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Full Length Research Paper

Evaluation of concentrate, grass and legume combinations on performance and nutrient digestibility of grower rabbits under tropical conditions

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Thirty-five (35) grower crossbred rabbits were randomly allocated to seven combinations of concentrate, grass and legume in proportions of 50 g:60 g:40 g in a completely randomized design. The treatments were: (1) rabbit meal, Rhodes grass and groundnut haulms (RRG), (2) rabbit meal, Rhodes grass and sweet potato vines (RRP), (3) rabbit meal, Rhodes grass and soybean forage (RRS), (4) Soybean cheese waste meal, Rhodes grass and groundnut haulms (SRG), (5) Soybean cheese waste meal, Rhodes grass and sweet potato vines (SRP), (6) Soybean cheese waste meal, Rhodes grass and soybean forage (SRS) and (7) rabbit meal and Rhodes grass (RR) constituted the control. The control consisted 100 g rabbit meal and 100 g Rhodes grass, which was the normal feeding regime. Diet had a significant effect (P<0.05) on feed intake of grower rabbits. Rabbits on RRS had lower feed intake compared with the other groups. There were non-significant (P>0.05) differences in daily weight gain for all the treatments. Feed cost/kg gain was, however, higher for rabbits fed RRP combination compared with the other treatments. Dry matter digestibility was higher (P<0.05) in SRP, SRS and SRG and lowest in RRP. Crude protein digestibility was significantly (P<0.05) higher in RR, RRS and SRS than RRP, while nitrogen free extract digestibility was significantly (P<0.05) higher for SRG, SRP than the control (RR) and RRS. Crude fibre and ether extract digestibility were similar for all the treatment groups. The combination of concentrate, grass and legume shows promise in the reduction in the cost of production of grower rabbits.

Keywords: Concentrate, forage, performance, digestibility, rabbits.

INTRODUCTION

Poor economic conditions in many tropical countries and associated increase in the shortage of animal protein has turned attention to rabbit production as a ready solution to the problem. This is in view of the rabbit's fast growth and short generation interval. The problem for most producers however, is the high cost of concentrates feed for the rabbits. This has necessitated the need to seek for alternative feed sources in forages. This is especially so because of the greater availability of forages and ability of rabbits to convert forage into meat for human consumption. The high cost of feed has resulted in the search for cheaper ways of producing rabbits. Use of forage and by-products of agriculture and food processing to substitute concentrate feed may be an alternative means of reducing the high cost of production associated with all-concentrate feeding systems.

Soybean cheese waste, a by-product of soybean cheese production is readily available and cheap in towns and villages of northern Nigeria where soybean cheese is widely eaten. Soybean waste meal is widely used by farmers for fattening sheep and cattle. This product has the potential of reducing the cost of concentrate feeds used for rabbits. Agricultural by-products such as sweet potato vines and soybean forage, which are in abundant

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supply, are used for livestock feeding. In many tropical countries, rabbits are sold at live weights ranging from 2.4 to 2.8 kg usually achieved when rabbits are about 20 to 25 weeks old. This long rearing period is because of the slow rate of growth especially of growing rabbits between the ages of 61 to 200 days old (Iyeghe-Erakpotobor et al. (2001). Fraga (1998) recommended a reduction in dietary protein intake of rabbits in the latter stages of growth where rabbits are raised up to 2.5-2.8 kg live weight. This study was designed therefore to evaluate the utilization of combinations of concentrate, grass and legume forages on performance and nutrient digestibility of grower rabbits.

MATERIALS AND METHODS

Site of study

The experiment was conducted in the National Animal Production Research Institute (NAPRI), Shika, Nigeria, located in the Northern Guinea Savanna ecological zone. The area lies between Latitude 10°11' N and Longitude 7°8' E, and 650 meters above sea level. The area receives an annual rainfall of 1100 mm, which is spread from April to October. The mean minimum and maximum temperatures range from 12 –28° C during the cold (harmattan) season and 20 - 36° in the hot season. Relative humidity during the rainy season is about 75% and 21% during the dry season.

