THREONINE REQUIREMENT OF GROWING RABBITS

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Abstract - In this study, two hundred and eighty eight 29 day old Grimaud Hyplus medium rabbits were used and distributed into 4 groups fed with T1 to T4 diets containing respectively 0.46, 0.58, 0.56, and 0.68 % crude threonine. There were 2 basic diets T1 and T3 containing 13.2 and 15.5 % Crude Protein. Diets T2 and T4 were obtained by adding industrial threonine to T1 and T3. From 29 to 49 days, the Average Daily Weight Gains obtained were 46.3_a, 47.1_a, 49.2_b and 48.3_{ab} (g/d) for diets T1, T2, T3 and T4 respectively, showing that the threonine / lysine ratio of T3 seems to be optimum. From 49 to 63 days, the Average Daily Weight Gains were 40.9_{ab}, 42_a, 39_b and 42_a (g/d), and the 63 day old rabbit body weight reached 2247, 2277, 2278, and 2302 g : the addition of industrial threonine in diets T2 and T4 allows a significantly faster growth rate, which might imply a higher threonine / lysine ratio requirement for finishing rabbits compared to young growing rabbits.

INTRODUCTION

The digestible protein requirement for rabbits is well documented (LEBAS, 1989, SANTOMA *et al.*, 1989). For essential amino acids requirements, SANTOMA *et al.* (1989) stressed the discrepancies in the recommendations of different authors. MOUGHAN *et al.* (1988) proposed the use of amino acid balance, based on rabbit whole body composition, as a first approximation of ideal protein for growth. This approximation did not take into account the supply of amino acids by caecotrophy (17 % of protein intake), the requirements for maintenance and the discrepancies between individual amino acid digestibility. More recently, BERCHICHE *et al.* (1994) studied the effect of increasing level of methionine on a low sulfur amino acid diet. TABOADA *et al.* (1994) did the same with lysine. This study proposes a further investigation on another essential amino acid : threonine.

MATERIAL AND METHODS

Animals and rearing conditions

This trial was conducted in UFAC experimental farm from April to June 1995. In this trial, 288 Grimaud Hyplus medium rabbits of both sexes were used. The young rabbits came from the breeding unit of the experimental farm. The trial began at weaning (29 days old). The average weaning weight was 748 g. The rabbits were divided into 4 treatment groups with 12 replicates each. They were housed in 48 cages of 6 rabbits. The cages were set out in flat-deck. All in, all out system was used in this trial. In this room, the forced ventilation was electronically regulated with overpressure through a glass fiber ceiling and depression along the dropping pit. The pit was scrapped everyday. The temperature was kept above 17 °C.

Group formation

The litters were limited to 8 rabbits so that the homogeneity of weights at weaning is improved. Litters with less than 6 rabbits at weaning or with difference between rabbit weights in the litter higher than 15%, were excluded. With the remaining litters, blocks of 4 males or 4 females were selected following these criteria : mean rabbit weight in the litter, age at weaning and paternal origin. This was easily done, thanks to the exclusive use of artificial insemination on the farm. The 4 rabbits of each group were allocated to the 4 treatments. Three males and 3 females were put in each cage. The battery was filled from one end to the other with 2 cages on both side for each repetition. This group formation has been tested before with the same feed for all the cages : no zone effect was detected.

Feeding

Ad libitum feed was provided. For each of the 4 experimental diets, 500 kg of a single mixture was made in our experimental plant. Pellet diameter was 3.5 mm. Formulas were made with the value obtained by nutrient analysis of raw materials. The nutrient analysis of the 4 experimental feeds was done to verify the theoretical values.

Design of the 4 formulas.

The first data we had was the level of threonine recommended by different authors and in conventional diets for fattening rabbits. The simplest way of finding the optimum level of threonine was to create a low threonine formula and then add increasing level of threonine in the 3 other available formulas. First, a formula with low level of threonine, about 20 % under the level of a conventional diet, was calculated **(T1)**. A second diet **(T2)** with conventional level of threonine was done by adding threonine to T1. The protein level of these 2 formulas was very low (13.2 %). Although they were balanced for sulfur amino acids and lysine, this could create a limiting factor and preventing a threonine effect. Therefore, a third formula was calculated with conventional threonine level **(T3)** and a fourth one **(T4)** was been created by adding 20% more industrial threonine in diet T3.

