Pertanika J. Trop. Agric. Sci. 27(1): 65 - 71 (2004)

ISSN: 1511-3701

Effect of Varying Levels and Sources of Dietary Fat on Growth Performance and Nutrient Digestibility in Rabbits

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Keywords: Rabbits, fat, growth performance, digestibility

ABSTRAK

Kesan sumber lemak diet dan tahap ke atas prestasi pembesaran dan kebolehcernaan nutrient dikaji ke atas arnab-arnab baka kacukan Lopx New Zealand. Lima puluh arnab yang bercerai susu secara rawak diberikan lima rawatan diet yang mengandungi satu kawalan (tiada lemak) dan empat yang lainnya dengan lemak, sama ada daripada sumber tumbuhan (minyak kacang tanah) atau haiwan (mentega), setiap satunya pada dua tahap pemasukan (3% dan 6%). Terdapat 10 arnab untuk setiap diet. Arnab-arnab yang 6% berasaskan diet lemak haiwan direkodkan lebih tinggi (P<0.01) daripada arnab berasaskan 6% diet haiwan. Pengambilan bahan organic (OMI) diperhatikan sama antara kawalan pemakanan arnab-arnab dan 3% diet lemak haiwan. Walau bagaimanapun, 6% diet lemak mentega direkodkan terendah. Kebolehcernaan protein kasar (CPD) adalah sama dalam 3% pemakanan arnab dan 6% tahap lemak haiwan yang tertinggi manakala 6% tahap diet lemak tumbuhan mempunyai CPD yang terendah. Dapatan ini menunjukkan bahawa pemasukan lemak haiwan pada tahap 6% meningkatkan tambahan berat dan keberkesanan penggunaan makanan kepada arnab-arnab.

ABSTRACT

The effects of dietary fat sources and levels on growth performance and nutrient digestibility were investigated in cross-breed Lopx New Zealand rabbits. Fifty weaned rabbits were randomly allotted to five dietary treatments consisting of a control (no fat) and four others with fat, either from plant (groundnut oil) or animal (butter) sources, each at two levels (3% and 6%) of inclusion. There were ten rabbits per diet. Rabbits on 6% animal fat-based diet recorded the highest (P<0.01) better in rabbits on 6% animal diet. Organic matter intake (OMI) was observed to be similar between rabbits fed control and 3% animal fat diets. However, the 6% butter fat diet recorded the lowest. Crude protein digestibility (CPD) was similar in rabbit fed 3% and 6% level of animal fat which were the highest while 6% level of plant fat diet had the lowest CPD. These findings show that the inclusion of animal fat at 6% level improved the weight gain and efficiency of feed utilization in rabbits.

INTRODUCTION

Fats are frequently used in commercial feed formulae. Fats are added to rations for several reasons. Nutritionally, fat are exclusively energy sources, because they contain very little, if any, protein, minerals or vitamins. As a source of energy, fats are highly digestible (especially by monogastric animals). Digestible fat supplies have about 2.25 times as much energy as digestible starch or sugar, thus fat can be used to increase energy density of a ration. Fats generally increase absorption of fat soluble nutrients, such as the fat soluble vitamins (Mc Donald *et al.* 1987). In addition linolenic acids in fat are required by monogastric animals. According to NRC (1977), Barge *et al.* (1984) and Lebas (1980), the requirement for dietary fat by rabbits has been set at 2% of the diet. Since plant feedstuffs are the basis of rabbit diet, the essential fatty acid requirement will be satisfied at this level. Also, this level probably guarantees a sufficient absorption of fat-soluble vitamins (Barge *et al.* 1984). Pote *et al.* (1980) used 20% added fat in

a high oil alfalfa diet and found a significant improvement in feed conversion efficiency. Beynen (1988) stated that there was a need to raise the fat content of diets for rabbit fryers to enhance body weight gain and improve feed conversion and that carbohydrate can be replaced by fat on calorie for caloric basis. A high fat level is not recommended in hot environment (Ekpenyong 1988), probably because of the high temperature and high cost of supplementary fats. The dry ration for rabbits should contain between 1% and 8% crude fat (Ekpenyong 1988). Maize is a major source of energy for monogastric animals. However, the quantity produced annually in the Northern states of Nigeria is not enough for human consumption, therefore, there is a shortage in animal feeding. The search for an alternative source of energy now becomes inevitable. The present experiment was therefore designed to study the effects of source and levels of replacement of maize with fat on nutrient intake, digestibility and growth rate of rabbits.

