EFFECT OF DIETARY FAT ADDITION ON GROWTH PERFORMANCE, NUTRIENT DIGESTION AND CAECUM FERMENTATION IN 2-3 MONTHS OLD MEAT RABBITS

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ABSTRACT

An experiment was conducted to determine the effect of different diet fat addition on growth performance, nutrients digestion and caecum fermentation of 2 to 3 months old New Zealand meat rabbits. Eighty four 2-month old rabbits were allocated in individual cages for seven treatments in which they were fed each diet with addition of fat (lard and soybean oil) at 0, 20, 40 and 60 g/kg. Compared with the control group, the lard addition decreased the average daily intake (ADI) and improved the feed conversion rate (FCR) (P<0.05). Compared with the control group, the fat addition increased the coefficients of total tract apparent digestibility (CTTAD) of ether extract (EE) (P<0.05) and decreased the pH and acetic acid/propionic acid ratio in the caecum (P<0.05), and did not affect the CTTAD of crude fiber and energy (P>0.05). The CTTAD of EE of control group, 20, 40 and 60 g/kg fat addition was 0.695, 0.827, 0.840 and 0.851, respectively. When the dietary fat level increased, pH and acetic acid/propionic acid ratio decreased (P<0.05) and butyric acid content in the caecum increased (P<0.05).

Key words: New Zealand rabbits, Fat, Growth performance, Nutrient digestion, Caecal fermentation.

INTRODUCTION

Because fat has high efficiency of conversion of the metabolizable energy into retained energy and supplies essential fatty acids, the fat was often used in commercial meat rabbit production. NRC (1977) recommended that the dietary fat requirement of growing rabbits was 2-5%. The addition of fat to diets of growing rabbits increased digestible energy content and feed conversion ratio (FCR) (Santoma *et al*., 1987) when diets contain high fiber content. However, studies on the effect of dietary fat on caecal fermentation of growing meat rabbits are still scarce. The objective of the present study was to assess the effects of different dietary fat varieties and levels on growth performance, nutrient digestion and caecal fermentation of 2 to 3 months old meat rabbits.

MATERIALS AND METHODS

Animals and experimental design

Eighty four 2-month old New Zealand rabbits (mean body weight 1.52±0.19 kg, male and female had half each) were allocated to seven groups according to the average body weight, with twelve rabbits per group. Rabbits were individually housed in self-made metabolism cages in which urine from faeces could be separated. Each cage contained a feeder to provide free access to feed and a nipple waterer to provide free access to water. Control diet and experimental diets, with two different sources of fat, and in each case with different fat levels, were made for a 2×4 factorial arrangement. Sources of fat were lard and soybean oil. Levels of fat were 0, 20, 40 and 60 g/kg, respectively. Table 1 gives the ingredients and chemical composition of experimental diets. The diets were formulated according to NRC (1977) and were pelleted.

Table 1: Ingredients and chemical composition and nutritive value of diets

	Control	20 g/kg lard	20 g/kg soybean oil	40 g/kg lard	40 g/kg soybean oil	60 g/kg lard	60 g/kg soybean oil
Ingredients (g/kg diet):							
Clover meal	150	100	90	85	90	85	80
Peanut vine	235	310	310	305	300	290	285
Maize	230	310	290	210	190	110	75
Wheat bran	210	80	115	190	215	300	350
Soya bean meal	145	150	145	140	135	125	120
Salt	5	5	5	5	5	5	5
$CaHPO_4$	15	15	15	15	15	15	15
Lard	0	20	0	40	0	60	0
Soybean oil	0	0	20	0	40	0	60
Premix[a]	10	10	10	10	10	10	10
Chemical composition (g/kg DM):							
Ca	11.6	9.6	9.5	9.4	9.4	9.2	9.1
P	6.8	6.1	6.3	6.7	6.9	7.4	7.7
Crude protein	139.8	139.3	136.4	141.4	142.7	137.9	138.5
Crude fibre	124.1	122	124.1	127.6	128.9	122.5	129.4
Ether extract	36.5	53.2	51.7	74.5	76.5	88.6	89.8
DE[2] (MJ/kg DM)	10.39	10.51	10.48	10.51	10.53	10.50	10.53

[a]Premix composition (by kg diet): Lys, 1.5 g; Met, 1.5 g; Cu, 50 mg; Fe, 100 mg; Zn, 50 mg; Mn, 30 mg; Mg, 150 mg; I, 0.1 mg; Se, 0.1 mg; vitamin A, 8000 IU; vitamin D, 800 IU; vitamin VE, 50 mg
[b]DE: Digestible energy, calculated from value of feed ingredients

Feed was offered in equal portions at 8:30 and 17:30 daily. Total experiment consisted of a 7-day adjustment period followed by a 23-day experimental period (including a 7-day (10th week) collection of faeces and residual feed daily). Faeces and residual feed were collected in the metabolism cages. After feeding trial, 6 rabbits from each experimental group were slaughtered and the cecal contents were collected.

