Effect of Varying Protein and Energy Levels on Dry Matter, Protein and Energy Digestibility in Pregnant and Lactating Does in the Humid Tropics of Southern Nigeria

Obinne, J.I[1]. and Okorie A.U.[2]

[1]*Department of Agricultural Education, Federal College of Education (Technical) Asaba, Delta State.*
[2]*Department of Animal Science, University of Nigeria, Nsukka.*

Target Audience: Researchers and Rabbit Farmers

Abstract

Dry matter (DM), protein and energy utilization in pregnant and lactating does were determined in a study a 3 x 3 factorial in a completely randomized design. In the first feeding trial which lasted for 31 days, twenty-seven does were assigned to nine dietary treatments, each with three replicates. The diets furnished three crude protein (CP) levels (15.2, 17.0 and 19.0%) and three digestible energy (DE) levels (7.6,9.6 and 11.5 MJ/kg. In the second feeding trial which lasted for 35 days, the does at kindling were re-assigned to another nine treatments. The diets contained three CP levels (16.2, 18.2 and 20.1%) and three DE levels (8.6,11.2 and 12..5 MJ/kg). All data were subjected to Analysis of variance, correlation and regression analyses. DM matter, protein and energy digestibility in pregnant does were not significantly affected by protein X energy interaction. The effect of energy level was, however, significant ($P < 0.05$), and protein level significantly ($P<0.05$) affected energy digestibility. DM, protein and energy utilization in pregnant does improved significantly ($P < 0.01$) for every increase in energy level. On the other hand, DM, protein and energy utilization in lactating does were significantly ($P < 0.05$) affected by protein and energy levels.

Keywords: CP and DE levels; DM, protein and energy digestibility; pregnant and lactating does.

Description of Problem

The shortage of animal protein in Nigeria has long been recognized and remains one of her greatest problem today. The traditional sources of animal protein cannot cope with the ever increasing human population. There is therefore, the need for a shift to faster growing animals with short generation intervals. Recently, the rabbit has attracted attention because of its potential in meat production.

Reproductive performance of rabbits largely depend on their ability to utilize feed and the nutrients effectively. The ability of rabbits to digest feeds, however, depend on the nutrient composition of the diet and the higher the protein content of the diet, the higher the digestibility (8). It has been demonstrated that sufficient energy is required for efficient protein utilization (1). Digestibility coefficients of 81.8, 82.2 and 81.2 % for DM, CP and gross energy respectively, have been obtained with rabbits fed three CP levels of 13,15 and 17% in combination with three ME levels of 2.8, 3.0 and 3.2 Mcal/kg (11.72,12.56 and 13.40 MJ/kg (3).

The influence of varying protein and energy

[1]Author for correspondence.

levels on the utilization of nutrients by does in temperate regions is well documented. It is reported (6) that digestibility of DM, organic matter, ether extract, crude fibre (CF) and gross energy (means 66.75, 68.87, 86.68, 20.15 and 67.55% respectively), were not significantly affected by the amount of CP (18-28%) in the diet, but that the digestibility of CP increased linearly with increasing CP in the diet from 70.71 to 75.88%. Digestibility of nutrients did not change during the first 3 weeks of pregnancy; in the last 10 days it decreased. But digestibility of crude protein was 2 percentage units higher at the start of lactation than at the beginning of pregnancy (6). The efficiencies of utilization of dietary protein and body protein for milk in rabbit were 0.80 and 0.60 respectively (11).Rabbits as non-ruminant herbivores efficiently utilize high forage diets, but have the poorest ability to digest fibre (9). However, very little information is available on the effects of different CP and DE levels on the digestibility of feeds by rabbits in the tropics. This study was, therefore, designed to investigate the effects of different CP and DE levels on the digestibility of DM, protein and energy in pregnant and lactating does in the humid tropics of southern Nigeria.

Materials and Methods

Experimental diets and feeding trials

A total of 54 rabbit does were used in two feeding trials. In the first feeding trial, twenty-seven does were randomly assigned to nine dietary treatments, aimed to determine the effect of varying CP and DE levels on the utilization of DM, protein and energy contents of the diets in pregnant does. The diets furnished three CP levels (15.2, 17.00 and 19.0 %) and three DE levels (7.6, 9.6 and 11.5 MJ/ Kg). Each doe was mated until pregnancy was confirmed by palpation.

