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Performance of West African Dwarf nursing does and kids fed graded levels of palm kernel cake as replacement for formulated concentrates

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***Target Audience:** Extension agents, Goat farmers and Ruminant nutritionist*

Abstract

A sixteen-week feeding trial was conducted to evaluate the replacement value of formulated concentrate (FC) supplemented with palm kernel cake (PKC) using Pennisetum purpureum as a basal diet for nursing West African Dwarf (WAD) goats. Parameters assessed were dry matter intake, average initial live weight, average live weight change of the does and suckled kids. Fifteen lactating WAD goats and suckling kids were randomly allocated to five concentrate supplement groups of FC: PKC ratio, namely, diet 1 (100:0), diet 2 (75:25), diet 3 (50:50), diet 4 (25:75), and diet 5 (0:100) respectively in a completely randomized design (CRD). Each treatment had three replicates of one nursing doe and a suckling kid. The replacement of FC supplemented with PKC had a significant (P < 0.05) effect on the silage DM intake of the nursing does but no observable significant (P>0.05) effect was observed in their total DM intake. The levels of replacement of FC by PKC indicated a significant (P<0.05) effect on the average feed intake, average live weight of nursing does and suckled kids. The results concluded that 50% fraction replacement of of FC by PKC perfectly enhaced better performance.

***Keywords:** Nursing does, Suckling kids, Formulated concentrate, Palm kernel cake, performance*

Description of Problem

One of the major constraints to increasing animal production in developing countries is the unavailability and lack of all-year-round conventional feed resources coupled with competition for available conventional feed resouces between human and livestock [1]. To meet the high demand for livestock products and fulfill the future hope of adequate animal protein for the ever-growing population, improvement in the utilization of non-conventional feed resources is imperative. There is a need to source locally available cheap, new and lesser-known feed that can be added to the feed industry [2]. [3] reported that in places where increased pressure on available land dictates the total confinement of small ruminants, the animals depend solely on what is been brought to them as feed. The nutrient requirements for small ruminants vary substantially over the years [4], and there are doubts about the welfare of goats fed only with forage. Milk is the sole source of nutrients for the newborn mammal [5, 6] hence, the survival and potential to reach maturity is directly dependent upon the success of the dam's lactation as reported

[5]. The influence of the does diet on the milk fatty acid (FA) profile consequently influences the growth and development of the offspring. As long as the kids are suckling, their development is largely dependent on the dam's diet [7] and this influence can linger for several months post-weaning [8]. The inclusion of concentrates in a forage-based ration mostly leads to higher nutrient intake and higher weight gain [9**].** The proper development of fetuses and the newborn requires adequate transport of nutrients across the placenta and mammary glands, therefore a balanced diet during late gestation is very crucial to fetal development and survival [10]. Forage fortification with concentrate is very important to pregnant animals at trimester state as buttressed by [11] who reported inadequate and poor quality feed, especially during the dry season as one of the major constraints to small-scale goat production. The survival of small ruminants' offspring in the first hours following kidding is influenced by many factors including the dam's nutrition during pregnancy [12]. An inadequate nutrient supply during late pregnancy may result in weight loss in does and reproduction wastage (including abortion and neonatal death due to low birth weight). The problem of inadequate nutrient content may be aggravated by the reduced intake capacity of the pregnant animal in the last trimester [13], resulting in problems like pregnancy toxemia and inadequate milk supply in animals, as well as low viability and poor pre-weaning growth of offspring. This usually necessitates the provision of supplementary feeding to provide additional energy and protein [14, 15]. The application of better management practices such as improved feeding level of natural and supplemented feeds using the concentrate for dams during, before and after parturition would go a long way in improving the performance of the dam and the growth of the kids. This study was designed to evaluate the effect of replacing formulated concentrate supplements with palm kernel cake on the intake, weight performance of lactating does fed grass silage basal diet, and the weight performance of their kids.

Materials and Methods

Site of the study and Experimental supplement diets**:** The experiment was carried out at the Ruminant Unit of Teaching and Research Farm (TRF) of Landmark University, Omu-Aran, Kwara State, Nigeria. The Formulated concentrate (FC) was prepared by mixing maize (33%), Soya bean (15%), wheat offal (50%), bone meal (1%), salt (0.5%), and vitamin premix (0.5%) together. The proportion of the formulated concentrates was then replaced with palm kernel cake at 0, 25, 50, 75, and 100% levels to obtained five experimental concentrate supplements that complement the silage as shown in Table 1 of this study.

