EFFECTS OF DIFFERENT DIETARY CRUDE PROTEIN AND ENERGY LEVELS ON PRODUCTION PERFORMANCE, CARCASS CHARACTERISTICS AND ORGAN WEIGHTS OF RABBITS RAISED UNDER THE HUMID ENVIRONMENT OF NIGERIA

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Abstract

An experiment was conducted to test the effects of different dietary crude protein and energy levels on the production performance, carcass characteristics and organ weights of rabbits raised under the humid environment of Nigeria. Twenty-seven 6–8 weeks –old cross bred kittens (comprising New Zealand White, Flemish Giant and California as (parent- stock) of mixed sexes, were fed diets containing 14.2,16.2 and 18.1 % crude protein(CP) and 6.7, 8.7 and 10.8 MJ/kg digestible energy (DE) respectively. The experiment lasted for 84 days. The rabbits were assigned to the nine dietary treatments in a 3 × 3 factorial design with three rabbits per treatment. Each rabbit was housed in an individual hutch. Feed and water were supplied ad libitum. Faecal excretions were collected in perforated catch tray in the last 7 days of the feeding trials. The rabbits were slaughtered and dressed at the end of the experiment. Data generated were subjected to statistical analysis using Genstat (2000) statistical package. Dietary crude protein and DE levels produced highly significant effects ($P < 0.01$) on carcass dressing percentage but had no significant ($P > 0.05$) effects on carcass yield. However, carcass yield significantly ($P < 0.05$) increased as dietary crude protein levels increased. Weight of lungs and liver expressed as percentage of the body weight significantly ($P < 0.05$) improved with increasing levels dietary crude protein and digestible energy in the feed compositions. Weights of heart and abdominal fat were not significantly ($P > 0.05$) affected by the dietary combination. Based on the carcass dressing percentage, a diet with 16.2% crude protein and 6.7 MJ/kg digestible energy is proposed as being able to produce optimum meat yield under the conditions of this experiment

Key words: rabbits, protein and energy levels, organ weights, dressing percentage, carcass characteristics

INTRODUCTION

Many investigators have suggested ways of increasing the low animal protein intake of Nigerians. One of the cheapest sources of meat but which has been neglected in Nigeria is the rabbits. Rabbits meat is high in protein, about 22%, low in fat, 4% and cholesterol, 5% and thus possesses health promoting qualities (Aduku and Olukosi, 1990)

Rabbits have been found to give high performance when fed concentrate feeds (Obinne, 2002). Growth performance, carcass yield and organ weights of rabbits are influenced by dietary crude protein level in the diet of rabbits. Egboh (2008) reported that the weights of heart, thyroid gland, adrenal gland and ovary increased as the level of CP increases while the weights of liver, spleen, kidney and pancreas increase with low dietary levels of crude protein(12 and 14% CP). However, Jacob et al. (1992) reported that carcass yield, relative weight of liver and kidney and carcass composition of rabbits fed diets containing 14, 16 and 18% CP did not differ significantly ($P > 0.05$) among the treatments. Similarly, Sankhyan et al. (1991) reported that average dressing percentage and average weights of the hind limbs, fore limbs, breast lumber cuts, heart, liver and kidney were not affected by levels of dietary crude protein.

NRC (1977) recommended 16% protein and 10.46 MJ per kg digestible energy for high meat production in temperate climate, but owing to high ambient temperatures which cause depression in feed intake, livestock and poultry in the tropics may have requirements for these two nutrients that are different from the levels recommended for similar animals in temperate climates (Okorie et al., 1987). In a latter study conducted to investigate the effect of varying protein and energy levels on the growth performance of rabbits in terms of dry matter (DM) intake, weight gains, feed conversion ratio and apparent digestibity, Obinne and Okorie (2008) found that a diet containing digestible energy level of 8.7 MJ/kg in combination with 16% protein was adequate for the optimum growth of rabbits in the tropics.