MATERIALS AND METHODS

Animals and their Management

The experiment was conducted with weanling Lopx New Zealand cross-bred rabbits, purchased from the National Veterinary Research Institute (NVRI) in Vom. The rabbits were weighed and randomly allocated to the metabolic cages. Fifty weaned rabbits (533g average body weight) were randomly allotted to five dietary treatments. Each treatment had ten rabbits with 2 rabbits per replicate (5 replicates). One group of rabbits was fed a control diet containing 3% and 6% of either cow milk butter or groundnut oil. The rabbits were provided six days adaptation to the diets and each animal was fed 100g/day of feed at 8.00 hour daily and had free access to drinking water. The design of this experiment was completely randomized. The composition of the dietary treatment is shown in Table 1. The diets were formulated to contain about 18% CP and 11.30KJ/g digestible energy (Table 2).

Data Collection

Daily feed allowance (100g/rabbit) was offered to the rabbits and the residue was weighed the following day to give the daily feed intake. The rabbits were weighed at the beginning of the experiment and thereafter weekly. Faecal collection, which lasted for seven (7) days was conducted during the third week of the experiment. Faeces voided daily by each rabbit were collected and oven dried at 80° for 12 hours. All samples from each rabbit were bulked and kept in sample bottles until required for chemical analysis. The feeding trial lasted for 5 weeks.

Chemical Analysis

Proximate analysis of the experimental diets and the faecal samples were carried out using AOAC (1985) standard methods of analysis. Acid Detergent Fibre (ADF) and Neutral Detergent Fibre

TABLE 1
Percentage composition of the diets fed to rabbits

Ingredients	Dietary Sources of Energy				
	Control No. Added Fat $Diet_1$	Animal Fat		Plant Fat	
		3% $Diet_2$	6% $Diet_3$	3% $Diet_5$	6% $Diet_5$
Maize	46.41	33.82	25.1	33.75	25.00
Groundnut cake	24.00	26.00	25.00	26.00	25.00
Butter	-	3.00	6.00	-	-
Groundnut oil	-	-	-	3.00	6.00
Maize offal	12.00	15.00	10.00	15.00	10.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Premix	0.50	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50	0.50
TOTAL	100.00	100.00	100.00	100.00	100.00

(NDF) of the samples were determined by the method of Goering and Van Soest (1970).

Statistical Analysis

All the data collected were subjected to analysis of variance technique according to Steel and Torrie (1980) based completely on randomized design. Where significant differences between means existed, the least significant difference (LSD) method was used to test the differences between the means. The data were analyzed using Minitab for window statistical package.

RESULTS

The feed intake and growth performance of rabbits fed diets with different levels and sources of fat are shown in Table 3.

There were differences (P<0.01) in feed (fresh) intake (DM) of the diets fed to the rabbits. The rabbits fed 6% animal fat diet had the lowest DM intake of 74.82g/day and this value is even lower for that obtained for the control-diet (75.36g/day). Those on 6% plant fat diet had the highest feed intake of 79.58g/day. The rabbits fed control diet and 3% animal fat diet had similar daily weight gain (DWG).

There were significant differences (P<0.01) in daily weight gain (DWG) of the animals fed the different diets. Rabbits fed 6% animal fat diet had the highest weight gain of 31.10g/day, while those fed 6% plant fat had the lowest (17.85g/day). There were significant differences (P<0.01) in DWG of the animals fed control diet (27.53g/day) and the plant fat diet at both levels (23.28g/day and 17.85g/day) at 3% and 6% level respectively. The results showed that the feed conversion ratios (FCR) of the diets fed to the rabbits were significantly (P<0.01)

TABLE 2
Chemical composition (%) of the diets fed to rabbits

	Diets				
Nutrient	1	2	3	4	5
Energy (KJ/g)	11.30	-	-	-	-
Crude protein (g)	18.38	18.63	18.56	18.50	18.33
ADF	16.74	18.04	18.96	18.64	18.33
NDF	25.12	25.68	26.82	26.22	26.93

TABLE 3
Nutrient intake and growth performance of rabbits fed diets with varying levels and sources of fat

	Control	Butter		Level and Source of Dietary Fat Groundnut Oil		
Parameters	No added fat $Diet_1$	3% $Diet_2$	6% $Diet_3$	3% $Diet_4$	6% $Diet_5$	SE
FI	73.36^{ab}	76.30^{b}	74.82^{a}	77.24^{b}	79.58^{c}	0.329
DWG	27.53^{c}	27.08^{c}	31.10^{d}	23.28^{b}	17.85^{a}	0.45
FCR	2.74^{b}	2.83^{b}	2.40^{a}	3.23^{c}	4.46^{d}	0.06
DMI	64.50^{b}	65.77^{c}	64.19^{a}	67.37^{d}	68.91^{e}	0.28
OMI	60.06^{b}	60.75^{b}	58.99^{a}	62.37^{c}	63.28^{c}	0.26