Table 1 : ingredients of the 4 experimental diets

Ingredients	T1, T2	T3, T4
Wheat	15.00	5.00
Barley	1.30	10.80
Wheat fine bran	23.36	11.35
Sugarcane molasses	4.79	4.00
Sunflower meal	6.83	13.67
Wheat straw	9.19	4.58
Beet pulp	15.00	13.91
Alfalfa meal	22.28	29.55
Pea		1.88
Rapeseed meal		3.00
Microingredients	2.25	2.28
Total	**100.00**	**100.00**

Table 2 : calculated nutrient analysis of the 4 experimental diets (INRA 89)

Nutrient %	T1	T2	T3	T4
D E (kcal/kg)	2404	2406	2495	2507
Crude Protein	13.2	13.2	15.5	15.5
Crude Fiber	15.2	15.2	16.0	16.0
Lysine	0.67	0.67	0.63	0.63
Met + cyst	0.53	0.53	0.53	0.53
Threonine	**0.46**	**0.58**	**0.56**	**0.68**

DE : Digestible Energy

Controls

The body weight of each cage was recorded at the beginning (29 day old rabbits), the body weight and the feed intake at 49 and 63 days. When a rabbit died, its weight, the weight of the remaining rabbits in the cage and the remaining feed weight were recorded. The estimated feed intake of the dead rabbit was then subtracted from the intake of the remaining live rabbits in the cage. The results per cage were studied with these criteria : weight, average daily weight gain, average daily feed intake and feed conversion ratio. The statistical analysis was done using the Student test.

RESULTS AND DISCUSSION

Nutrient analysis

The nutrient analysis agreed with the values calculated from the raw material composition

Table 3 : verified nutrient analysis

(%)	T1	T2	T3	T4
Humidity	11.1	11.6	10.8	10.9
Crude Protein	13.8	13.3	15.3	15.1
Crude fiber	16.0	15.5	16.0	16.3
Methionine + Cystine	0.51	0.49	0.49	0.50
Lysine	0.64	0.63	0.65	0.65
Threonine	**0.48**	**0.58**	**0.60**	**0.70**

Results from 29 to 49 days

For young growing rabbits, the highest daily weight gain was obtained with T3 and was significantly lower with T1 and T2. The body weight at 49 days was significantly higher (+58 g) for the rabbits fed the T3 diet compared to the rabbits fed the T1 diet.

Table 4 : Results from 29 to 49 days

	T1	T2	T3	T4	T1	T2	T3	T4
Weight at 29 days (g)	748 ± 32	748 ± 31	748 ± 31	748 ± 32				
Weight at 49 days (g)	1675 ± 75	1690 ± 84	1733 ± 55	1714 ± 70	a	ab	b 5%	ab
Daily Weight Gain (g)	46.3 ± 2.9	47.1 ± 3.3	49.2 ± 2.0	48.3 ± 2.9	a 1%	a 10%	b	ab
Daily Feed Intake (g)	114.7 ± 6.7	113.3 ± 7.5	117.7 ± 4.7	115.8 ± 5.4				
Feed / gain	2.47 ± 0.10	2.40 ± 0.08	2.39 ± 0.04	2.39 ± 0.06	a	b 10%	b 1%	b 2%
Mortality (%)	1.28	2.56	0	0				

The feed intake was not significantly affected by the level of threonine.
The feed / gain ratio was significantly higher with the lowest level of threonine (T1).
T3 diet seems to be the best choice for young growing rabbits.
Results from 49 to 63 day old.
The body weight at 63 days increased with the level of threonine and was the highest for the rabbits fed T4 diet (marketing weight - 2.3 kg - was reached at 63 days with T4 diet). With T2 diet, the growth delay acquired in the first period was compensated in this second period of the experimentation.