However, Gordon, Ceylon and Llidiz (2007) studied the effects of dietary energy density and L-carnitine supplement on growth performance, carcass traits and body parameters of broiler chickens and found that higher levels of dietary metabolisable energy increased broiler performance, though there was no significant interactions between energy and carnitine levels. Moreover, Babiker and Abbas (2009) carried out an experiment to test the effects of 3 levels of protein and 3 levels of energy during several stages of pullet growth and developments, and concluded that birds fed high levels of crude protein during the early stages of growing period had the best body weight gain , average body weight and well developed reproductive organs. Study of the effect of dietary protein on growth, uniformity and mortality of two commercial broilers indicated that growth, uniformity and mortality were influenced by dietary protein levels (Berne and Gous, 2008) Similarly, Okonkwo et al. (2010) determined the replacement value of concentrates with cassava leaf meal in the diets of growing rabbits and concluded that 30% cassava leaf meal and 20.88% of crude protein gave optimum replacement combination.

The differences in dietary crude protein and energy levels reported by the different authors prompted the present study which was conducted to investigate the effect of different crude protein (CP) and digestible energy (DE) levels on DM intake, weight gain, carcass yield , dressing percentage and organ weight of rabbits under the Nigerian environmental conditions.

MATERIALS AND METHODS

Twenty-seven hybrid weaner rabbits derived from crosses between New Zealand White, Flemish Giants and California breeds of mixed sexes with an initial average weight of 551.1 g were used for the feeding trials at the Rabbit Unit of the Teaching and Research Farm of the Federal College of Education (Technical), Asaba-Delta State of Nigeria. The Farm is located at Latitude 6°11'N and Longitude 6°44'E. It is situated in the equatorial rainforest vegetation zone, about 3 kilometres away from River Niger. Here the annual rainfall ranges from 1800 mm to 3000 mm while the maximum day temperature ranges from 27.5° to 30°C. The area experiences rainy season between April and October and dry season between November and March (NMET, 2008). The rabbits were assigned to the treatments in a 3 × 3 factorial design. There were nine feeding trials comprising the following:

Diet 1= 14% CP and 9.2 MJ/kg DE
Diet 2 =14% CP and 11.3 MJ/kg DE
Diet 3 =14% CP and 13.0 MJ/kg DE
Diet 4 =16% CP and 9.2 MJ/kg DE
Diet 5 =16% CP and 11.3 MJ/kg DE
Diet 6 = 16% CP and 13.0 MJ/kg DE
Diet 7 = 18% CP and 9.2 MJ/kg DE
Diet 8 =18% CP and 11.3 MJ/kg DE
Diet 9 = 18% CP and 13.0 MJ/kg DE

Three rabbits were randomly allocated to each of the nine diets groups (Table 1). The rabbits belonging to each diet groups were housed in an individual hutch.

Tab. 1: Composition of experimental diets (%)

Ingredients	DIET GROUPS								
	1	2	3	4	5	6	7	8	9
Maize	28	47	59.5	25	48	60	25	42.5	55
Soya beans (toasted)	5	5	6.5	5	5	9.5	10	8.5	13
Fish meal	2	2	3	5	5	6	7	8	8
Palm kernel meal	10	10	20	9	18	16.5	6	20	10
Spent grain	17	6	2	22	9	–	21	11	5
Wheat offal	10	10	–	11	10	–	20	11	5
Rice bran	23	5	–	18	–	–	–	–	4
Palm oil	–	–	4	–	–	3	–	–	4
Bone meal	4	4		4	4	4	4	4	4
Vitamin –Mineral premix	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

Supply per kg diet: 2 000 000 iu vit. A; 400 000 iu D_3; 8.0 g vit. E; 4 g vit. k; 0.3 g Vit b_1; 1.0 g vit. B_2; 0.6 g vit.; 4.0 mg vit. B_{12}; 24.0 g Niacin; 0.2 g Folic acid; 8.0 g Biotin; 48.0 g Choline; 320.0 g BHT; 16.0 g Manganese; 8.0 g iron; 7.2 g Zinc; 0.32 copper; 0.25 iodine; 36.0 mg cobalt; 16.0 mg selenium