Table 1: Average daily feed intake of lactating WAD goat does fed *Pennisetum purpureum* silage supplemented with palm kernel cake as a replacer of formulated concentrate

	Concentrate / Palm Kernel Cake					
DM INTAKE (g/day)	**100/0**	**75/25**	**50/50**	**25/75**	**0/100**	**SEM ±**
Silage	880.00^{b}	880.00^{b}	880.00^{b}	979.33^{a}	1000.00^{a}	4.594
Supplement	400.00^{a}	400.00^{a}	380.00^{a}	260.00^{b}	261.00^{b}	2.341
Total	1280.00^{a}	1280.00^{a}	1260.00^{ab}	1239.00^{a}	1261.00^{ab}	2.222

* Means in the same row but with different superscripts are statistical different ($p > 0.05$).

Table 2: Weekly feed intake (kg) of lactating goat does fed *Pennisetum purpurem* silage supplemented with Palm kernel cake as a replacer of formulated concentrate.

	Weekly Feed Intake (kg)																
Conc./PKC	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AFI
100/0	5.60	5.60	5.62^{b}	7.00^{a}	7.23^{a}	7.23^{a}	8.40^{a}	8.40^{a}	8.40^{a}	8.40^{b}	8.40^{b}	8.40^{b}	9.30^{a}	9.30^{a}	9.30^{a}	9.30^{a}	7.87^{a}
75/25	5.60	5.60	5.60^{b}	5.60^{c}	6.53^{b}	6.50^{a}	8.07^{a}	8.40^{a}	8.07^{a}	8.06^{a}	8.30^{b}	8.30^{b}	8.40^{b}	8.40^{b}	8.40^{b}	8.90^{b}	7.42^{a}
50/50	5.60	5.60	5.60^{b}	5.60^{c}	6.00^{c}	6.67^{a}	7.70^{a}	8.07^{a}	8.40^{a}	8.77^{a}	8.76^{a}	8.77^{a}	8.87^{a}	8.77^{b}	8.77^{b}	8.76^{b}	7.55^{a}
25/75	6.17	6.17	6.17^{a}	6.17^{b}	6.17^{c}	6.50^{a}	7.63^{a}	7.63^{a}	7.63^{a}	6.70^{c}	6.70^{c}	7.07^{c}	6.87^{c}	6.87^{c}	6.86^{c}	6.67^{c}	6.74^{b}
0/100	6.30	6.30	6.30^{a}	6.30^{b}	6.30^{bc}	5.27^{b}	8.30^{a}	6.37^{b}	6.36^{b}	6.30^{b}	6.37^{c}	7.00^{c}	7.00^{c}	6.90^{c}	7.00^{c}	7.00^{c}	6.59^{b}
SEM ±	0.06	0.16	0.07	0.04	0.07	0.12	0.14	0.15	0.18	0.07	0.07	0.06	0.09	0.09	0.09	0.09	0.07

a,b,c, : Means in columns with different superscripts are significantly different ($p < 0.05$), AFI – Average feed intake

Table 3: Weekly weight (kg) of Lactating goat does fed *Pennisetum purpureum* silage supplemented with Palm kernel cake as a replacer of formulated concentrate