Table 5 : Results from 49 to 63 days

	T1	T2	T3	T4	T1	T2	T3	T4
Weight at 63 days (g)	2247 ±110	2277 ± 90	2278 ± 100	2302 ± 90				
Daily Weight Gain (g)	40.9 ± 4.2	42.0 ± 9.6	39.0 ± 3.8	42.0 ± 2.8	ab	a 10%	b	a 5%
Daily Feed Intake (g)	157.2 ± 12.3	162.8 ± 8.4	162.3 ± 9.9	167.2 ± 9.1	a 10%	ab	ab	b
Feed / gain	3.85 ± 0.29	3.90 ± 0.32	4.18 ± 0.29	3.98 ± 0.17	a 2%	a 5%	b	a 10%
Mortality (%)	2.56	1.28	0	1.28				

The daily weight gain was significantly higher with the two threonine added diets T2 and T4 compared to T3.
The daily feed intake increased with the threonine level and was significantly higher for T4 compared to T1.
The feed / gain ratio was significantly higher for T3 compared to the 3 other feeds.
Results from 29 to 63 days.
The growth rate and the feed intake increased with the level of threonine. However only the difference between the feed intake of T1 and T4 was statistically significant.

Table 6 : Results from 29 to 63 days

	T1	T2	T3	T4	T1	T2	T3	T4
Daily Weight Gain (g)	44.1 ± 2.7	45.0 ± 2.3	45.0 ± 2.3	45.7 ± 2.4				
Daily Feed Intake (g)	131.8 ± 12.3	133.4 ± 8.4	136.1 ± 9.9	136.8 ± 9.1	a 10%	ab	ab	b
Feed / gain	2.99 ± 0.29	2.96 ± 0.32	3.02 ± 0.29	2.99 ± 0.17				
Mortality (%)	3.84	3.84	0	1.28				

The feed conversion ratio was nearly the same for all the feeds (less than 2% difference between extremes T2 and T3).

DISCUSSION

In the first interval, there was a limiting factor in diets T1 and T2 due to the low protein content of these feeds. This limiting factor was not the threonine because, although diets T2 and T3 had nearly the same crude threonine content, the growth rate was significantly better with T3. As the higher threonine content of diet T4 did not increase the growth rate, T3 diet seems to have the optimum threonine / lysine ratio for growing rabbits.

In the second interval, the growth rate was significantly higher with the 2 threonine added diets T2 and T4. Diets T2 and T3 had nearly the same crude threonine content, but T2 digestible threonine content was certainly higher due to threonine supplementation. These facts may indicate a higher threonine / lysine ratio requirement for finishing rabbits compared to young growing rabbits. HAHN and BAKER (1995) found similar trends for pigs : threonine, tryptophane and sulfur amino acids ratios to lysine used for young pigs are too low for use in finishing pigs.

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Besoins en thréonine du lapin en croissance - Pour cette étude, nous avons utilisé 288 lapins Grimaud Hyplus medium de 29 jours répartis sur 4 régimes T1 à T4 titrant respectivement 0,46 0,58 0,56 et 0,68 % de thréonine brute. Il y avait 2 formules de base T1 et T3 contenant respectivement 13,2 et 15,5 % de Matières Protéiques Brutes. Les formules T2 et T4 ont été obtenues en rajoutant de la thréonine industrielle respectivement à T1 et T3. De 29 à 49 jours, les Gains Moyens Quotidiens 46,3a 47,1a 49,2b et 48,3ab (g/j), pour respectivement T1 , T2 , T3 et T4, indiquent que le rapport thréonine / lysine de T3 (0,89) semble optimal. De 49 à 63 jours, les Gains Moyens Quotidiens ont été 40,9ab 42a 39b et 42a (g/j), avec des poids atteignant respectivement à 63 jours 2247 2277 2278 et 2302 g : les régimes supplémentés en thréonine industrielle permettent une croissance plus rapide, ce qui peut indiquer le besoin d'un rapport thréonine / lysine supérieur en finition.