Tab. 2: Chemical composition of experimental diets (%)

Composition diet No.	DIET GROUPS								
	1	2	3	4	5	6	7	8	9
Dry matter	90.0	88.5	87.5	86.0	87.0	88.5	88.0	88.0	87.0
Ash	12.5	5.5	4.0	14.5	9.o	4.5	12.0	9.0	2.5
Crude fibre	15.2	6.3	6.5	17.5	6.6	7.1	12.9	9.0	5.8
Ether extract	3.5	4.0	4.6	4.0	3.7	6.7	5.9	5.0	9.7
Crude protein	14.2	14.2	14.2	16.2	16.2	16.2	18.1	18.1	18.1
Nitrogen free extract	44.6	58.5	58.5	33.8	51.5	54.0	39.1	46.9	50.9
Digestible energy (MJ/kg)	6.7	8.7	10.9	6.7	8.7	10.8	6.7	8.7	10.8
Calculated values									
Crude protein	14	14	14	16	16	16	18	18	18
Gross energy (MJ/kg)	9.2	11.3	13.0	9.2	11.3	13.0	9.2	11.3	13.0

Feed and water were supplied *ad libitum* in specially made clay pots in all the trials. Feacal excretions were collected in perforated catch trays in the last seven days of the feeding trials. The experiment was replicated three times.

Proximate composition of the experimental diets (Table 2) and bucked feaces were determined according to Association of Official Analytical Chemists (AOAC) methods (1980). Gross energy of the diets and faeces were determined using Parr Adiabatic oxygen Bomb Calorimeter 1241. DE of the diets was then calculated by the methods of estimating the nutritive value of feeds. Digestion coefficient of the energy of ingredients and feaces were obtained. The values were used to calculate digestible energy intake and all the data have been expressed in percentage.

The animals were weighed at weekly intervals. The feeding trials lasted for 84 days. At the end of the experiment, two rabbits were randomly selected from each treatment unit. The rabbits were killed by dislocation of their heads. The stomach, head, lung, heart, liver, kidney and abdominal fat were removed and weighed individually before weighing the hot carcass including skin as carcass yield. Organ weights were expressed individually as percentage of the body weight, while dressing percentage was obtained by expressing carcass yield as percentage of final live weight.

Data were subjected to analysis of variance using Genstat (2005) software package. Significantly different means were separated using the multiple range tests of the same package. Pearson's correlation coefficients were estimated between dietary variables and carcass parameters.

RESULTS

Effects of the dietary crude protein and digestive energy levels on the production performance of the experimental rabbits are presented on Table 3.

Tab. 3: Effect of varying dietary crude protein and dietary energy levels on life performance of growing rabbits

Protein levels (%)	14.2			16.2			18.1			±SEM
DE levels (MJ/kg)	6.7	8.7	10.8	6.7	8.7	10.8	6.9	8.7	10.8	
Diet Groups	1	2	3	4	5	6	7	8	9	
Av. Initial weight (s)	495.05	553.84	618.20	645.00	415.56	585.12	566.68	543.84	418.72	
Av. Final weight (g)	1312.50	1542.50	1370.00	1535.00	1570.00	1830.00	1510.00	1635.00	1630.00	
DM intake (g/rabbit/day)	50.23	58.82	35.76	51.46	52.24	52.27	51.35	53.82	46.85	2.60
Weight gain (g/rabbit/day)	10.16	11.77	8.95	10.60	13.74	14.82	11.23	12.99	14.42	1.69
FCR (g feed/gain)	4.94	4.99	3.99	4.85	3.68	3.66	4.57	4.14	3.24	1.64

Dry matter intake

There was no significant interaction (P > 0.05) between dietary crude protein and digestible energy on dry matter intake. The combined effects of CP and DE levels on DM intake were negligible, though the rabbits consumed apparently, more feed as the CP content decreased.

Weight gain and FCR

Dietary CP and DE level did not produce significant (P > 0.05) effect on weight gain. However, correlation analysis showed that CP levels resulted in significant (P < 0.05) increase in the body weight of the rabbits. Neither protein by energy interaction nor treatment had significant effect on FCR.