In the second feeding trial which lasted for 35 days, the does with their kits at kindling were reassigned to nine treatments, to determine the effect of varying CP and DE levels on digestibility of DM, protein and energy contents of the diets in lactating does. The diets contained three CP levels (16.2, 18.2 and 20.1%) and three DE levels (8.6, 11.2 and 12.5 and 12.5 Mj/kg).

In the two feeding trials, the does were assigned to the dietary treatments, each with three replicates in a 3 x 3 factorial in a completely randomized design. Each rabbit was housed in an individual wooden hutch. Feed and water were supplied ad libitum in specially made clay pots.

Digestibility trials

Faecal excretions were collected in perforated metal catch trays in the last seven days of each feeding trial. Each catch tray was lined with polythene sheets to prevent contact of voided faeces with its surface. Known weights of respective experimental diets were given to each doe for the period of collection. The faeces collected for each doe were weighed once daily and oven-dried at 100°C, cooled and stored in sample bottles for calculating DM and nutrient digestibility. At the end of the seven days collection period, the dried samples for each treatment were pooled together and representative samples taken for proximate analysis of constituents.

Chemical Analysis

Proximate composition of the diets and faeces were assayed according to standard method (4). Gross energy of the diets and faeces were determined using Par Adiabatic Bomb Calorimeter. Digestible energy of the diets were calculated by methods of estimating the nutritive value of feeds (2)

Statistical Analysis

All data obtained were subjected to Analysis of variance (10), correlation and regression analyses. Significantly different means were separated using Duncan's Multiple Range Test (5).

Table 1. Composition (%) of experiment I diets

Analyz. CP level %	15.2			17.0			19.0		
Analyz. DE level MJ 1kg	7.6	9.6	11.5	7.6	9.6	11.5	7.6	9.6	11.5
Diet	1	2	3	4	5	6	7	8	9
Ingredients									
Maize	41.5	52.0	58.1	39	50	55	32.5	48	54.3
Soyabean (toasted)	6	5	12.2	6.5	9	16.9	10	14	19
Palm kernel meal	10	15	14	12	16	9. 9.1	15	16	5.2
Vitamin-mineral premix[a]	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Total	100	100	100	100	100	100	100	100	100
Chemical Composition (% dry basis)									
Dry matter	89.8	90.8	90.0	91.4	90.0	89.5	91.0	90.5	91.5
Nitrogen free extract	50.1	53.4	57.35	52.8	55.5	55.0	44.45	52.55	50.55
Calculated crude protein	15	15	15	17	17	17	19	19	1
Calculated gross energy (NJ/Kg)	10.2	12.1	14.0	10.2	12.1	14.0	10.2	12.1	14.0

[a] supplied per kg of diet: 8000000iu Vit. A; 1.60000iu Vit. D_3;50000iu Vit. E; 2000mg Vit. K; 1500mg Vit. B_1; 4000mg Vit. B_2; 15000mg Vit.B_6; 5000mg Folic acid; 20mg Biotin; 200mg choline; 80g manganese; 50g Iron; 50g Zinc; 5g Copper; 1.2g Iodine; 200mg Cobalt; 2000mg Selenium; 15500mg Niacin; 5000mg panthotenic acid 125g Antixidant.

