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Effect of Concentrate Feed Restriction with a*d libitum* Forage Feeding on Performance and Carcass Yield of Growing Rabbits

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Target audience: Rabbit farmers, nutritionists, researchers.

Abstract

Effect of concentrate feed restriction with ad libitum forage (Tridax procumbens) feeding on performance, carcass yield and relative organ weights were investigated in weaner rabbits in a humid tropical environment of Nigeria. Thirty-six growing rabbits of mixed breed (Chinchilla x Dutch x California White) and sexes with an average weight of 600 g were assigned to three feeding regime in a completely randomized design. The study lasted 8 weeks. The three feeding regime were: (A) ad libitum concentrate feeding + ad libitum forage feeding (control), (B) skip-a-day concentrate feeding per week + ad libitum forage feeding and (C) skip-2-days concentrate feeding per week + ad libitum forage feeding. The forage used was air-dried Tridax procumbens. Drinking water was supplied free-choice throughout the duration of the experiment. Each treatment group was replicated six times with two rabbits housed in the same cage serving as replicate. Weight gain (Total and Average daily), final body weight, feed intake (Total and Average daily) and feed: gain ratio of rabbits were not significantly (P>0.05) different among the treatment groups. Although feed intake was not different among the three treatments, however concentrate intake (Total and average daily), forage intake (total and average daily) as well as percentage concentrate and forage in daily feed intake were significantly (P<0.05) influenced by treatments. Total concentrate intake was significantly higher with rabbits in treatment A (ad libitum feeding) compared with rabbits in treatment B, which was also significantly (P<0.05) higher than the intake of rabbits in treatment C. Rabbits fed ad libitum consumed 10.75 and 25.94% more concentrates than rabbits fed skip-a-day and skip-two-days per week concentrate . Daily concentrate intake reduced from 33.35 g in treatment A to 29.76 g and 24.69 g in treatment B and C respectively. The daily forage intake however increased with severity of concentrate restriction, the trend being C > B > A. The Concentrate percentage of daily feed intake reduced with increased severity of concentrate restriction while that of forage increased with concentrate restriction from 56.15% in ad libitum concentrate fed group to the highest amount of 68.45% in rabbits on skip-two-days of concentrate feeding per week. Dressing percentage and retail cuts were not significantly (P>0.05) affected by feeding regime. Similarly the internal organs (livers, kidneys, lungs and hearts) were not affected by the treatments (P>0.05). The results obtained from this study showed that rabbits could be subjected to two days skipping of concentrate feed per week with ad libitum forage feeding without compromising performance and carcass quality characteristic.

Keywords: Feeding regime, skip-a-day, skip-two-days, forage, rabbits and performance.

Description of problem

Rabbit production has gained considerable interest recently in Nigeria because of the exorbitant prices of the conventional sources of meat, such as cattle (beef), goats (chevon), sheep (mutton), pig (pork) and poultry. Rabbits are renowned for their fecundity and prolificacy (1)) and ability to utilize forages (2). Rabbit meat is low in fat and cholesterol (3) thus making the flesh a desirable one for diabetics, hypertensive and middle aged people.

However, Rabbit like most other monogastric animals derives most of their nutrients from concentrates. This dependence on concentrates has created a lot of demand on cereal grain. In order to address the problem, there is the need to find alternative ways, which are cheap, adequate and readily available for feeding livestock. Similarly, the development of alternative feeding sytems that will be relatively cheap when compared with conventional feeding system of finished feeds is desirable.

In recent years, there has been an increased interest in studying feed restriction in rabbits as a means of reducing cost of production. Early feed restriction also help to address problems associated with early life fast growth rate such as increased body fat deposition.

Therefore, feed restriction could be exploited in the feeding of rabbits, especially in period of inadequate supply of concentrate. Also as a promising strategy for optimizing body development of young rabbit and thus the production of cheap animal protein (4). This study was embarked upon to determine the effect of concentrate feed restriction with *ad libitum* forage feeding on performance and carcass yield of rabbit.

