utilized by growing West African dwarf goats. Therefore, this study was designed to assess the impact of pelleting methods on the intake, digestibility, and carcass characteristics of growing West African dwarf goats fed varying levels of rice bran in pelleted diets.

Material and Methods

Experimental Site

This study was conducted at the sheep and goat unit of the Teaching and Research Farm, Landmark University, located in Omu-Aran, Kwara State, Nigeria. Omu-Aran is situated at Latitude 8.9N and Longitude 50.61E, with an approximate altitude of 306 meters above sea level. The region experiences uniformly high temperatures, ranging between 25°C and 30°C during the wet season and between 33°C and 34°C during the dry season. Relative humidity typically ranges from 75% to 80% in the wet season and around 65% during the dry season

Experimental Diet

A mechanical grinder was utilized to finely grind dry cassava peel. The four diets formulated for this study were prepared by substituting portions of ground dry cassava peel with rice bran. Ingredients were thoroughly mixed using a mechanical mixer, and pelleting was conducted using a mechanical pelletizer equipped with a die size of 8mm. Pelleted diet 1 comprised 93.50% ground cassava peel and 0% rice bran. Pelleted diets 2, 3, and 4 contained 15%, 25%, and 35% rice bran, respectively, replacing an equivalent proportion of ground cassava peel meal in the formulated diets (Table 1). Equal measured quantities of other additives were incorporated into each of the four diets prior to mixing. To facilitate pelleting, each diet was sprayed with a molasses solution prepared by reconstituting 5 kg of molded molasses in 100 liters of water, serving as a binder.

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Table 1: The composition of pelleted diet

Ingredient	Diet 1	Diet 2	Diet 3	Diet 4
dried cassava peel(kg)	93.50	78.50	68.50	58.50
Rice bran(kg)	0	15	25	35
Molasses (kg)	5	5	5	5
Bone meal (kg)	1	1	1	1
Salt (kg)	0.25	0.25	0.25	0.25
Vitamin-mineral premix	0.25	0.25	0.25	0.25

Experimental Animals and Management

Sixteen West African Dwarf (Wad) goats, aged between 5 to 6 months and weighing an average of 8kg initially, were divided into four groups of four animals each using a complete randomized design. They were individually housed in concrete-floor pens. Prior to the start of the study, the animals were subcutaneously treated with ivermectin to prevent worm infestation, and long-acting injectable oxytetracycline solution was administered intramuscularly to guard against microbial infections. Each group of animals was assigned one of the diet treatments described previously for a period of seventy (70) days, which included a seven-day adjustment period and 63 days of data collection. The goats were weighed at the beginning of the study and then weekly thereafter. The formulated diet, equivalent to 5% of the goats' body weight on a dry matter basis, was provided once daily at 8:00 AM in a clean feed trough. Clean water and salt licks were also freely available to the animals. Throughout the study, various parameters including body weight, feed intake, feed digestibility coefficient, feed conversion efficiency, and carcass characteristics were assessed. Feed efficiency ratio was calculated by dividing the feed intake by weight gain.

Animal Slaughter procedure and Carcass Characteristics Evaluation

Following 70 days of confinement on their respective experimental diets, the goats underwent a 12-hour period of water, diet, and solid fasting. Subsequently, they were randomized for slaughter. Prior to slaughter, the goats were weighed to determine their slaughter weight (SW), as outlined in Elias et al. (2015). During slaughter, the goats were stunned, and bleeding out occurred through incisions made in the carotid artery and jugular vein using a knife. Blood was collected and weighed. Following bleeding, manual skinning was performed using a sharp knife. The head was separated by sectioning the cervical vertebrae at the atlanto-occipital joint. The legs were obtained by sectioning the forelimbs at the carpal-metacarpal joints and the hind limbs at the tarsal-metatarsal joints. The weights of the skin, head, and limbs were recorded, following Elias et al. (2015) protocol. The carcass was then eviscerated, and the weight of gastrointestinal tract content was determined by the difference between full and empty gastrointestinal tract weights. The empty body weight (EBW) was calculated by subtracting the weight of gastrointestinal content from the SW, as described by Skapetas et al. (2006). The hot carcass weight (HCW) consisted of the goats post-decapitation, bleeding, and skin removal, excluding viscera and limb extremities but including kidneys and perirenal fat. Additionally, the weights of the heart, spleen, lungs, kidneys, non-carcass gut, and by-products (blood, skin, and head) were measured and classified relative to the slaughter weight or the goats.