Table 2: composition (%) of experiment 2 diets

Analyz. CP Level%		16.2			18.2			20.1		
Analyz. DE Level MJ/kg		8.7	11.2	12.5	8.7	11.2	12.5	8.7	11.2	12.5
Diet		1	2	3	4	5	6	7	8	9
Ingredients										
Maize		42.5	53	59.1	40	49.5	57.5	37	48	54
Soya bean (toasted)		6	8	16.5	9	12	21	14	18.5	21.5
Fish meal		6	7	6.1	9	9.5	9	12.5	11	12.8
Palm Kernel meal	9.5	21	6	8	16	0.5	3.5	1.5	8.5	
Brewer's dried grain		21.5	5	-	21	6.5	-	17	5	-
Rice bra		11	-	-	9.5	-	-	12.5	-	-
Palm Oil		-	2.5	8.8	-	3	8.5	-	1.5	8.5
Bone meal		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Vitamin-mineral premix[a]		0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Salt		0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Total		100	100	100	100	100	100	100	100	100
Chemical Composition (% dry basis)										
Dry matter		87.8	9.2	87.5	90.5	90	88.5	88	92.0	89.5
Ash		6.2	6.5	5.6	8.15	11	5.7	10.5	12.5	8
Crude Fibre		9.1	3.5	4.0	8.55	4.7	4.35	9.55	6.55	3.25
Ether Extract		3.8	4.0	5.3	3.6	3.8	6.4	3.55	3.6	8.5
Nitrogen Free extract		52.5	61.3	56.4	52.0	52.3	53.85	44.3	49.25	49.65
Calculated crude protein		16	16	16	18	18	18	20	20	20
Calculated gross energy (NJ/kg)		10.5	12.5	14.5	10.5	12.5	14.5	10.5	12.5	14.5

[a] supplied per kg of diet: 8000000iu vit. A; 1.60000iu Vit. D_3 ;50000iu Vit E; 2000mg Vit. K;15000m Vit.

B_1; 4000mg VIT. B_2; 15000mg Vit.B_6; 5000mg Folic acid; 20mg Biotin; 200mg choline; 80g manganese; 50G Iron; 50g Zinc; 5g Copper; 1.2 Iodine; 200mg Cobalt; 2000mg Selenium; 15500mg Niacin; 500m panthotenic acid 125g Antixidant.

Results and Discussion

The effects of dietary CP and DE levels on DM, protein and energy utilization in pregnant does is presented in table 3. The effect of protein and protein x energy interaction on apparent DM digestibility in pregnant does were not significant. The effect of energy was, however, significant ($p<0.05$).

Table 3. Effect of varying CP and DE level on DM, protein and energy Digestibility on pregnant rabbit does.

Analyz. CP level %	15.2			17.0			19.0			
Analyz.DE level MJ/kg	7.6	9.6	11.5	7.6	9.6	11.5	7.6	9.6	11.5	S.E.
Diet	1	2	3	4	5	6	7	8	9	
Dry Matter Digestible%	79.59^{a}	83.30^{b}	84 70^{b}	76.67^{a}	80.73^{a}	82.42^{b}	79.59^{a}	83.19^{b}	86.37^{b}	2.70
Protein Digestibility %	73.75^{a}	79.31^{a}	85.55^{b}	79.94^{a}	81.72^{a}	80.23^{a}	79.19^{a}	82.76^{a}	87.82^{b}	2.81
Energy Digestibility%	74.36^{a}	80.92^{b}	82.52^{b}	67.11^{a}	76.16^{a}	79.17^{a}	77.43^{a}	83.09^{b}	85.04^{b}	3.21

^{abc} Means bearing different superscripts on the same row are significantly different ($P < 0.05$).

Results also indicate a progressive increase ($r= 0.52$; $p<0.01$) in apparent DM digestibility for every increase in energy level regardless of the protein level (Table4), thus suggesting a linear relationship between the level of energy and DM utilization in pregnant rabbits. Rabbits fed 9.6 and 11.5 MJ DE/kg irrespective of the CP levels recorded better ($P<0.05$) DM digestibility coefficient (83.19-86.37%) than those fed 7.6 MJ DE/kg that recorded DM digestibility coefficient of 76.67-86.37%. The average digestibility coefficient of 81.5% obtained in this study is relatively similar to 81.80% (77.5-85.8%) obtained in an earlier study (3), but generally higher than the 64.4%, 52-79.8% and 66.75% obtained by other workers (1,6).

Table 4. Correlation coefficient (r) between dietary variables and response parameters(DM, protein and energy digestibility) in pregnant rabbit does.