Animals and housing

Thirty-five (35) 15-week old grower crossbred rabbits of average weight 1.5 kg were randomly allocated to seven treatments in a completely randomized design. The rabbits were progenies obtained from mating between New Zealand White X California and California X Chinchilla breeds. The rabbits were individually housed and fed in metal cages located in a well-ventilated house.

Ration formulation/feed composition

The treatments comprised of feeding a combination of concentrate, grass and legume in proportions of 50 g:60 g:40 g respectively. The treatments were:

Rabbit meal, Rhodes grass and groundnut haulms (RRG),
Rabbit meal, Rhodes grass and sweet potato forage (RRP),
Rabbit meal, Rhodes grass and soybean forage (RRS),
Soybean-cheese waste meal, Rhodes grass and groundnut haulms (SRG),
Soybean-cheese waste meal, Rhodes grass and sweet potato forage (SRP),
Soybean-cheese waste meal, Rhodes grass and soybean forage (SRS).

The control comprised 100 g rabbit meal and 100 g Rhodes grass (RR). This is the standard feeding regime in the rabbitry. All the forages were fed dry. Groundnut and sweet potato vines were harvested, dried, chopped and bagged for the study. The soybean forage used was obtained after harvesting, and threshing the soybean. Rhodes grass (*Chloris gayana*) hay was obtained from the Forage Production Unit of NAPRI. The ingredient compositions of the concentrate diets are shown in Table 1. The soybean cheese waste diet was compounded as practical diet farmers can compound for themselves. Sweet potato forage was included in this study because of its high protein content.

Table 1. Composition of concentrate diets fed to grower rabbits.

Ingredients	Rabbit meal	Soybean cheese waste meal
Maize	39.24	-
Groundnut cake	42.26	-
Soybean cheese waste	-	15.07
Maize offal	15.00	84.64
Bone meal	3.00	-
Salt	0.25	0.29
Vit./Min. premix*	0.25	-
Total	100.00	100.00
Feed cost/kg (₦)	30.00	11.59
Crude protein (%DM)	21.94	12.53
Crude fibre (%DM)	10.13	10.26

*Vitamin/mineral premix content per kilogram ration: vit. A 1251 IU, vit. D3 2750 IU, vit. E 151 IU, vit. K 0.002 g, vit. B_2 0.006 g, nicotinic acid 0.035 g, calcium D-pantothenate 0.01 mg, vit. B_6 0.0035 g, vit. B_{12} 0.02 g, folic acid 0.001 g, biotin 0.0005 g, vit. C 0.025 g, cholin chloride 0.39g, zinc bacitracin 0.02 g, methionine 0.2 g, avatec (lasolocid) 0.09 g, manganese 0.1 g, iron 0.05 g, zinc 0.04 g, copper 0.002 g, iodine 0.00153 g, cobalt 0.000225 g, selenium 0.0001 g. ₦ – Naira.

Growth study

The concentrate, grass and legume were weighed out and offered in separate flat bottom earthen feeders in the morning (08:00 hours) so the rabbits determined their intake of the concentrate, grass and forage. Feed left over and/or wastage were weighed daily before feeding. Water was supplied daily in earthen pots. The rabbits were treated routinely against ecto- and endo-parasites using 10 mg/ml ivomectine (Pantex, Holland) and coccidiostats. All rabbits were weighed at the start of the study before being randomly allocated to the treatments and at weekly intervals during the study. The growth study lasted six weeks. Parameters determined were feed intake, weight gain, feed conversion efficiency (weight gain/feed intake), feed cost and feed cost/kg gain.

Digestibility study

Digestibility study was conducted using three rabbits per treatment (21 rabbits) in the fourth and sixth weeks of the growth study and for four days in each case. Fecal samples were collected daily and stored at –20° C in a deep freezer immediately after collection. At the end of each collection period, the samples were bulked for each animal for proximate analysis according to AOAC (1980) procedures. Compositions of the concentrates, Rhodes grass, groundnut haulms, sweet potato forage and soybean forage was determined according to AOAC (1980). Parameters determined were feed and nutrient intake, and nutrient digestibility coefficients.

Data analysis

Data were subjected to analysis of variance using General Linear Model procedure (PROC GLM), while orthogonal pair-wise difference method was used to separate significant means (SAS, 1987).

Table 2. Proximate composition of concentrate and forages fed to grower rabbits (%DM basis).