Statistical Analysis

Data obtained from this study was subjected to analysis of variance with SAS General Model (2000) and means separated with Duncan Multiple range test at $p>0.05$ (Duncan, 1955).

Results

Table 2 presents the proximate composition of the experimental diets. The moisture content (MC) and dry matter content (DM) were found to be similar across all diets ($p > 0.05$). Diet 3 exhibited a significantly higher crude protein (CP) content (6.11%, $p < 0.05$) compared to the lowest CP content in diet 1 (0.30%). The ether extract content of the diets increased with the inclusion of rice bran; however, diet 3 showed a significant value (5.90%) that was comparable to the values of 5.34% and 4.46% in diets 1 and 2, respectively. Diet 4 had significantly higher crude fiber (CF) content (9.70%, $p < 0.05$), while there was comparability ($p > 0.05$) among the treatment means for nitrogen-free extract (NFE) values, which followed a similar trend.

Table 2: Proximate composition of experimental diets

	0% Rb (Diet1)	15% Rb (Diet2)	25% Rb (Diet3)	35% Rb (Diet4)	SEM ±
DM (%)	93.50^{a}	92.32^{a}	93.43^{a}		0.57
MC (%)	6.50^{a}	7.68^{a}	6.57^{a}	7.80^{a}	0.03
CP (%)	0.30^{c}	5.41^{ab}	6.11^{a}	5.90^{b}	0.57
EE (%)	4.46^{b}	3.60^{c}	5.90^{a}	5.34^{ab}	0.40
CF (%)	7.80^{ab}	8.56^{b}	9.20^{a}	9.70^{a}	2.25
ASH (%)	5.20^{b}	6.73^{a}	4.52^{bc}	4.60^{c}	0.45
NFE (%)	60.27^{c}	68.88^{b}	72.37^{b}	77.41^{a}	1.90

a,b= Means in the same row having different superscript differs significantly ($P< 0.05$).
Rb- Rice bran, DM-Dry matter, MC-Moisture content, CP- Crude protein, EE-Ether extract, CF-Crude fibre, NFE- Nitrogen free extract.

Table 3 illustrates the performance of growing West African Dwarf (WAD) goats fed varying levels of rice bran as a replacement for ground dry cassava peel (GDCP) in pelleted diets. The total feed intake decreased as the proportion of rice bran (Rb) in the diet increased. However, the highest mean intake (22.55 kg) was observed in diet 2, which was similar ($p > 0.05$) to the intake of 21.90 kg in diet 1. The lowest values were recorded in diets 3 and 4, respectively, and were comparable ($p > 0.05$). Total weight gain increased as more rice bran replaced GDCP, with goats on diet 4 displaying a significantly higher weight gain (1.18 kg, $p < 0.05$) compared to the lowest weight gain observed in diet 1. The feed conversion ratio followed a similar trend to total weight gain, with goats on diet 4 showing a significant ($p < 0.05$) value.

Table 3: performance of growing WAD goats fed rice bran replacement for cassava peel in pelleted diet

Parameters	DIET1	DIET2	DIET3	DIE 4	SEM±
Total feed intake (kg)	21.90^{a}	22.55^{a}	16.90^{b}	17.14^{b}	0.85
Average daily feed intake	0.35^{a}	0.36^{a}	0.27^{b}	0.28^{b}	0.01
Total weight gain(kg)	0.34^{b}	0.67^{b}	0.65^{b}	1.18^{a}	0.16
Average daily weight gain (kg)	0.01^{a}	0.01^{a}	0.01^{a}	0.02^{a}	0
feed conversion ratio	66.36^{a}	33.66^{b}	25.22^{bc}	12.96^{b}	6.17

a,b= Means in the same row having different superscript differs significantly ($P< 0.05$)