	Weekly Weight of Doe (kg)																
Conc./PKC	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AWt
100/0 (T_1)	14.50^{bc}	13.40^{bc}	13.40^{b}	14.40^{abc}	14.1	14.20^{ac}	14.50^{a}	13.70^{ab}	13.90^{ab}	13.90^{bc}	13.90^{bc}	14.10^{ab}	14.00^{ab}	14.17^{a}	14.20^{bc}	14.10^{b}	14.03^{b}
75/25 (T_2)	13.20^{c}	12.20^{c}	12.00^{b}	13.67^{c}	12.58	12.80^{c}	13.30^{a}	12.20^{b}	12.90^{b}	12.40^{c}	12.40^{c}	12.50^{c}	12.27^{c}	12.30^{b}	12.20^{c}	12.23^{c}	12.67^{c}
50/50 (T_3)	15.20^{b}	14.80^{b}	14.60^{a}	15.40^{ab}	15.3	15.17^{a}	15.00^{a}	15.00^{a}	15.40^{a}	15.00^{a}	15.10^{a}	14.90^{a}	14.77^{a}	14.63^{a}	14.70^{a}	14.67^{a}	18.92^{a}
25/75 (T_4)	14.40^{bc}	13.00^{bc}	12.20^{b}	13.87^{bc}	12.48	13.10^{bc}	13.40^{a}	12.40^{b}	13.00^{b}	12.80^{bc}	12.80^{c}	12.70^{c}	13.03^{c}	13.10^{b}	12.80^{c}	12.50^{c}	13.00^{c}
0/100 (T_5)	16.40^{a}	16.50^{a}	14.00^{ab}	15.90^{a}	14.8	14.60^{ab}	15.00^{a}	14.70^{a}	14.70^{a}	14.50^{ab}	14.40^{ab}	13.93^{bc}	13.70^{bc}	13.37^{ab}	13.27^{bc}	12.23^{bc}	14.45^{b}
SEM ±	0.22	0.4	0.37	0.30	0.22	0.28	0.31	0.27	0.28	0.30	0.30	0.26	0.27	0.27	0.26	0.26	0.30

a,b,c: = Means in columns with different superscripts are significantly different ($p < 0.05$), AWt – Average weight

Experimental animals and management: Fifteen matured West African Dwarf does weighing between 10 and 13 kg each was sourced from TRF. The goats were randomly partitioned into five groups and each group was assigned a different experimental diet in a completely randomized design (CRD) layout. Prior to the trial, the lactating does were treated against endo- and ectoparasites with Ivermectin injectable solution at a dosage of l ml/50kg body weight, allowed free grazing, and supplied with freshwater as well as salt lick within the fenced unit area of 100 x 60 m^2. Two WAD bucks were introduced to their midst for effective mating of the does at the third day after they had been synchronized for estrus intramuscularly with lutalyse^R injectable solution (1ml/doe). Two weeks prior to the expected kidding time, the pregnant does were housed individually in the partitioned kidding pen of 3 animals per dietary treatment. The measured quantity of silage in *ad-libitum* was offered alongside 400 g of supplement 10 hours after morning cleaning. Fresh water and mineralised salt lick were adequately provided.

Data collection

All the does used in this study attained end of term and kidded within six days. The weight of the does and kids were taken 1 hour after kidding and weekly afterward before daily feeding in the morning (10:00 hour). Weekly feed intake was computed through the daily record of the intake.

Statistical analysis

Data obtained were subjected to analysis of variance (ANOVA) and the significant differences among the treatment means were tested using Duncan Multiple Range Test as contained in SAS (2011) package

Results

The average daily dry matter intakes of the experimental does during the feeding trial are presented in Table 1. The silage intake of the does increased as the quantity of the PKC increased. The highest value (1000g) of silage intake was observed from animals that were offered T_5 supplement ($P<0.05$) and a low value (880g) was obtained from animals offered T_1 to T_3 concentrate supplements. The silage DM intake values of the animals fed diets T_1, T_2, and T_3 were similar (Pp>0.05), likewise, the values obtained from animals offered T4 and T5. However, there was no significant (Pp>0.05) difference in the total dry matter intake. Table 2 shows the weekly feed intake of does fed grass silage supplemented with formulated concentrate and palm kernel cake. The feed intake (DM) for all treatment groups increased weekly through the experimental period. The average feed intake indicated no significant ($P>0.05$) difference between mean values of T1, T2, and T3 but the values were significantly (Pp>0.05) different from average values of T4 and T5. The lowest average feed intake (AFI) value (6.59kg) was obtained from the group offered diet T5 and it was similar (Pp>0.05) to the AFI value (6.74kg) obtained from the does offered diet T4. At the end of the study, weight loss was observed in the does across the treatments (Table 3). At the end of the trial period, the average weights of the animals offered T^1 and T^5 were similar (Pp>0.05) while the average live weight of animal fed T3 was significantly (Pp<0.05) different among the means. The weekly live weights of kids were shown in Table 4. The weight of the kids increased weekly as the trial progressed. The live weight of kids on the day of parturition among the groups were similar (Pp>0.00). The weekly average live weight of kids from does offered experimental diets T1 and T2 were similar (p>0.05) while the average live weight of kids from does offered diet T3 was significantly (Pp<0.00) different. The kids of the does offered diet T3 displayed a high average live weight of 3.82 kg while a low average live weight of 3.12 kg was recorded from the kids resulting from does that offered diet T^5. However, all kids from the does offered the experimental diets showed increased live weight.