Response parameters	Protein level %	DE Level MJ/kg
DM Digestibility %	0.0318	0.5196**
Protein Digestibility %	0.1665	0.5741**
Energy Digestibility %	0.0970	0.5156**

* Significant correlation ($P<0.05$)
** Significant correlation ($P<0.01$)
NS Non-significant correlation ($P>0.05$)

The effect of protein x energy interaction on energy digestibility in pregnant does was not significant. However, the effects of protein, and energy components were significant ($p<0.05$). Correlation analysis (Table 4) showed that efficiency of energy utilization in pregnant does increased progressively ($r = 0.52$; $p< 0.01$) with increase in energy level, but protein level did not show

significant relationship with energy digestibility. Pregnant rabbit does fed diets containing 19.0% protein and 9.6 and 11.5 MJ DE/kg recorded highest energy digestibility coefficient (85.04%). This value is, however, not significantly different from the digestibility coefficient of 80.92% which was recorded by does fed the diet containing 15.0% protein and DE 9.6 MJ/kg. The mean digestibility coefficient of 78.49% (67.11-85.04%) obtained in this study is higher than the mean value of 63.1 and 67.55% reported by other investigators (1,6). But the value obtained was slightly lower than the 81.2% recorded in an earlier study (3). The disparity may be related to differences in the nutrient density of the different diets.

The effect of protein, and protein x energy

Table 5. Simple and Multiple regression equation relating dietary protein (X_1) and DE in MJ/kg (X_2) to response parameters (DM, protein, and energy digestibility) in pregnant rabbit does (Y)

Response Parameters	Regression on	n	Regression Equation	Syx	R^2
DM Digestibility	X_1 alone	27	$Y=81.24 +0.21X_1$	1.33	0.0010
%	X_2 alone	27	$Y=74.90+3.38X_2$	1.13	0.2700
	X_1 and X_2	27	$Y=74.48+0.21X_1 - 3.38X_2$	1.60	0.2712
Protein Digestibility	X_1 alone	27	$Y=73.22+3.33X_1$	2.11	0.0920
%	X_2 alone	27	$Y=67.49+6.09X_2$	1.82	0.32.79
	X_1 aloneX_2	27	$Y=61.05+3.22X_1+6.08X_2$	1.73	0.6480
Energy Digestibility	X_1 alone	27	$Y = 76.16-0.90X_1$	1.86	0.0094
%	X_2 alone	27	$Y = 68.43 + 4.76X_2$	1.61	0.2659

interaction on protein digestibility were not significant (P>0.05). As was earlier reported, there was a progressive increase ($r = 0.57$; $p< 0.01$) in protein digestibility for every increase in energy level regardless of protein level. Pregnant rabbit does fed diets containing 19.0% CP and DE 11.5 MJ/Kg recorded the best protein digestibility coefficient (87.82%). But this value is not significantly different from the 85.55% obtained by does fed diets containing 15.0% CP and 11.5MJ DE/kg. R^2 value (Table 5) showed that protein and energy combined (64.8%) was a better predictor of protein digestibility in pregnant does than protein alone (9.20%) or energy alone (32.79%). The mean crude protein digestibility coefficient of 80.19 (73.75-87.82%) obtained is higher than the 70.71-75.88% reported in an earlier study (6). But the value obtained compares favourably with the 82.2% (79.0-85.97%) reported by another investigator (3).

Generally, DM and protein digestibility in pregnant does improved significantly with increase in energy level, but energy digestibility improved with increase in protein and energy levels.

The effect of dietary CP and DE levels on DM, protein and energy digestibility in lactating does is presented in table 6. The effect of protein x energy interaction on DM digestibility was significant ($p< 0.05$). There was a highly

significant (P< 0.01) effect of energy level on DM digestibility but the effect of CP was not significant (p>0.05). Lactating does fed diets containing 18.2 and 20.1% CP in combination with DE 11.2 MJ/kg recorded highest digestibility coefficient of 91.17-91-20%. The value obtained by does fed 20.1% CP (91.17%) is not significantly different from the mean value ((91.20%) obtained by does fed on diets containing 18.2% CP. The mean digestibility of 86% (77.62-90.20%) was generally higher than the 64.4, 81.8 and 66.75% earlier reported by some authors (1, 3 and 6).