Materials and methods

Location

The experiment was carried out at the Rabbitry Unit of the Teaching and Research Farm, Directorate (TREFAD), University of Agriculture, Abeokuta. It lies within the rainforest vegetation zone of South West Nigeria with a mean annual rainfall of 1100mm and a temperature of 34.7^0C and a relative humidity of 82%. It is in the region of 70m above sea level of 7^0S - 5^0N longitude 3^0W 11.2^0E (Federal University of Agriculture, Abeokuta, Meteorological Station).

Experimental animals and management

Thirty-six (36), growing rabbits of mixed breed (Chinchilla x Dutch x California White) and sexes with an average live weight of 600 g were assigned to three feeding regime in a completely randomized design. The rabbits were treated for endo- and ectoparasites using Ivomec® at 1ml/50 kg live weight. Thereafter, they were acclimatized for a week, during which they were fed concentrate and forages *ad libitum*. Twelve rabbits were assigned to each of the feeding regime. Each of the feeding regimes was replicated six times with two rabbits housed together in a cell measuring 64 cm x 62 cm x 48 cm

serving as a replicate. The three feeding regime are as follows:

1 *ad libitum* concentrate feeding + *ad libitum* forage feeding
2 Skip a day concentrate feeding per week + *ad libitum* forage feeding
3 Skip 2 days concentrate feeding per week + *ad libitum* forage feeding

The composition of the concentrate fed during the trial is shown in Table 1. The forage used was *Tridax procumbens,* which was fed after wilting overnight under shade. The trial lasted 8 weeks during which measurements were**,** concentrate intake, forage intake, live weight and live weight gain.

Table 1: Composition of concentrate diet

Ingredient	(%)
Maize	47.50
Groundnut cake	10.00
Soybean meal	8.00
Wheat offal	31.00
Bone meal	3.00
Salt	0.25
Vitamin/mineral premix*	0.25
Total	100.00
Determined Analysis (% DM)	
Dry matter	89.45
Protein	18.74
Ether extract	4.58
Crude Fibre	15.68
NDF	34.29
ADF	20.54
ADL	3.31
Ash	4.25

*contains *Vit. A 4000000IU; Vit. D. 800000IU; Vit. E 40000mg; Vit. K_3 800mg; Vit. B_1 1000mg; Vit. B_2 6000mg; Vit.B_6 5000mg; Vit.B_{12} 25mg; Niacin 6000mg; Pantothenic acid 20000mg; Folic acid 200mg; Biotin 8mg; Manganese 300000mg; Iron 80000mg; Zinc 20000mg; Cobalt 80mg; Iodine 400mg; Selenium 40mg; Choline 800000mg*

At the end of the feeding trial, six rabbits whose weight were close to the mean treatment weight were selected from each treatment, tagged and moved to the meat processing laboratory (a distance of 2 kilometers).The animals were fasted but allowed access to water over a 24 hour period, reweighed to get the slaughter weight (SW) and stunned by hitting with a wooden mallet at the base of the neck before slaughtering by cutting the jugular vein. Carcass trait definitions and dissection technique recommended by (5) was followed. Briefly, weight of the Hot

Carcass (HC) was recorded about 30 min after slaughter and bleeding. HC did not include the skin, distal part of the tail, fore and hind legs, digestive tract and urogenital organs. Carcasses were then cooled at 4°C for 24 h and re-weighed to obtain chilled carcass weight (CC). The proportion of CC to SW was determined to get the dressing out percentage (DoP). Edible organs were removed from the chilled carcass to get the reference carcass (RC) weight (meat, fat and bone). Edible organ weights and RC were presented as percentage of CC. Peri-renal and scapular fat were dissected out and the RC was split between the 7th and 8th thoracic and between the 6^{th} and 7^{th} lumbar vertebrae to obtain the fore-, intermediate and hind parts. Carcass parts and depot fats were weighed and expressed as percentage of RC.