Table 4 displays the nutrient digestibility of the graded rice bran in pelleted diets based on dried cassava peel. As rice bran replaced ground dry cassava peel in the diet, the crude protein (CP) values increased. A significant ($p < 0.05$) high CP value was recorded in diet 3; however, all CP values obtained were comparable ($p > 0.05$). The ether extract (EE) values were similar for all the diets, while the crude fiber (CF) values indicated a reduction as rice bran replaced ground dry cassava peel in the diet. The ash content values were similar ($p > 0.05$), whereas the nitrogen-free extract (NFE) values increased with the replacement. The highest NFE value (61.57%) was obtained from diet 4, which was significant compared to the low value (37.98%) of diet 1.

Table 4: nutrient digestibility of the graded rice bran in pelleted dried cassava peel based diet fed to wad growing goat

	DIET 1	DIET 2	DIET 3	DIET 3	SEM±
CP (%)	11.15^{ab}	10.66^{b}	10.15^{b}	11.59^{a}	0.22
EE (%)	6.75^{a}	7.77^{a}	8.0^{a}	6.5^{a}	0.33
CF (%)	37.57^{a}	29.27^{a}	28.33^{a}	12.62^{b}	3.37

ASH (%)	3.22^{a}	3.65^{a}	4.46^{a}	4.32^{a}	0.27
NFE (%)	37.98^{b}	45.86^{ab}	45.70^{ab}	61.57^{a}	3.41

a,b= Means in the same row having different superscript differs significantly ($P< 0.05$).
Rb- Rice bran, DM-Dry matter, MC-Moisture content, CP- Crude protein, EE-Ether extract, CF- Crude fibre, NFE- Nitrogen free extract wad- West African dwarf goat.

Table 5 presents the carcass evaluation of goats fed the experimental diets. The mean live weight values were similar ($p > 0.05$), but they increased as rice replaced ground dry cassava peel in the diets (diets 1 - 4), as did the carcass weight. A significantly ($p < 0.05$) higher carcass weight (2907.08 g) was obtained in diet 4, and head weight values followed the same trend. Skin weight values were similar ($p > 0.05$), but blood volume values differed ($p > 0.05$) between diets 1 and 2, and between diets 3 and 4, respectively. The mean values for all other assessed parts were similar ($p > 0.05$). However, the mean values indicated an increase as rice bran replaced ground dry cassava peel in the diet.

Table 5: Effects of the graded levels of rice bran replacement for ground dry cassava peel in pelleted diet on the carcass characteristic of Wad buck goat.

Parameters	DIET1	DIET2	DIET3	DIET4	SEM±
LWT(kg)	5.67	5.60	6.27	6.53	0.18
CW(g)	2400.14^{ab}	2166.96^{b}	2581.98^{ab}	2907.08^{a}	120.48
HWT(g)	562.73^{ab}	550.24^{b}	652.10^{a}	654.90^{a}	19.29
LEG WT(g)	216.21	210.51	247.92	257.75	9.45
SKIN(g)	355.73^{b}	339.03^{b}	442.06^{a}	362.25^{b}	13.33
ISWT(g)	1419.73	1479.43	1454.42	1603.47	41.19
LIVER(g)	107.10	106.80	122.42	123.09	4.07
KIDNEY(g)	25.15	26.72	28.19	27.87	0.62
HEART(g)	44.56	40.22	45.45	49.88	1.66
SPLEEN(g)	14.95	12.92	18.17	20.65	1.33
LUNGS(g)	104.74	104.29	120.46	125.68	4.67
DWT(g)	5.40	5.33	5.97	6.17	0.16
BVOL(g)	150^{c}	160.67^{bc}	230^{a}	213.33^{ab}	12.61

^{a,b}= Means in the same row having different superscript differs significantly ($P< 0.05$)

LWT=live weight, CW= carcass weight, HWT= head weight, ISWT= intestinal weight, DWT= dead weight, BVOL= blood volume