Carcass yield

The carcass yield, dressing percentage and organ weights of the experimental rabbits are summarized on Table 4. Though, there was no significant (P > 0.05) protein by energy interaction effect on carcass yield, analysis of variance revealed that there were significant (P < 0.05) differences among the treatments. Thus the dietary crude protein levels significantly (P < 0.05) affected carcass yield with rabbits fed diet containing medium CP level (16.2%) in combination with high energy content (10.8 MJ DE/kg) recording the highest carcass yield (1076.43 g). As would be expected percent crude protein in the diet was significant (P < 0.05) and positively correlated with carcass yield (r = 0.57). This indicates that increasing levels of CP in the diet resulted to increase in carcass yield.

Carcass dressing percentage

There was a highly significant (P < 0.01) interaction effect of dietary CP and DE levels on carcass dressing percentage. Diet containing 18.1% CP in combination with 8.7 MJDE/kg produced the highest carcass dressing percentage of 72.24. This figure however is not significantly different from the values of 71.38%, 67.29%, 71.19% and 71.35% obtained with diets containing 16.2% CP, and 8.7 MJ/kg DE; 18.1% CP and 10.8 MJ/kg DE; 18.1% CP and 6.7 MJ/kg DE; 18.1% CP and 10.8 MJ/kg DE respectively (diets 5, 6, 7 and 9). Correlation analysis, however showed that DE level alone was not significant and thus contributed very little to carcass dressing percentage. There was, therefore, the tendency for the dressing percentage of the rabbits to increase with increasing dietary CP and DE levels, but the effect of DE alone was negligible.

Organ weights

There was a highly significant effect (P < 0.01) of dietary CP and DE levels on weight of lungs expressed as a percentage of body weight. Percentage weight of lungs improved with decreasing dietary CP and DE level such that Diet 1 which had low CP and DE levels produced the highest weight of lungs. Similarly, there was significant (P < 0.05) effect of dietary CP and DE levels on percentage weight of liver. The protein and energy con-

Tab. 4: Treatment effect varying dietary crude protein and dietary levels on carcass yield, dressing percentage and organ weight of rabbits

Protein level (%)	14.2			16.2			18.1			± SEM
DE levels (MJ/kg)	6.7	8.7	10.8	6.7	8.7	10.8	6.7	8.7	10.8	
Diet	1	2	3	4	5	6	7	8	9	
Carcass yield (g)	814.02^{a}	1008.01^{a}	871.93^{a}	1030.71^{a}	1120.61^{a}	1241.00^{b}	1076.43^{a}	1181.90^{a}	1164.22^{a}	93.18
Carcass dressing percentage	62.02^{a}	65.34^{ab}	63.64^{ab}	67.10^{bc}	71.37^{cd}	67.81^{bcd}	71.28^{cd}	72.28^{d}	71.42^{cd}	1.13**
Lungs (% body weight)	0.19^{a}	0.14^{bc}	0.09^{a}	0.11^{abc}	0.06^{a}	0.07^{a}	0.09^{a}	0.08^{a}	0.06^{a}	0.03*
Kidney (% of body weight)	0.09b^{c}	0.07^{abc}	0.10^{b}	0.07^{abc}	0.06^{a}	0.52^{a}	0.07^{abc}	0.05^{a}	0.05^{a}	0.02
Abdominal fat deposit (% of body weight)	0.04	0.16	0.09	0.11	0.23	0.05	0.20	0.16	0.14	0.04
Liver (% of body weight)	0.60^{c}	0.38^{ab}	0.56^{bc}	0.40^{ab}	0.34^{a}	0.39^{b}	0.36^{a}	0.29^{a}	0.33^{ab}	0.05*

$^{a, b, c, d}$means bearing different superscripts on the same row are significantly different (P < 0.05)
**significant protein by energy interaction (P < 0.01); *significant protein by energy interaction (P < 0.05)