Table 4: Weekly weight (kg) of suckling kids of Lactating goat does fed *Pennisetum purpureum* silage supplemented with Palm kernel cake as a replacer of formulated concentrate

	Weekly weight of suckling kids																
Conc./ PKC	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AWt
100/0	0.61	1.27^{a}	1.87^{a}	2.17^{b}	2.60^{c}	2.87^{b}	3.20	3.50^{ab}	3.90^{ab}	3.83^{b}	4.40^{a}	4.60^{b}	4.70^{b}	4.92^{bc}	5.00^{b}	5.07^{b}	3.41^{b}
75/25	0.60	1.20^{a}	2.00^{a}	2.47^{a}	2.90^{b}	3.10^{ab}	3.40	3.63^{ab}	3.77^{ab}	3.80^{b}	3.70^{b}	4.27^{b}	4.70^{b}	5.10^{b}	5.50^{a}	5.77^{a}	3.50^{b}
50/50	0.60	1.40^{a}	1.93^{a}	2.30^{ab}	3.40^{a}	3.40^{a}	3.40	4.00^{a}	4.40^{a}	4.60^{a}	4.70^{a}	4.90^{a}	5.20^{a}	5.40^{a}	5.60^{a}	5.90^{a}	3.82^{a}
25/75	0.60	1.10^{b}	2.03^{a}	2.50^{a}	2.80^{bc}	3.10^{b}	3.36	3.47^{b}	3.70^{b}	3.90^{b}	4.17^{b}	4.40^{b}	4.50^{b}	4.70^{c}	4.77^{b}	4.82^{b}	3.37^{bc}
0/100	0.61	0.80^{b}	1.20^{b}	1.90^{b}	2.40^{c}	2.70^{b}	3.00	3.20^{b}	3.60^{b}	3.80^{b}	4.10^{b}	4.20^{b}	4.40^{b}	4.50^{c}	4.67^{b}	4.70^{b}	3.12^{c}
SEM±	0.020	0.060	0.080	0.070	0.080	0.080	0.070	0.100	0.120	0.110	0.100	0.070	0.081	0.075	0.066	0.077	0.080

*a,b,c: Means in columns with different superscripts are significantly different (P<0.05), AWt – Average weight

Discussion

The observed increase DM intake of silage together with a low supplement intake as the PKC replaced formulated concentrate could be due to specific feeding behavior of the does as reported by [16] that goats often have a marked preference for some feeds over others according to their palatability. The reduced weight balance of the does observed at the end of the study could be attributed to loss of nutrients in suckling during lactation. This was in line with the to report of [17] and [18] that breastfeeding was associated with weight loss. The consumption of more of the silage as the PKC level in the supplement mix increased could also mean an increase in the intakes of dietary crude fibre fractions and decreased intake of direct protein and energy. Therefore, reduction in intakes of concentrate supplements that contained more PKC compared to supplements with lesser PKC could be attributed to the fact that goats did not have the opportunity for feed preference. Also, the increasing CF content of the concentrate supplement with an increasing proportion of PKC in the concentrate diets may responsible for the reduced intake, and the observed variation in the weights of the animal across the treatment groups. According to [19] and [20] that feeding of high fibre diets often results in slower growth rates in animals. A further report by [21] opined that increasing levels of dietary fibre decreased fat lay down in animal carcass and non-carcass portions in goats. More so, a report by [22] indicated that in lactating dairy ruminants, dry matter intake is limited by physiological regulation during high concentrate feeding and by physical factors during high forage feeding. The report of [23] indicated that in other ruminant species, increase in dietary fibre content reduces dry matter intake in goats. The physical influence of the gut fill capacity of the rumen, with the reports of the afore-mentioned researchers tend to give credence to the reduced DM intake of the animals studied as PKC replaced the FC. This makes it a factor that gave rise to the varying weights of the animals fed grass-silage and PKC contained supplements. This could further be butressed by the report of [24] that feeding of high-fibre diets usually slow the growth rate compared to the feeding of high concentrate diets.