	Dry matter	Ash	Ether extract	Crude fibre	Crude protein
Rabbit meal	96.57	6.68	12.61	10.13	21.94
Soybean cheese waste meal	96.10	6.14	20.28	10.26	12.53
Chloris	97.50	5.58	6.54	47.81	1.41
Groundnut haulms	96.94	12.77	10.35	30.43	10.84
Sweet potato vines	96.80	8.99	10.73	26.33	11.19
Soybean forage	96.57	9.92	8.85	35.38	11.58

Table 3. Performance of grower rabbits fed concentrate, grass and forage mixtures.

Treatment	Weight gain (g/d)	Total feed intake (g/d)	Concentrate intake (g/d)	Grass intake (g/d)	Legume intake (g/d)	Feed conversion efficiency (gain/intake)	Feed cost (₦))	Feed cost/kg gain (₦)
RR	8.86	130.00^{a}	86.00a	44.07a	0.00a	0.073	21.14^{b}	150.59^{b}
RRG	4.58	101.69^{bc}	43.74c	21.79bc	35.01b	0.044	21.33^{b}	192.67^{b}
RRP	5.71	107.42^{b}	47.71bc	24.72b	34.83b	0.050	21.94^{b}	299.70^{a}
RRS	3.14	98.79^{c}	44.82bc	22.98c	31.54c	0.026	20.62^{b}	198.26^{b}
SRG	11.42	107.47^{b}	48.15b	20.96c	35.21b	0.127	16.10^{ab}	122.72^{b}
SRP	5.48	102.67^{bc}	48.35b	22.76c	30.97c	0.055	14.88^{a}	148.26^{b}
SRS	3.14	103.58^{bc}	48.43b	20.97c	33.43bc	0.023	15.58^{ab}	167.47^{b}
SEM	5.00	2.74	1.52	1.18	0.95	0.044	2.19	31.06

Means with different superscript along columns are significantly different (P<0.05). RR –Rabbit meal and Rhodes grass, RRG – Rabbit meal, Rhodes grass and groundnut haulms, RRP – Rabbit meal, Rhodes grass, sweet potato vines, RRS – Rabbit meal, Rhodes grass and soybean forage, SRG – Soybean cheese waste meal, Rhodes grass and groundnut haulms, SRP - Soybean cheese waste meal, Rhodes grass and sweet potato vines, SRS - Soybean cheese waste meal, Rhodes grass and soybean forage, 1$ = N140.

RESULTS

The proximate composition of concentrates and forages are shown in Table 2. Soybean cheese waste meal diet had high ether extract and low protein content compared with the rabbit meal diet. Groundnut haulms had high ash content. Sweet potato vines had similar crude protein contents with groundnut haulms and soybean forage. Total feed intake of the rabbits varied significantly (P<0.05) among the dietary treatments (Table 3). Rabbits on the control (RR) consumed significantly more feed than those on the other treatments. The feed intake pattern showed that, the control rabbits (RR) consumed significantly (P<0.05) more concentrate and grass than the other treatments. This is expected considering the fact that they were fed higher quantity of concentrate and grass. However, total forage (grass and legume) intake was higher for the treatments than the control. Among the concentrate, grass forage treatments, concentrate intake was higher (P<0.05) for the soybean cheese waste diets (SRG, SRP and SRS) than RRG but similar to RRP and RRS while grass intake was higher for RRP compared with the other treatments except RRG. Legume intake was significantly (P<0.05) lower for RRS and SRP compared with other treatments.

There were no significant (P>0.05) differences in daily weight gain (Table 3) for all the treatments though rabbits offered soybean forage had the lowest gain and would likely take a longer time to reach market weight than the other groups. Feed conversion efficiency was poor for all the treatments and control. Feed cost was significantly lower for rabbits fed SRP than those on rabbit meal, grass, and legume combinations. Feed cost/kg gain was however, higher (P>0.05) for rabbits fed RRP compared with the other treatments. This is because of higher cost of the concentrate diet and low weight gain.