Cost analysis

The prevailing market prices of the feed ingredients at the time of the experiment were used to estimate the unit cost of the Concentrate diet. The labour cost of harvesting and overnight wilting of *Tridax procumbens* was also determined and from these costs the unit cost for a kilogramme of the forage was determined. Feed cost per kilogramme and cost per kilogramme weight gain were calculated. The percentage feed cost saving of rabbits on restriction compared to the ad libitum fed rabbits were also determined.

Chemical and data analyses

The proximate composition of the test ingredients and experimental diets were determined by the method of (6). Data was analyzed by one way analysis of variance using the statistical package of (7).

Results and Discussion

The mean values for the performance indices of rabbits were presented in Table 2. Weight gain (Total and Average daily), final body weight, Feed intake (Total and Average daily) and feed: gain ratio of rabbits were not significantly ($P>0.05$) different among the growing rabbits in the treatment groups. Although feed intake was not different among the three treatments, however concentrate intake (Total and average daily), forage intake (total and average daily) as well as percentage concentrate and forage in daily feed intake were significantly ($P<0.05$) influenced by treatments. Total concentrate intake was significantly ($P<0.05$) higher in rabbits fed treatment A (*ad libitum* feeding) compared with rabbits fed treatment B which was also significantly higher than the intake of rabbits in treatment C. Rabbits fed *ad libitum* consumed 10.75 and 25.94% more concentrates than rabbits fed skip-a-day and skip-two-days per week concentrate . Daily concentrate intake reduced from 33.35 g in treatment A to 29.76 g and 24.69 g in treatment B and C, respectively. The daily forage intake however increased with increase in concentrate restriction, the trend being C > B > A. The concentrate percentage of daily feed intake reduced with increased severity of concentrate restriction while that of forage increased with concentrate restriction from 56.15% in *ad libitum*

concentrate fed group to the highest amount of 68.45% in rabbits on skip-two-days of concentrate feeding per week. Restriction of concentrate feeding with *ad libitum* forage feeding did not have a significant effect on daily weight gain in this study. Earlier studies on restricted feeding in rabbits had reported reduction in daily weight gain (8, 9, 10, 11 and 12). Reduced daily weight gains in restricted rabbits were linked to lower daily feed intake. Decrease in the body weight gain during feed restriction is a function of plane of nutrition thereby resulting in inadequate intake of nutrients required to sustain rapid growth and development (13). In this study however, feed intake was not lowered as the rabbits on skip-a-day and skip-two-day concentrate feeding had unlimited access to forage which they must have used to meet their dietary needs. This could have been due to the fact that feed intake was similar across treatment even though the partitioning of what constituted the intake varied.

Rabbits as pseudo-ruminants have improved capacity to handle forages and still be able to derive nutritional benefits from them. Rabbits have been earlier reported to perform well with mixed regime of forages and concentrates without adverse effect (14, 15 and 16). Feeding rabbits on sole forage in the tropics resulted in weight loss (17 and 18) and low feed intake (19), inferior body weight gain as compared to those whose forage diets were supplemented with concentrate feed (20). Tumova *et al.* (11), showed that feed efficiency was not significantly affected by feed restriction systems for growing rabbits.

According to (21), the use of concentrates alone has not given optimum results and the feeding of high concentrate and low forage levels as practiced by rabbit producers has in recent times resulted in very expensive rabbits.

The effect of treatments on economy of production measured as cost per kilogram weight gain indicated that rabbit on skip-a-day concentrate feeding per week and skip-two-days concentrate feeding per week resulted in a reduction of 6.89 and 18.42 % respectively compared with the *ad libitum* concentrate fed control group.