Tab. 5: Correlation coefficient between variables and carcass parameters

Response parameter	Protein level (%)	DE level (MJ/kg)
Carcass yield (g)	0.5669*	0.2770^{Ns}
Carcass of dressing percentage	0.8451**	0.0989^{Ns}
Lungs (% body weight)	–0.6371**	–0.5227*
Liver (% body weight)	–0.6685**	0.0756^{Na}
Kidney (% body weight)	–0.5285*	–0.2641^{Ns}
Heart (% body weight)	–0.2556^{Ns}	0.3775^{Ns}
Abdominal fat deposit (% body weight)	0.3182^{Ns}	–0.1155^{Ns}

**significant correlation (p < 0.01); *significant correlation (p < 0.05); NS = not significant correlation

tents of diets affected weight of liver in a similar manner as in the case of lungs. Rabbits on low CP and DE levels produced the highest liver weights. It appeared that a reduction in weight was observed initially as the DE content decreased (Diet 2) but later the diet with low CP and DE produced the highest liver weight. There was no significant effect (P > 0.05) of dietary CP and DE levels on weight of kidney as a percentage of body weight. However, the weight increased as dietary protein content decreased as the rabbits on the low dietary CP produced the kidney with the highest weight. The effect of DE appeared to be negligible. Percentage weight of hearts and abdominal fat were not significantly (P > 0.05) affected by dietary CP and DE levels.

DISCUSSION

The significant increase in carcass dressing percentage is an indication of synergistic interactive effect of protein and energy levels. This implies that sufficient energy is required for protein to produce significant effect on carcass composition of rabbits. The slaughter yield of rabbits in terms of dressing percentage depends on both dietary protein and energy composition. This finding agrees with the report of Ouhagoun (1998) that the effect of protein content on growth and body composition of rabbits depend on the energy concentration of the diet, and that for a given dietary energy level, the slaughter yield is modified when the variation in the protein level has significant effect the growth rate. The finding is also consistent with the reports of Berne and Gous (2008) that growth, uniformity and mortality of broilers were influenced by dietary protein, and Babiker and Abbas (2009) that pullets fed high levels of crude protein diets produced the best body weight gain, average body weight and feed conversion ratio.

The improvement of carcass yield resulting from increase in protein level is probably a reflection of the significant increase in body weight of the rabbits due to effect of protein levels or involvement of proteins in the glycolytic process in the muscle biochemistry of the rabbit.

The significant increase in lungs and liver weights are not in agreement with reports of Sankhyan et al. (1991) and Jacob et al. (1992) who stated that carcass yield, dressing percentage and weights of organs evaluated were not by dietary CP levels. The significant increase in lungs and liver weights at low CP and DE combinations may be a reflection of the allometric relationship between growth rate of organs and body weight of rabbits. Ouhagoun (1998) reported that the allometric coefficient of each organ of the rabbit vary during growth and usually decreases with the exception of adipose tissue and the skin. The responses of these organ weights could also be as a result of the decrease in the requirement of protein or its efficiency of utilization by rabbits as maturity was attained. Fraga (1998) observed that the efficiency of protein utilization decreases regularly as slaughter weight increases. The high lungs and kidney weights recorded at low CP and DE levels may also have resulted from a compensatory response of the rabbits at low dietary protein level. Egoh (2007) found that rabbits on low CP diets produced highest weight to compensate for low level of dietary protein.

Based on carcass dressing percentage, which is one of the major indices for measuring meat yield as the target of rabbits production in Nigeria, a diet containing 16.2% crude protein and digestible energy content of 6.7 MJ/Kg is proposed to be adequate for optimum carcass yield and dressing percentage of rabbits under the humid environmental conditions of Nigerian. This crude protein level is consistent with the 16% CP recommended by NRC (1977) and Obinne (2008) for growing rabbits in temperate and tropical climates respectively. However, the digestible energy suggested is lower than the 10.46 MJ/kg recommended by NRC (1977) for rabbits in temperate climates, and 10.42 MJ/kg and 8.7 MJ/kg proposed by Adegbola and Akinwande (1981) and Obinne (2008) respectively.

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