Table 4 shows the daily nutrient intake of grower rabbits from the various combinations. The control group had significantly higher dry matter intake than all the other groups. This is likely because of the higher concentrate offered the control group. Mineral (ash) intake was significantly higher for control (RR), RRG and SRG groups likely because groundnut haulms was higher in ash (Table 2) than the other forages used. Ether extract intake was significantly higher for the control (RR), SRG and SRP groups. This could probably be as a result of residual oil in the soybean cheese waste. Crude fibre and crude protein intake was higher for the rabbit meal group than the soybean cheese waste meal group. Nitrogen free extract intake was similar for most of the treatments except the control, which was higher.

Table 4. Nutrient intake (grams/day) of grower rabbits fed concentrate, grass and forage combinations.

Treatment	Dry matter	Ash (minerals)	Ether extract	Crude Fibre	Crude protein	Nitrogen free extract
RR	125.87^{a}	7.98^{a}	13.52^{a}	27.38^{a}	19.64^{a}	57.34^{a}
RRG	95.46^{b}	8.43^{a}	10.03^{c}	24.43^{ab}	12.89^{b}	39.67^{c}
RRP	103.11^{b}	7.52^{ab}	11.14^{bc}	23.62^{ab}	14.74^{b}	46.08^{b}
RRS	102.96^{b}	7.78^{ab}	10.33^{c}	27.40^{a}	14.50^{b}	42.93^{bc}
SRG	96.02^{b}	8.12^{a}	13.72^{a}	23.13^{ab}	9.60^{c}	41.45^{bc}
SRP	95.21^{b}	6.61^{c}	14.10^{a}	20.95^{b}	9.66^{c}	43.88^{bc}
SRS	91.86^{b}	6.90^{bc}	12.94^{ab}	22.63^{b}	9.86^{c}	39.53^{c}
SEM	3.96	0.34	0.44	1.49	0.65	1.73

Means with different superscript along columns are significantly different (P<0.05). RR –Rabbit meal and Rhodes grass, RRG – Rabbit meal, Rhodes grass and groundnut haulms, RRP – Rabbit meal, Rhodes grass, sweet potato vines, RRS – Rabbit meal, Rhodes grass and soybean forage, SRG – Soybean cheese waste meal, Rhodes grass and groundnut haulms, SRP - Soybean cheese waste meal, Rhodes grass and sweet potato vines, SRS - Soybean cheese waste meal, Rhodes grass and soybean forage.

Table 5. Apparent coefficient of digestibility of grower rabbits fed concentrate, grass and legume combinations.

Treatment	Dry matter	Ash (minerals)	Ether extract	Crude fibre	Crude protein	Nitrogen free extract
RR	0.66^{bc}	0.45^{b}	0.69	0.51	0.70^{a}	0.73^{bc}
RRG	0.66^{bc}	0.60^{a}	0.71	0.50	0.69^{ab}	0.75^{b}
RRP	0.59^{c}	0.42^{b}	0.68	0.43	0.59^{b}	0.69^{c}
RRS	0.67^{bc}	0.57^{b}	0.68	0.51	0.71^{a}	0.76^{b}
SRG	0.70^{ab}	0.67^{a}	0.71	0.53	0.69^{ab}	0.80^{ab}
SRP	0.72^{a}	0.57^{b}	0.77	0.55	0.68^{ab}	0.82^{a}
SRS	0.71^{a}	0.62^{a}	0.80	0.51	0.74^{a}	0.79^{ab}
SEM	0.03	0.05	0.04	0.05	0.03	0.03

Means with different superscript along columns are significantly different (P<0.05). RR –Rabbit meal and Rhodes grass, RRG – Rabbit meal, Rhodes grass and groundnut haulms, RRP – Rabbit meal, Rhodes grass, sweet potato vines, RRS – Rabbit meal, Rhodes grass and soybean forage, SRG – Soybean cheese waste meal, Rhodes grass and groundnut haulms, SRP - Soybean cheese waste meal, Rhodes grass and sweet potato vines, SRS - Soybean cheese waste meal, Rhodes grass and soybean forage.

Nutrient digestibility of rabbits (Table 5) showed higher digestibility of dry matter by rabbits offered SRP, SRS and SRG compared with those on control, RRG, RRP and RRS. Digestibility of ash was higher (P<0.05) for SRS, SRG and RRG treatments. Though intake of ether extract and crude fibre were significantly different among the groups, digestibility of ether extract and crude fibre was similar for all the treatments. Crude protein digestibility was significantly (P<0.05) higher in the control (RR), RRS and SRS than RRP though similar with SRG, SRP and RRG. Digestibility of nitrogen free extract was higher for SRG and SRP than the control, RRG and RRS.