Table 2: Effect of restricted concentrate feeding with *ad libitum* forage feeding on performance of growing rabbits

Performance Indices	*ad libitum* Feeding (A)	Skip-a-day Concentrate Feeding/Week (B)	Skip-two-days Concentrate Feeding/Week (C)	SEM
Initial weight (g)	608.30	607.44	607.32	
Final weight (g)	1293.33	1286.00	1268.30	11.38
Total weight gain (g)	685.03	678.56	672.98	8.22
Average daily weight gain (g)	12.23	12.11	12.02	1.24
Total feed intake(g)	4258.64	4406.64	4359.04	10.23
Average daily feed intake (g)	76.04	78.68	77.84	6.05
Total concentrate intake (g)	1867.44[a]	1666.66[b]	1383.04[c]	4.01*
Average daily concentrate intake (g)	33.35[a]	29.76[b]	24.69[c]	1.86*
% Concentrate in daily feed intake	43.86[a]	37.83[b]	31.72[c]	3.15*
Total forage intake(g)	2391.2[c]	2740.08[b]	2983.68[a]	5.50*
Average daily forage intake (g).	42.70[c]	48.93[b]	53.28[a]	2.65*
% forage in daily feed intake.	56.15[c]	62.19[b]	68.45[a]	3.00*
Feed: gain ratio	6.22	6.49	6.47	0.08

[a,b] Mean in the same row bearing different superscripts are significantly (P<0.05) different. SEM = Standard error of mean

It was observed that in terms of economic efficiency rabbits on skip-two-days concentrate feeding per week were better than rabbits on the two other treatments. The superiority of rabbits on skip-two-days concentrate feeding per week compared to rabbits on the control and skip-a-day concentrate feeding per week arose from the fact that although weight gain and feed conversion were similar among the treatments, proportion of concentrate : forage in the amount of feed required to attain the weights were however dissimilar.

Result of the effects of feeding regime on retail cuts of rabbits are presented in Table 3.

Dressing percentage was not significantly (P>0.05) affected by feeding regime. The dressing out percentage was in the range 54.50 – 55.77. The values obtained for dressing out percentage in this study are similar to 52.05 - 53.36% reported by (22), but lower than 69.49 – 73.98% obtained by (23). The non significant effect of feeding regime on dressing out percentage was in agreement with the

results of (24), (11) or (25), who reported that restriction did not affect dressing percentage, However, our results are at variance with the report of (26), that in the middle of the restriction period dressing percentage was higher in restricted rabbits in comparison with the *ad libitum* fed ones.

Table 3: Effect of restricted concentrate feeding with *ad libitum* forage feeding on feeding cost of growing rabbits

Performance Indices	*ad libitum* Feeding (A)	Skip-a-day Concentrate Feeding/Week (B)	Skip-two-days Concentrate Feeding/Week (C)	SEM
Cost/ Kg Concentrate (₦)	65.25	65.25	65.25	-
Cost/Kg. Forage (₦)	7.14	7.14	7.14	-
Cost of concentrate intake /rabbit (₦)	121.38 [a]	108.75 [b]	90.24 [c]	3.02
Cost of Forage intake/rabbit (₦)	17.07 [c]	19.56 [b]	21.31 [a]	1.24
Cost of feed intake (Concentrate + Forage) (₦).	138.45	128.31	111.55	-
Cost/Kg of feed (Concentrate +Forage) intake	32.51	29.12	25.59	-
Cost of Feed/ Kg Weight Gain (₦)	202.96 [a]	188.99 [b]	165.57 [c]	3.11
% Feed cost savings/Kg Weight Gain compared to control treatment.	-	6.89[b]	18.42[a]	2.12

[a,b] Mean in the same row bearing different superscripts are significantly (P<0.05) different.
SEM = Standard error of mean
Where:

1. Cost of concentrate intake/ rabbit (A) = Cost/kg concentrate x concetrate intake.
2. Cost of forage intake/ rabbitn (B) = Cost/kg forage x forage intake.
3. Cost of Feed intake (C) = A + B.
4. Cost/Kg of feed (Concentrate +Forage) intake (D)= C / Kg. of feed intake
5. Cost of Feed/ Kg Weight Gain = D x Feed:Gain

Feeding regime had no effect on retail cuts in this experiment. These results are in agreement with (8), but (27) reported a significantly higher proportion of hind part and hind legs in *ad libitum* fed rabbits. The division of a carcass into primal parts will enable comparison be made between various defined areas of the carcass. Increased weight of retail cuts improves profitability of rabbits

(28). Carcass characteristics are important factors to consider when evaluating alternative feeding programs. Ledin (29), concluded that carcass and dissection characteristics were not influenced by restriction.