The kids' average birth weight recorded in this study was similar to that described by [25] for kids of the same breed and the increased live weight of the kids studied was in agreement with the report of [26] and [27] who reported increased growth rate with natural suckling. The observed variation in live weight of the kids at the end of the trial can be attributed to different supplement diets offered the lactating does which according to [28] that the intake of doe can influence the development of the offspring as long as offspring is suckling.

Conclusion and Applications

1. The response of kid live weight and the does fed in this study revealed the adequacy of replacement of FC by PKC. However, the best result was obtained in goat offered a supplemental diet of 50% replacement of FC with PKC.
2. PKC at 50% replacement of FC could be used as a supplementary concentrate to improve weight gain or reduce the cost of maintaining the goat during production.

References

1. Ogunbosoye D. O., Tona, G. O. , Akinfemi, A. and Ajani, M. R (2016). A preliminary study on nutrient digestibility by West African dwarf goats fed graded levels of shea nut (Vitellaria paradoxa) cake-based rations. *Nigerian Journal of Animal Production*.
2. Olorunsanya, A. E. O. (2004). Egg farming business in Kwara State, how profitable? ***Agrosearch*** 6 (1). Pp: 9-14
3. Panda, R. Das, B. C., Swain, P. and Chandrakar, K. (2018). Knowledge level of Goat Farmers of Mayurbhanij District of Odisha, India on Health and Care and General Management. *Exploratory Animal and Medical Research* 8 (2), 173-177
4. NRC, (2007). Nutrient requirements of small ruminants 7th edition. *National Academy Press*, Washington, D.C, U.S.A.
5. Daphna K. D. and Lindsay H. Al., (2018). Overview of Nutrients in Human Milk. *Adv Nutr*. 2018 May; 9(Suppl 1): 278S–294S. doi: 10.1093/advances/nmy022
6. Herwijnen, M. J. V., Driedonks, T. A., Snoek, B. L., Kroon, A. T., Kleinjan, M., Jorritsma, R., ... & Wauben, M. H. (2018). Abundantly present miRNAs in milk-derived extracellular vesicles are conserved between mammals. *Frontiers in nutrition*, *5*, 81.
7. Valvo M. A., Lanza M., Bella M., Fasone V., Prioloa (2005). Effect of ewe feeding system (grass v concentrate) on intramuscular fatty acids of lambs exclusively on maternal milk. *Animal Science.* **81**:431-436.
8. Morand-Fehr, P. and Tran, G. (2001). La faction lipidique des aliments et les corps gas utilizes en almentaion animale (The lipid fraction and fatty substances used in animal nutrition). *INRAE Productions Animales*, *14* (5), 285–302. https://doi.org/10.20870/animal-productions.2001.14.5.3753.
9. Hao, C., Chunjie W., Simujide H., and Aorigele C., (2021). Effects of dietary forage to concentrate ratio on nutrient digestibility, ruminal fermentation and rumen bacterial composition in Angus cows. *Sci Rep*. 2021; 11: 17023. doi: 10.1038/s41598-021-96580-5
10. Richard I. L., Diane D. S. and Christie N. (2016). Current Concepts of