DISCUSSION

Significant decrease in total feed intake of rabbits fed concentrate and forages have been reported in literature (Cheeke, 1984; Adegbola et al., 1985; Asuquo, 1997; Nworgu et al., 1999; Iyeghe-Erakpotobor et al., 2002). Nworgu et al. (1999) reported that an increase in the percentage of forage meal in the diet reduced feed intake of rabbits. This reduction in intake was attributed to the high crude fibre content of all forages (Asuquo, 1997). Non-significant effect of diet combinations on weight gain of rabbits observed in this study agrees with the report of Iyeghe-Erakpotobor et al. (2002) who fed varying levels (100, 75, 50 and 25%) of concentrate and forage (groundnut haulms, lablab and mucuna) to grower rabbits. Nworgu et al. (1999) however reported significant differences in daily weight gain of weaner rabbits fed varying levels of concentrate, cynodon and centrosema combinations (10.13-6.51 g/d) and the all-concentrate control (19.22 g/d). The daily weight gains reported in this study are similar to those reported by Odeyinka and Ijiyemi (1997), Nworgu et al. (1999) and Iyeghe-Erakpotobor et al. (2002) but lower than that reported by Cheeke (1984) and Asuquo (1997). Asuquo (1997) attributed differences in body weight and rate of gain of rabbits to differences in the nutrient composition of forages offered. The rate of gain in this study also agrees with the daily growth rate of 5-10 g reported by Iyeghe-Erakpotobor et al. (2001) during the grower phase.

Low feed conversion efficiency obtained in this study could be due to the high fibre content of the feed combinations. Feed cost/kg gain obtained in this study is high-

er than that reported by Nworgu et al. (1999) for weaner rabbits. This could be because of the relative cost of the forages used. Groundnut haulms and sweet potato vines are sold by farmers as by-products from their farms and would therefore be more expensive though available, than cynodon and centrosema in the North. Poor performance of rabbits fed increased forage meals is attributed to limited post-gastric fibre digestion by rabbits, which was not sufficient to provide adequate nutrients necessary for maximizing growth performance (Onibi and Owa, 1999, Iyeghe-Erakpotobor et al., 2002). Poor performance has also been attributed to depression in feed intake as a result of high ambient temperatures in tropical regions (Adegbola et al., 1985). Similar gains by grower rabbits fed high forage combinations and the standard (control) regime in this study negates this theory.

It is apparent from similar weight gains obtained in this study despite varying levels of protein intake from the various combinations that high protein intake by grower rabbits may not be effectively converted to high rate of gain therefore, any reduction in the cost of feeding this category of rabbits, especially between the weight range of 1.5 to 2.5 kg live weight, could result in higher profits for farmers. It would be expected that higher protein intake of rabbits should result in higher weight gain however this appears not to be the case in this study. Indicating that protein intake is likely not the only factor that affects weight gain of grower rabbits. Low weight gains obtained could probably be as a result of genetic ceiling placed on growth during this phase, as the rabbits approach puberty and adult weight, and would therefore, be growing at a slower rate compared with pre-weaning and weaner phases (Iyeghe-Erakpotobor et al., 2001). It is also likely that grower rabbits are able to handle a wide range of protein levels for growth without necessarily increasing feed intake. The rabbits in this study were able to efficiently utilize even the low protein available to them from the soybean cheese waste treatments for growth.