Chemical Analyses

All experimental rabbits were weighed at 2 and 3 months of age and the ADG of 2 to 3 months of age were calculated. The average daily feed consumed was recorded and the FCR was calculated. Dry matter (DM) of feeds and faeces were measured by oven at 104°C during 24 h. The crude fiber (CF) content was determined according to Van Soest *et al*. (1991). Ether Extract (EE) was measured in the Soxhlet extractor. Energies of feeds and faeces were measured in a bomb calorimeter.

The cecal chyme was collected, the pH values of samples were determined from each rabbit at 45 min postmortem with a pH meter. After that, the sample of caecal contents was diluted and centrifuged, the NH_3-N concentration and volatile fatty acids (VFAs) of supernate were measured. NH_3-N concentration was measured by the technique of Weatherburn (1967) and determined spectrophotometrically. VFA were measured by gas chromatography.

Statistical Analysis

The treatment means comparison was done using the Duncan´s multiple range test of the SPSS program (SPSS, 1998).

RESULTS AND DISCUSSION

Effect of different dietary fat addition on growth performance is shown in Table 2. The control rabbits had higher average daily intake (ADI) and worse FCR than lard group ($P<0.05$). The dietary fat addition did not improve the ADG of experimental rabbits ($P>0.05$). The fat variety and level had no effect on ADG, ADI and FCR ($P>0.05$).

Table 2: Effects of different fat addition on growth performance of experimental rabbits

Treatment		Daily feed intake (g/d)	ADG (g/d)	Feed conversion ratio
Fat varieties (A)	Control	135.9[b]	25.7	5.3[a]
	Soybean oil	127.5[ab]	26.2	5.0[ab]
	Lard	119.6[a]	25.8	4.7[b]
	RSD[a]	3.1	1.7	0.7
Fat levels (B)	0 g/kg	135.9	25.7	5.3
	20 g/kg	119.6	24.6	4.4
	40 g/kg	125.0	25.8	5.0
	60 g/kg	129.4	26.6	4.9
	RSD[a]	3.4	2.0	0.8
P value	A	0.043*	0.809	0.037*
	B	0.052	0.891	0.051
	A×B	0.123	0.623	0.666

Note: The data with different small letters in the same row differ significantly ($P<0.05$), [a] RSD: root mean square difference, *$P<0.05$

The dietary fat addition increased energy concentration of the diet and decreased the dry matter intake (DMI) of rabbits, accordingly, the feed conversion ratio (FCR) was improved. Kermauner *et al*. (1996) found that the ADG was higher for the rabbits fed fat addition diet than the control, and the FCR was improved by the addition of fat. Fernandez-Carmona *et al*. (1998) reported that increasing the level of dietary fat did not increase ADG, while resulted in a lower DMI ($P<0.001$), accordingly, the FCR was improved ($P<0.001$) for the diets with added fat. In this study, the lard addition decreased the ADI and improved FCR, however, the ADG and FCR were not improved when the dietary fat addition levels increased.

Coefficients of total tract apparent digestibility (CTTAD), measured at the 10th week, are presented in Table 3. The control group rabbits had lower CTTAD of ether extract (EE) than lard and soybean oil groups ($P<0.01$). The control group rabbits had lower CTTAD of EE than those of 20, 40 and 60 g/kg fat addition ($P<0.05$). The dietary fat addition did not affected CTTAD of energy and CF ($P>0.05$).

Table 3: Effects of different fat addition on treatment on coefficients of total tract apparent digestibility (CTTAD) at 10 weeks of age

Treatment		Energy (%)	Ether extract (%)	Crude fiber (%)
Fat varieties（A）	Control	0.598	0.695[B]	0.344
	Soybean oil	0.664	0.838[A]	0.378
	Lard	0.662	0.815[A]	0.373
	RSD[a]	0.021	0.023	0.019
Fat levels（B）	0 g/kg	0.598	0.695[b]	0.344
	20 g/kg	0.691	0.827[a]	0.356
	40 g/kg	0.658	0.840[a]	0.376
	60 g/kg	0.639	0.851[a]	0.377
	RSD[a]	0.022	0.022	0.020
P value	A	0.925	0.009**	0.768
	B	0.394	0.036*	0.687
	A×B	0.600	0.467	0.568