Maternal Nutrition. *Obstet Gynecol Surv*. 2016 Jul; 71(7): 413–426. doi: 10.1097/OGX.0000000000000329
11. Lamidi, A.A. and Ologbose, F.I. (2014). Dry season feeds and feeding: A threat to sustainable ruminant animal production in Nigeria. *Journal of Agriculture and Social Research*, Vol. 14, No. 1.
12. Xiaoling Z., Qiongxian Y., Hong Y., Ao R., Zhiwei K., Shaoxun T., Xuefeng H., Zhixiong H., Musibau A. B. and Zhiliang T. (2019). Animals (Basel). 9(4): 173. doi: 10.3390/ani9040173
13. Franca M., Irene C., Elvira V., Giuseppe C., M., Paolo S., Giovanni C. and Andrea P. (2016). Nutrients. 8(10): 629. doi: 10.3390/nu8100629
14. Adeyina, A. O., Annongu, A. A. and Awe, O. (2008). Effect of cocoa beans shell on the performance, blood indicies and organ characteristics of cockrels. *Agrosearch* 10 (1) Pp: 11 – 19
15. Oyedeji, J. O., Ajayi, H. I., Epoudo, I., Eden, I. I. and Sokondi, R. S. (2015). The effects of blood rumen content mixture (BRCM) meal supplemented with yeast on the performance and gut microbial population of broiler chickens. ***Agrosearch*** 15(2). Pp: 93 - 105
16. Morand-fehr, P., Boutonne, J. P., Devendra, C., Dubeuf, J. P., Haenlein, G. F. W., Hoist, P., Mowlem, l., Capote, J. (2004). Strategy for goat farming in the 21st century. *Small Ruminant Research*. **51**, 175-183.
17. 17. Baker J. L., Gamborg M., Heitmann B. L., Lissner L., Sørensen, T. I. A. & Rasmussen, K.M. (2008). Breastfeeding reduces postpartum weight retention. *The American Journal of Clinical Nutrition* **88**, 1543– 1551
18. Stuebe, A. M., Kleinman, K., Gillman, M. W., Rifas-Shiman, S. L., Gunderson, E. P., & Rich-Edwards, J. (2010). Duration of lactation and maternal metabolism at 3 years postpartum. *Journal of Women's Health*, *19*(5), 941-950.
19. Mahgoub, O., Lu, C. D, Hameed, M. S., Richie, A., Al-Halhli, A.S. and Annamalai. K (2003). Performance of Omani goats fed diets containing various Metabolizable energy densities. *Small Ruminant Research* **37**(1):35-42
20. Lu, C. D., Kawas, J. R. and Mahgoub, O. G. (2008). Recent advancements in fiber digestion and utilization in goats [advances recientes en digestion y utilización de la fibra en caprinos. *]*. *Tropical and Subtropical Agroecosystems*, 9: 65 -72.
21. Mahgoub, O., and Lu, C. D. 2004. Effects of various levels of metabolizable energy on chemical composition of whole carcass and non-carcass portion of goats and sheep. *8th International Conference on Goats.*
22. Sanz Sampelayo, M. R., Chilliard, Y., Schmidely, P., Boza, J. (2007). Influence of type of diet on the fat constituents of goats and sheep milk. *Small Ruminant Research* **68**:42-63.
23. Kawas, J. R., Lopes, J., Danelon, D. L and Lu, C. D. (1991). Influence of forage-to-concentrate ratios on intake, digestibility, chewing, and milk production of dairy goats. *Small Ruminant Research* **4**:11-18.
24. Mahgoub, O., Lu, C.D., Hameed, C.D., Richie, A., Al-Halhali, A.S.,Annamalai, K., 2005. Performance of Omani goats fed diets con-taining various metabolizable energy densities. *Small Rumin.Res.* 58, 175–180
25. Pena-Blanco, F., Vega-Vilca, J., Sanchez-Rodriguez, M., Martos-Peinado, J., Garcia-Martinez, A., Domenech-Garcia, V. (1999). Produccion lacteal ajuste de la curva de lactacion en caprinos de raza Florida.*Archivos de Zootecnia-Uco*

48:451-424.

26. Arguello, A., Castro, N., Capote, J. (2004). Growth of milk replacer kids fed under three different managements. *Journal of Appllied Animal Resources*. **25:** 37-40.
27. Piasentier, E., Mills, C. R., Sepulcri, A., Valusso, R. (2000). Effect of rearing system on the growth rate and meat quality of young goats. In: Ledin, I., Morand-Fehr, P. FAO (Eds.). Sheep and Goat Nutrition: Intake, Digestion, Quality of Products and Rangelands. *Proceedings* of the 8th seminar of the Sub-Network on Nutrition of the FAO-CIHEAM Inter-Regional Cooperative Research and Development Network on Sheep and goats. CIHEAM, FAO, INA-PG, and INRA. Grignon (France), 3-5 September 1998; Cahiers Options Mediterraneennes (France), v. 52, pp. 119-124.
28. Morand-Fehr**,** P. (2003). Dietary choices of goats at the trough. *Small Ruminant Research* 49 (3):231-239.