FI = Feed Intake
DWG = Daily Weight Gain
FCR = Feed Conversion Ratio
DMI = Dry Matter Intake
OMI = Organic Matter Intake

$^{a, b, c, d, e,}$ Means in the same row with different superscripts are different (P>0.01)

different. The rabbits on 6% animal recorded the lowest FCR of 2.40, while rabbits fed 6% plant fed diet had the highest FCR of 4.46. The rabbits fed 3% and 6% plant fat diets had significantly (P<0.01) higher DMI than those fed the control and the 3% and 6% animal fat diets. However, those rabbits fed control and 6% animal fat diets had similar DMI, which was followed by the animals fed 3% animal fat diet.

The results showed that the rabbits fed 3% and 6% plant fat had significantly (P<0.01) higher OMI than those fed control, 3% and 6% animal fed diets. Those rabbits fed the control and 3% animal fat diets have similar OMI (P<0.05). The rabbits fed the control and 6% animal fat diet recorded the lowest OMI (58.99g/day) while those on 6% plant fat recorded the highest (63.28g/day). Digestibility of diets containing various levels and sources of fat are presented in Table 4. The rabbits fed the control and 3% plant fat diets had similar dry matter digestibility (DMD). Those rabbits fed 3% plant fat diets had also similar DMD, which were significantly (P<0.01) higher than for those on the control, 3% and 6% plant fat diets. The rabbits fed 6% plant fat diet had the lowest DMD (55.79%) and those on 6% animal fat diet had the highest (66.33%). The rabbits fed 3% and 6% animal fat diets had similar CPD, which were significantly (P<0.01) higher than those fed the control and the 6% plant fat diets. The rabbits fed 5% animal had the highest CPD (91.45%) while those fed 6% had the lowest (59.27%).

The results showed that the rabbits fed 3%, 6% animal fat diets and 3% plant fat diet had similar ADFD, which were significantly (P<0.01) higher than the control and the 6% plant fat diets. The rabbits fed 3% plant fed diet had the highest ADFD (31.88%) while those fed 6% plant fat diet had the lowest (14.15%). The rabbits fed the control, 3%, 6% animal fat and 3% plant fat diets had similar NDFD, which were significantly (P<0.01) higher than those of rabbits fed 6% plant fat diet. The rabbits fed control diet had the highest NDFD (42.13%), while those fed 6% plant fat diet had the lowest NDFD (27.71%).

Effects of control vs. fat diets on nutrient intake, growth performance and nutrient digestibility in rabbits are shown in Table 5.

The rabbits fed fat diets had significantly (P<0.05) higher feed intakes than those on control diet. There was no significant difference in overall weight gain of the rabbits fed control and fat diets. The rabbits fed fat diets had significantly higher dry matter (P<0.01) and organic matter (P<0.05) intake than those fed control diet. Inclusion of fat in the diet had significant effect on Organic Matter Intake (OMI) of the rabbits. There was no significant difference in Dry Matter Digestibility (DMD) and Organic Matter Digestibility and Organic Matter Digestibility (OMD) of the rabbits fed

TABLE 4
Nutrient digestibility of diets containing varying levels and sources of fat by rabbits

Parameters	Control	Animal fat		Level and Source of Dietary Fat		SE
		3%	6%	3%	6%	
	fat $Diet_1$	$Diet_2$	$Diet_3$	$Diet_4$	$Diet_5$	
DMD	63.91^{b}	65.15^{b}	66.33^{d}	64.78^{c}	55.79^{a}	0.35
CPD	90.67^{b}	91.20^{cd}	91.45^{cd}	90.93^{bc}	87.00^{a}	0.12
OMD	65.73^{b}	67.85^{c}	70.07^{d}	67.86^{c}	59.27^{a}	0.32
ADFD	26.37^{b}	31.08^{c}	30.23^{c}	31.88^{c}	14.15^{a}	0.93
NDFD	42.13^{b}	40.66^{b}	41.26^{b}	41.11^{b}	27.71^{a}	0.62

PMD = Dry Matter Digestibility
CPD = Crude Protein Digestibility
OMD = Organic Matter Digestibility
ADFD = Acid Detergent Fibre Digestibility
NDFD = Neutral Detergent Fibre Digestibility

$^{a, b, c, d,}$ Means in the same row with different superscripts are different (p<0.01).