The physical structure and weights of internal organs (livers, kidneys, lungs and hearts) were not affected by experimental treatments (P>0.05). Studies have shown little effect of feed restriction on relative organ weights, carcass portions, meat quality and dressing out percentage (30, 31). More interesting, a potential of reducing carcass adipose fat (perirenal, scapular and intramuscular fat deposition) by limiting feed intake has been demonstrated in other studies (32, 31).

The result of the gut characteristics measured (Table 4) showed that the empty intestinal weight and full caecum weight were significantly influenced by type of restriction. Rabbit on two-days/week of concentrate restriction had the highest (P<0.05) empty intestinal weight. The value recorded for rabbits on *ad libitum* concentrate feeding and those on one-day/week of concentrate restriction were however similar (P>0.05).

Table 4: Effect of restricted Feeding with *ad libitum* Forage Feeding on Carcass yield and visceral organ Weights of Rabbits (% Dressed weight)

Carcass indices	*Ad libitum* Feeding (A)	Skip-a-day Concentrate Feeding (B)	Skip-two-days Concentrate Feeding (C)	SEM
Fasted live weight(g)	1268.33	1260.37	1263.30	12.95
Carcass weight (g)	710.14	693.08	688.49	6.80
Dressing percentage	55.77	54.99	54.50	54.52
Prime cuts				
Fore part	15.29	15.48	15.13	0.35
Fore leg	7.51	6.81	6.55	0.25
Hind part	18.30	18.52	17.99	0.60
Hind leg	8.29	8.48	8.13	0.40
Thoracic cage	9.17	9.35	8.50	0.33
Intermediate part	14.25	14.20	14.22	0.57
Weight of internal organs				
Liver	3.13	3.19	3.15	0.12
Kidney	0.50	0.50	0.54	0.02
Lungs	0.51	0.50	0.53	0.02
Heart	0.24	0.25	0.26	0.01

SEM = Standard error of mean

The high empty intestinal weight ($P<0.05$) value recorded for rabbits on concentrate restriction in comparison with those fed *ad libitum* concentrate could be as a result of high fibre content arising from the significantly higher forage intake which led to an increased capacity of the intestine to accommodate the resistant starch and fibre in the forage. The sizes of gut have been reported to be affected by the nature, forms and size of the dietary treatment given to livestock (28). A similar observation was made on full caecum weight. Forages are known to have lower energy (33, 34) than concentrates which could lead to high consumption because animals normally eat to satisfy their energy need. This increased feed consumption could lead to increased ceacal content.

Table 5: Effect of restricted concentrate feeding with *ad libitum* forage feeding on on gut characteristics of growing rabbits.

Gut characteristic	*ad libitum* Feeding (A)	Skip-a-day Concentrate Feeding (B)	Skip-two-days Concentrate Feeding (C)	SEM
Full intestinal weight (%)	18.63	20.45	19.91	0.52
Empty intestinal wt (%)	6.79[b]	7.77[ab]	8.39[a]	0.30*
Full caecum wt (%)	8.02[b]	8.79[b]	10.77[a]	0.60*
Empty caecum wt (%)	2.06	2.30	2.31	0.12

[a,b] Mean in the same row bearing different superscripts are significantly ($P<0.05$) different. SEM = Standard error of mean

Conclusion and Applications

The data from this study have demonstrated that

1. Concentrate feeding could be skipped for two consecutive days per week with *ad libitum* forage feeding without adverse effect of performance and carcass quality.
2. The restriction of concentrate in the present of ad libitum forage also led to significant reduction in the cost of production of rabbits.
3. It is concluded from this study that subjecting rabbits to concentrate feed skipping of up to two days per week in the presence of *ad libitum* forage feeding has no adverse effect on performance, carcass characteristics and prime cuts. This will result in reduction of feed cost for producing a unit weight of rabbit meat.

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