Discussion

Ground cassava peel could be taken to represent the array of low protein and low energy crop residues as indicated by the calculated CP (0.30), EE (4.46%) and NFE (60.27%) of diet 1 that contained no rice bran compared to CP, EE, NFE values of diets 2 - 4 that contained 15%, 25% and 35% rice bran replacement for grinded dry cassava peel (GDCP) in pelleted diet respectively. The report of Norton (1994) indicated that feeds containing less than 8% CP could not provide enough ammonia required by rumen microbes for optimum activity. However, Yousuf et al., 2007 affirmed that relatively high acid detergent fibre (ADF) but low (ether extract (EE) and CP content were suggestive of low nutritional quality. In this study the nutrient content of all the pelleted experimental diets (2-4) increased as the rice bran (Rb) replaced ground dry cassava peel (GDCP)in the pelleted ration, and these results were in agreement with earlier reports (Asaolu and Odeyinka, 2006; Asaolu et al., 2010). The CP of pelleted diets in this study was lower than the minimum of 8% required for optimum performance of microbes (Norton, 1994). Although the CP values for all the diets were low to 11% to 13% quoted for adequate requirement for maintenance and growth in goats (NRC 2007) but the replacement of more GDCP in the pelleted rations enhanced the nutrient availability for the animals. This was evidently shown by the animal through increased intake of more rice bran in the pelleted diet and improved weight gains. According to Gous et al. (2023) growing animal with insufficient protein will not efficiently utilize the metabolizable energy and this was observation as the rice bran replaced grinded dry cassava peel in the pelleted diet. The increased nutrient digestibility with rice bran as a replacer in suggest the potential valuable of pelleting feed for growing goats as suggested by Asaolu et al., 2011 that high and comparable nutrient digestibility predicted relative value of the feed. The experimental goats in this study gained weight as rice bran increased in the pelleted diet. Although the values obtained in this study were lower compared to the values reported by authors like (Babayemi et al., 2006). However, the observed difference in weight gain with earlier studies could have been due to differences in the basal components of the diet, voluntary dry matter intake, feed intake, efficiency of feed utilization and the physiological state of the animal with increasing rice bran inclusion. Animals in diet 4 (35% rice bran inclusion) were indicated to be more efficient in converting feed to weight gain than those on less bran inclusion (diet 1-3). An earlier similar observation was reported (Tripathi et al., 2006) between growth and feed conversion. The observed increased weight gain as rice bran increased could further be attributed to the better quality protein resulted from activity of microbial as the rice bran increased in the diet.

In this study, pelleting a mixture of rice bran and ground dry cassava peel demonstrated a positive effect on the carcass performance of the animals, as indicated by an increase in the mean carcass value with higher proportions of rice bran in the mixture. Pelleting improved the intake of rice bran, which might otherwise be rejected, even during periods of feed shortage. Furthermore, the non-significant mean values of carcass by-products (such as dead carcass weight, head weight, intestinal stomach weight, liver, lungs, kidneys, etc.) and the carcass itself in animals fed with increased rice bran at the expense of ground dry cassava peel in the mixture could suggest the positive impact of consuming the mixture without selective feeding. This observation may be attributed to parameters with similar weights and amounts of means, indicating that all body areas are in similar proportions, as reported by Maciel et al. (2015). Additionally, factors such as birth type, genetics, and age, as noted by Costa et al., 2013 that when body follows a growth pattern, the head is the first to be formed, followed by the trunk and finally the members. The observed similarity in mean values between the kidney and liver may be linked to the higher protein and energy turnout from diets, possibly due to the increased rice bran content. Atti and Mahouachi (2011) suggest that under conditions of dietary protein and energy restriction, the mechanisms involved in reducing overall energy consumption of liver and renal tissue may vary. This aligns with the findings of Casey and Webb (2010), who noted that feeding animals diets containing inadequate nutrients could lead to a reduction in the weight of the liver and kidneys. Galavani et al. (2014) state that tissues necessary for breathing and metabolism should be well developed at birth, while those involved in storage and movement should be less developed, and reproductive tissues should mature later. However, the notable similarity in lung weight observed in this experiment may be attributed to the acceptability of the pelleted feed combination, feed composition, and graded inclusion of rice bran in the mixture. The mean values of the heart and spleen for the treatment groups, which were not significantly affected by the diets, might be due to these organs maintaining their structural integrity despite not receiving food initially, as eating takes priority. This is consistent with the findings of Costa et al. (2013), who reported no differences in heart and spleen weight when goats were fed diets with varying protein and energy sources. The lack of variation in intestinal stomach weight may be attributed to pelleting, diet composition related to rumen/reticulum volume, and its nutrient fermentation activity. This is supported by Urbano et al. (2013), who found that the size of the rumen reticulum increased with the inclusion of more fodder in the diet. Additionally, it may be related to the animal's size and age, which could have influenced how hindgut growth was affected by age and therefore remained unaffected by feeding regime. The blood volume collected in this study may not be proportional to the amount of feed ingested due to inadequate blood drainage after slaughter.