Note: The data with different capital and small letters in the same row differ significantly at $P<0.05$ and $P<0.01$, respectively, [a]RSD: root mean square difference, *$P<0.05$; **$P<0.01$

Generally, the digestible energy (DE) content of diets with fat addition was greater than that of non-added fat diets, as a result of the influence of both GE content and energy digestibility, and many authors showed the increase of the digestibility of GE (Fernandez *et al*., 1994; Xiccato *et al*., 1995; Nizza *et al*., 1997). In the present study, the dietary fat addition did not improve the CTTAD of energy. Lipid digestibility depends primarily on the level and source of added fats. In three diets with 0 (control), 30 and 60 g added fat/kg, Santomá *et al*. (1987) observed a significant increase in EEd as fat level increased (0.64, 0.75 and 0.79, respectively) without any significant difference between fat sources. As the other animal, the CTTAD of fat had negative correlation with the fat saturation. The CTTAD of saturated fat (tallow, lard) was lower than those of the unsaturated fat (sunflower oil, bean oil) (Santoma *et al*., 1987). In the study, there was no significant difference in CTTAD of EE of soybean oil and lard groups. But, compared with control group, the CTTAD of EE of 20, 40 and 60 g/kg fat addition were higher (P<0.05). There was no significant difference in CTTAD of EE among different fat addition levels (P>0.05). The effect of the dietary fat addition on the CTTAD of CF was inconsistent in different studies. Some researchers pointed that the fat addition would restrict the caecal microorganism activities and damage the digestibility of the CF (Jenkins, 1993; Doreau *et al*., 1997). The others found that because fat digestion occur in the small intestine, therefor, there is no reason to attribute a negative influence of fat addition on the cecal microflora and consequently on crude fiber digestibility (Palmquist *et al*., 1986; Fernandez *et al*., 1994). In this study, the dietary fat addition did no affect CTTAD of CF.

Caecum fermentation characteristics of experimental rabbits are presented in Table 4. Compared with control group, the pH value and acetic acid/propionic acid ratio of soybean oil and lard groups were lower (P<0.05). The pH value and acetic acid/propionic acid ratio decreased (P<0.05), and butyric acid content increased (P<0.05) significantly when fat addition levels increased. The interaction of fat varieties and level were detected for the acetic acid/propionic acid in the caecum (P<0.05). Falcao *et al*. (1996) pointed that the proportion of the volatile fatty acid in caecum content was influenced by the fiber level, fiber source and fat addition to the diet. In this study, the decrease of pH, NH_3-N and acetic acid concentration and the increase of butyric acid concentration were observed in response to increased fat in the diets. This is likely due to the high starch in the fat diet and the starch fermented in the caecum to produce more butyric acid and propionic acid.

Table 4: Effects of different fat addition on traits of caecal fermentation in rabbits

Treatment		pH	NH_3-N (mmol/l)	Acetic acid (mmol/l)	Propionic acid (mmol/l)	Butyric acid (mmol/l)	Acetic acid/ propionic acid
Fat varieties	Control	6.64^a	34.01	35.72	2.33	4.56	15.32^a
(A)	Soybean oil	6.18^b	31.16	28.83	2.76	6.78	10.74^b
	Lard	6.20^b	29.79	29.36	2.65	7.53	11.05^b
	RSD[a]	0.36	5.94	6.89	2.12	3.18	0.89
Fat level	0 g/kg	6.64^a	34.01	35.72	2.33	4.56b	15.32^a
(B)	20 g/kg	6.36^b	30.42	30.00	2.65	6.78^a	11.60^b
	40 g/kg	6.21^{bc}	32.44	28.94	3.07	7.53^a	11.66^b
	60 g/kg	6.01^c	28.51	28.30	2.44	7.21^a	9.41b
	RSD[a]	0.39	7.95	8.59	2.54	3.82	1.15
P value	A	0.028*	0.105	0.913	0.323	0.202	0.050*
	B	0.019*	0.100	0.973	0.988	0.048*	0.026*
	A×B	0.163	0.216	0.979	0.388	0.648	0.028*

Note: The data with different small letters in the same row differ significantly (P<0.05), [a]RSD: root mean square difference, *P<0.05

CONCLUSIONS

The lard addition decreased the ADI and improved the feed conversion rate. The fat addition increased the CTTAD of EE and did not affect the CTTAD of CF and energy, but affected significantly the caecal fermentation of 2 to 3 months old rabbits.

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