Dry matter and crude protein digestibility obtained in this study are higher than that reported by Bamikole and Ezenwa (1999) who obtained dry matter digestibility of 0.45-0.56 and crude protein digestibility of 0.50-0.64 for combinations of concentrate and grass (guinea grass) or concentrate and legume (verano stylo). High crude fibre digestibility observed in this study is similar to that reported by Bamikole and Ezenwa (1999) and indicates that the forages were high in non-lignified materials (Cheeke et al., 1986). For dry forages and protein concentrates, the crude protein content is a good predictor of crude protein digestibility (Villamide and Fraga, 1998). Cheeke et al. (1986) reported that while digestibility of protein, fibre and energy of tropical grasses is very low in rabbits, many of the tropical legumes are as digestible as temperate forages. High digestibility of dry matter, crude protein, crude fibre and nitrogen free extract obtained in this study indicates that the rabbits were able to utilize nutrients in the high forage and low concentrate combinations used for growth. It could be concluded from this study that any of the combinations of concentrate, grass and forage would be adequate for grower rabbits. Though soybean forage treatments gave the lowest rate of gain, the difference was not significant. In the rural areas where soybean cheese waste meal, groundnut haulms, sweet potato vines and soybean forage are available, these could be efficiently utilized for feeding grower rabbits.

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REFERENCES

Adegbola TA, Tibi EU, Asogwa DC (1985). Feed intake and digestibility of rabbits on all-forage, forage plus concentrate and concentrate diets. J. Anim. Prod, Res. 5(2):185-191.

AOAC (1980). Official Method of Analysis, thirteenth edition. Association of Official Analytical Chemists, Washington, D.C.

Asuquo BO (1997). Nutritional potentials of Ipomea, centrosema, pueraria, emilia and tridax forages in mixed feeds for weaner rabbits. Nigerian Journal of Animal Production. 24(1):46-50.

Bamikole MA, Ezenwa I (1999). Performance of rabbits on guinea grass and verano stylo hays in the dry season and effect of concentrate supplementation. Anim. Feed Sci. Technol. 80:67-74.

Cheeke PR (1984). Rabbit nutrition and feeding: Recent advances and future perspectives. J. Appl. Rabbit Res. 7(1):31-37.

Cheeke PR, Grobner MA, Patton NM (1986). Fibre digestion and utilization in rabbits. J. Appl. Rabbit Res. 9(1):25-30.

Fraga MJ (1998). Protein requirements. IN: The nutrition of the rabbit. Eds C. de Blas and J. Wiseman. CABI Publishing. pp. 137-143.

Iyeghe-Erakpotobor GT, Abdulmalik ME, Uguru JO, Abeke FO (2002). Determination of optimum concentrate and forage combination for small holder feeding of rabbits. Trop. J. Anim. Sci. 5(1):181-187.

Iyeghe-Erakpotobor GT, Osinowo OA, Abdulmalik M, BI Nwagu (2001). Evaluation of growth rates of three breeds of rabbits raised in the northern guinea savanna of Nigeria. Journal of Animal Production Research. 17 (1&2):78-88.

Nworgu FC, Egbunike GN, Abu OA, Fapohunda JB, Omole AJ (1999). Effects of concentrate and leaf meals on the performance of rabbits. IN: Sustainability of the Nigerian livestock industry in 2000AD. Eds: AD Ologhobo, GN Egbunike, MK Adewumi, AM Bamgbose, EA Iyayi, AOK Adesehinwa. Proc. 4th Ann. Conf. Anim. Sci. Association of Nigeria (ASAN), IITA Conference center, Ibadan, Nigeria, September 14-16, 1999. pp. 150-153.

Odeyinka SM, Ijiyemi OC (1997). Performance of rabbits fed *Leucaena leucocephala* and concentrate between 9th and 25th weeks of age. Nigr. J. Anim. Prod. 24(1):51-53.

Onibi GE, Owa BO (1999). Influence of period of provision of commercial pellets and forage (*Aspilia africana*) on the growth performance and economics of production of rabbits. IN: Enhancing livestock production in Nigeria. Eds: JK Joseph, B Awosanya, DF Apata, MA Belewu, JO Atteh, KL Ayorinde. Proc. 26th Ann. Conf. Nig. Soc. Anim. Prod. (NSAP), Kwara Hotels, Ilorin, Nigeria. 21-25 March, 1999. pp. 151-153.

SAS. (1987). SAS/STAT. Guide for Personal Computers. Version 6. Ed. pp. 697-978. SAS INSTITUTE Inc. NC.

Villamide MJ, Fraga MJ (1998). Prediction of the digestible crude protein and protein digestibility of feed ingredients for rabbits from chem.ical analysis. Anim. Feed Sci. Technol. 70:211-224.