Conclusion

The findings of this study suggest that the pelleting method positively enhances the intake and utilization of rice bran in pelleted diets. Specifically, at a 35% replacement for ground dry cassava peel, it resulted in improved weight gain and carcass characteristics in growing West African dwarf goats.

References

Adamu, H.Y., Adesina, O.A,. Abdu, S.B., Hassan M.R., Dung. D.D., Bawa, G.S., Abdulrashid, M., Ibrahim, T.A., and Lawal, A. (2016). Comparative study on intake, Digestibility and Nutrient Balance of Cowpea, Groundnut and soybean Hays in a Mixed Diet Fed Red Sokoto Bucks. Nigerian Journal of Animal Science, Vol. 18, Nos, 1&2.

Animashahun, R., Omoikhoje, S., Alabi, O., Aro, S., Falana, M. and Agbede, J. (2023). Evaluation of the nutritive values of the leaves of three common tree at Landmark University as potential feed resource in poultry. In 2023 International Conference on Science, Engineering and Bussiness for sustainable Development Goals. (SEB – SDG) Vol . pp1 -5 IEEE

Asaolu VO, Odeyinka SM, Akinbamijo OO, Sodeinde FG. (2010) Effects of moringa and bamboo leaves on groundnut hay utilization by West African Dwarf goats. Livest Res Rural Dev; 22(1).

Asaolu .O., (2011): Utilization of moringa oleifera fodder combinations with Leucaena leucocephala and Gliricidia sepium fodders by West African Dwarf goats. International Journal of Agricultural Research 6(8):607-619 DOI:10.3923/ijar.2011.607.619

Atti, N. and Mahouachi, M (2011). The effects of diets, slaughter weight and docking on growth, carcass composition and meat quality of fat – tailed Babarine lambs, a review, Tropical Animal Health and Production 43: 1371 – 1378

Babayemi OJ, Bamikole MA. (2006) Effects of Tephrosia candida DC Leaf and its Mixtures with Guinea Grass on in vitro Fermentation Changes as Feed for Ruminants in Nigeria. Pak J Nutr. 5:14-18. doi: 10.3923/pjn.2006.14.18

Casey, N,H, and Webb, E.C . (2010)**.** Managing goat production for meat quality. Small Ruminant Research 89: 218 – 224.

Costa, M,R.G.F., Pereira, E.S,. Silva, A.M.A., Paulino, P.V.R., Mizubutie, I.V., Pimentel, P.G., Pinto, A.P. and Rocha, J.N. (2013). Body composition and net energy and protein requirements of Morada Nova lambs. Research 114: 206 – 213

Duncan, D.B. (1955). Multiple Ranges and Multiple F-Test. Biometrica. 11: 1-42.`

Elias, A.K., Alves, K.S., Liberal Veras, R.M., Oliveira, L.R.S., Mezzome, R., Curtrin, D.O. and Gomes, D.I. (2015). Carcass and non-carcass characteristics of sheep fed with acai seed meal- based diet. *African Journal of Agricultural Research 10(49):4395-4399*

Elfiana, E. (2020). Characteristics of Wafer Originated from Coffee Waste asRuminant Animal Feed. In *IOP Conference Series: Materials Science and Engineering (Vol. 654. No.1, p 02032). IOP Publishing*.