Protein digestibility followed the same pattern as

Table 6. Effects of varying CP and DE levels on DM, protein and energy Digestibility in lactating rabbit does

Analyz. CP level %	16.2			18.2			20.1			S.E
Analyz. DE level MJ/Ikg	8.6	11.2	12.5	8.6	11.2	12.5	8.6	11.2	12.5	
Diet	1	2	3	4	5	6	7	8	9	
DM Digestibility%	77.62^{a}	85.88^{b}	88.79^{b}	86.57^{b}	91.20^{c}	85.87^{b}	82^{a} 96^{a}	91.17^{c}	83.95^{a}	2.01
Protein Digestibility%	73.56^{b}	83.16^{a}	88.22^{b}	84.56^{b}	90.25^{b}	84.72b	82.67^{b}	91.26^{c}	83.66^{b}	2.42
Energy Digestibility %	78.70^{a}	76.74^{a}	88.72^{b}	85.82^{a}	90.00^{bc}	86.14^{a}	82.29^{b}	91.04^{bcd}	83.02^{a}	2.07

^{abcd} Means bearing different superscripts on the same now are significantly different (P < 0.05)

was recorded for DM digestibility. The effect of protein x energy interaction was highly significant (P < 0.01). The effect of energy level on protein digestibility was also significant (P < 0.01,) but the effect of protein was not significant (P>0.05). Lactating does fed diets containing 20.1% CP and 11.2 MJ DE/kg obtained the best digestibility coefficient (91.26%).

Energy digestibility in the lactating does was significantly (P< 0.05) affected by protein x energy interaction. The effect of energy was highly significant (P < 0.05). R^2 value (Table 8) however; indicated that energy alone or protein and energy combined in a multiple regression were better predictors of energy digestibility in lactating does and thus accounted for greater variability (6.22 or 6.25% respectively)than protein alone (0.04%).

Results generally indicated that protein x energy

Table 7. Correlation coefficient (r) between dietary variables and response parameters (DM, protein and energy digestibility) in lactating rabbit does.

Response parameters	Protein level %	DE level MJ/kg
DM Digestibility %	0.0870^{NS}	0.2575^{NS}
Protein Digestibility %	0.2947^{NS}	0.3222^{NS}
Energy Digestibility %	0.0194^{NS}	0.2493^{NS}

NS Non- significant correlation (P >o.05)

Table 8. Simple and Multiple regression equations relating dietary protein (X_1 and DE in MJ/kg (X_2) to response parameters (DM, protein, and energy digestibility) in lactating rabbit does (Y).

Response parameters	Regression on	n	Regression equation	Syx	R^2
DM Digestibility	X_1 alone	27	$Y=85.31+0.51X_1$	1.18	0.0076
%	X_2 alone	27	$Y=83.33+1.50X_2$	1.15	0.0739
	X_1 and X_2	27	$Y=82.31+0.51X_1+.1.50X_2$	1.17	0.1906
Protein Digestibility	X_1 alone	27	$Y=81.08+2.01X$	1.36	0.0868
%	X_2 alone	27	$Y=80.71+2.19X$	1.34	0.038
	X_1 and X_2	27	$Y=76.69+2.01X_1+2.19X_2$	1.31	0.1906
Energy Digestibility	X_1 alone	27	$Y=85.79+0.11X$	1.18	0.0004
%	X_2 alone	27	$Y=83.18+1.414X$	1.14	0.0622
	X_1 and X_2	27	$Y=82.76+0.11X_1+1.41X_2$	1.17	0.0625

interaction or energy component alone had significant effect on DM, protein and energy utilization in lactating does, but the effect of protein alone was negligible. The digestibility coefficient obtained for DM, protein and energy in lactating does were generally higher than the values reported in literatures.

The high digestion coefficients obtained for DM, protein and energy in all treatments in the two feeding trials are noteworthy. The results revealed the ability of rabbit does (during pregnancy and lactation) which are non-ruminant herbivores to efficiently utilize DM, protein and energy in concentrate feeds, at particular CP and energy levels.

Conclusion and Application

The results of the two feeding trials indicated the following.

1. Results revealed the ability of pregnant and lactating does which are non-ruminants to digest DM, protein and energy in concentrate feeds efficiently.
2. A diet containing 15.2% CP and a minimum DE level of 9.6 MJ/kg was found to be adequate for optimum DM, protein and energy digestibility in pregnant rabbit does in the humid tropics of southern Nigerian.
3. A diet containing a range of 18.2 -20.1% CP and DE 11.2 MJ/kg was found to support efficient DM, protein and energy utilization in lactating rabbit does in the humid tropics of southern Nigerian.

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