TABLE 5
Effect of control versus fat diets on nutrient intake digestibility and growth performance in rabbits

Parameters	Control Diets	Fat	Diets Level of Significance
FI	75.36	76.99	*
DWG	27.53	24.83	NS
FCR	2.47	3.25	NS
DMI	64.50	66.56	**
OMI	60.05	61.35	*
DMD	63.91	63.01	NS
OMD	65.73	66.25	NS
CPD	90.61	90.17	NS
ADFD	26.37	26.85	NS
NDFD	42.13	37.68	NS

* - Significant at 5%
** - Significant at 1%
NS - Not significant

TABLE 6
Multiple regression equation relating performance parameters to the nutrient content of diets in rabbits fed varying sources and levels of fat

	Independent Variables				
Dependent Variables	Constant	CP	ADP	NDF	R^2
DMI	51.80^{***}	-2.10^{***}	0.77^{***}	0.78^{***}	71.60^{***}
DWG	-119.90^{***}	5.79^{***}	-1.72^{***}	1.80^{***}	77.30^{***}
OMI	51.00^{***}	-2.04^{***}	0.73^{***}	-0.79^{***}	67.40^{***}
DMD	-59.30^{***}	3.65^{***}	-0.50^{*}	3.54	62.60^{***}
OMD	-64.70^{***}	3.72^{***}	-0.502^{***}	4.51	60.6^{***}
ADFD	-74.30^{**}	4.75^{***}	0.53	4.54	58.80^{***}
ADFD	-63.30	3.94^{**}	-6.12	2.33	31.10

*** Significant at 0.1%
** Significant at 1%
* Significant at 5%

CP = Crude Protein
ADF = Acid Detergent Fibre
NDF = Neutral Detergent Fibre
R^2 = Coefficient of Determination
DMI = Dry Matter Intake
DWG = Daily Weight Gain
DMD = Dry Matter Digestibility
OMD = Organic Matter Digestibility
ADFD = Acid Detergent Fibre Digestibility
NDFD = Neutral Detergent Fibre Digestibility

control and fat diets. No significant difference was observed in CPD, ADFD and NDFD of the rabbits fed control and fat diets.

Multiple regression equations, relating weight gain, nutrient intake and digestibility in rabbits to the chemical composition of the diets are shown in Table 6. For each unit increase in Crude Protein (CP) and Neutral Detergent Fibre (NDF). Dry Matter Intake (DMI) decreased by 2.1g and 0.78g respectively. The DWG decreased by 1.72g for each unit increase in NDF but increased by 5.8g for each unit increase un CP.

The DMD and OMD increased by 3.63% and 3.72%, respectively for each unit increase in CP and decreased by 0.50 for each unit increase in ADF. For each unit increase in CP, the ADFD increased by 4.75%.

DISCUSSION

Fernandez and Fraga (1996) reported significant variation in feed intake of the control plant and animal fat diets fed to rabbits as shown by the results in this study. The DWG attained with the control diet (27.53g/day) was not different from that obtained from 3% animal fat diet (27.08g/day). This showed that maize could be favorably replaced at 3% with animal fat. Increased levels of animal fat by 6% improved the DWG (31.10%/day) and are comparable to the findings of Fernandez and Fraga (1996) who obtained higher DWG values (34.0-36.40g/day).

Increase in plant fat inclusion level decreased the DWG mean values for 3% and 6% level respectively as was reported by Odunsi (1999) who used 2.50 and 5.0% level palm oil and reported DWG of 21.40 and 15.0g/day respectively. The OMI results obtained in this study are comparable to those of Fernandez and Fraga (1996), who observed significant differences in OMI in rabbits fed the animal and plant fat diets. The results showed improvement in DMD with animal fed addition as observed by Cobos *et al.* (1993), who reported that fat improves the diet and generally increases absorption of fat soluble nutrients. The CPD values obtained in this study are comparable to those of Patridge *et al.* (1986) and Santoma *et al.* (1987), who reported that fat addition and increase in fat level did not affect the crude protein digestibility. The rabbits fed 3% animal and plant fat and 6% animal fat diets had similar DFD, which were significantly higher than those on control diet. These findings indicated that fat addition increased ADF digestibility. The ADFD increased by 4.75% with each unit increase of CP, and these results are comparable to those reported by Fernandez *et al.* (1994). The ADFD obtained from the diets are comparable to Patridge *et al.* (1986) and Santoma *et al.* (1987), who reported that fat inclusion in the diet and increase in fat level did not affect NDFD. The NDFD increased by 3.94% with each unit increase in CP. These findings are similar to those reported by Fernandez *et al.* (1994).

CONCLUSION

According to the above findings, fat is effective in rabbit's diets at the levels studied. Animal fat at 6% level produced the highest weight gain whereas plant fat at 3% level can also be used in rabbit diets without affecting their performance. Animal fat at 6% level could be used to improve the weight gain of rabbits and fat generally can be used as an energy booster in diets low in energy.

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(Received: 14 October 2003)
(Accepted: 17 June 2004)