Fasae, O. A. (2014). Evaluation of cassava leaf pellets as dry season feed in smallholder sheep production. *Nigeria Journal Animal Science, 16(1):116-123*

Galvani, D,B., Pires, C.C., Hubner, C.H., Carhalho, S. and Wommer, T.P (2014).Growth performance and carcass traits of early – weaned lambs as affected by the nutritional regimen of lactating ewes. Small *Ruminant Research* 120: 1 – 5

Gous, R. M., Fisher, C., Tůmová, E., Machander, V., & Chodova, D. (2023). Dietary energy: protein ratio influences the efficiency of utilisation of dietary protein by growing turkeys. British Poultry Science, 64(1), 116-121.

Maciel, M. V., Carvaliho, F.F.R., Bastista, E.M.V., Guim, A., Souza, E.J.O., Marciel, l. P.A.A., Pereira-Neto, J.D., and Lima-Junioor, D.M (2015). Carcass and characteristics of sheep fed on cassava (*Manihot pseudoglaziovii* Pax andK. Hoffm). *Chilean Journal of Agricultural Research* 75(3): 307 - 312

National Research Council (NRC). (2007). Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids and New World Camelids. National Research Council, National Academy of Science, Washington, DC.

Norton B. W. (1994). Anti-nutritive and toxic factors in forage tree legumes. In: Gutteridge, R.C. and Shelton HM (editors). Forage tree legumes in tropical agriculture. CAB International 1994. pp. 202-215.

Olawale, O., Okeniyi, F. A., Animashahun, R. A., Joseph, A., Adekanye, T. A., & Adeniran, M. O. (2023). Effects of palm kernel cake supplement on fatty acid profile and milk composition of lactating wad goats fed grass silage. *Journal of Xi'an Shiyou University, Natural Science Edition*, *20*(1), 194-205.

Oyewole, S. T. & Aderinola, O. A. (2019).*Growth Performance and Bio-Economic Indices of Varying Mixtures of Grass-Legume Pellets Fed to West African Dwarf (Wad) Goats*. *Journal of Biology, Agriculture and Healthcare*, 9(24), 2019.

Reese, D. A., Foltz, K. L. & Moritz, J. S. (2017). *Effect of mixing and sampling method on pelleted feed nutrient analysis and diet formulation validation. The Journal of Applied Poultry Research*, pfw065. doi:10.3382/japr/pfw065.

Skapetas, B., Sinapis, E., Hettziminaouglou, J., Karala A. and Katnos, J. (2016). Effect of age at slaughter on characteristics and carcass composition in lambs mountain Greek breeds. *Czech Journal of Animal Science* 51 (7): 311 – 317

Tripathi M K, Karim S A, Chaturvedi O H and Singh V K 2006: Effect of ad libitum tree leaves feeding with varying levels of concentrate on intake, microbial protein yield and growth of lambs. Livestock Research for Rural Development. Volume 18, Article #179. Retrieved July 13, 2022, from http://www.lrrd.org/lrrd18/12/trip18179.htm

Urbano, S.A., Ferreria, M.A., Dutra – Junior, W.A., Xavier de Andrade, R., Bernardo de Siqueira, M.C. and Felix, S.C.R (2013).carcass characteristics of sheep fed castor bean hulls in replacement of tyon 85 hay. Ciene Agrotecnological Larras 36(1): 85 – 93.

Yousuf M, Belewu M, Gbadamosi A, Ogudun NI, Ogudun NI. (2007). Replacing Cotton Seed Cake with Cassava Leaf Meal in Corn Bran Based Diet Fed to the Goat. https://www.seman ticscholar.org/paper/Replacing-Cotton-Seed-Cake-with-Cassava-Leaf-Meal-Yousuf-Belew u/7115bbc8c164923e23d6694874d 2d18fc9920a7