FITTING DIGESTIBLE PROTEIN TO DIGESTIBLE ENERGY RATIO IN GROWING RABBITS SELECTED BY GROWTH RATE

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ABSTRACT

Growth rate of rabbits has been improved throughout the years as consequence of genetic selection programmes. However, there is not enough knowledge about the consequences of this progress on the protein requirements of animals. To explore this subject, two experimental diets, differing in digestible protein (DP) to digestible energy (DE) ratio, were evaluated in growing rabbits from a paternal line selected by average daily gain during the growing period. Diet L (low DP/DE ratio) was formulated to obtain the current dietary recommendations of PD/DE ratio for fattening rabbits (10.7 g/MJ), while diet H (high DP/DE ratio) had a higher ratio (12.2 g/MJ). A total of 180 weaned rabbits (28 d of age) were divided into two experimental groups and housed in individual cages until the end of the trial (63 d of age). Animals fed with diet H showed higher feed intake (+12.5 g dry matter/d; $P<0.001$) and average daily gain (+4.3 g/d; $P<0.001$) during the experimental period than animals fed with diet L. No significant differences in mortality and morbidity were observed between diets. However, the results related to the feed conversion ratio were not consistent along the growing period. Animals fed with diet H showed better feed conversion rate during the first week of growth (–0.10; $P<0.05$), whereas those fed with diet L showed better results during the last two weeks of the trial (–0.17; $P<0.05$). These results probably suggest that the proper PD/DE ratio for growing rabbits changes with age. In conclusion, the use of a higher DP/DE ratio during the first weeks after weaning could contribute to improve the performance of the current growing rabbits, characterised by a high growth rate, without compromising their digestive health status.

Keywords: Energy, Protein, Growth performance, Requirements, Rabbit.

INTRODUCTION

The purpose of rabbit lines selected by average daily gain (ADG) during the growing period is to indirectly improve the feed conversion ratio (FCR), which is considered one of the most important economic traits (Cartuche et al., 2014). These animals have a substantially higher growth than those from other lines (50-60 g/d during the growing period) as well as a greater adult weight. Therefore, the use of these lines allows reducing feeding and housing costs due to a shorter growing period. However, it is essential to ensure that their energy and protein needs are being fully covered, so they can reach their maximum growth. Hence, it is recommended to define a diet that will meet all the requirements.

High growth rate rabbits need sufficient protein intake during the growing period, both in quantity and quality, since the lack of one essential amino acid could have the same result as a general shortage of protein, impairing their growth (De Blas et al., 2010). Adequate levels of essential amino acids (lysine, sulphur amino acids and threonine) should be provided (Marín-García, 2019). On the other hand, rabbits regulate their feed intake according to the digestible energy (DE) content of the feed. Therefore, all nutritional requirements should be defined relative to the energy level to guarantee the animals' needs are satisfied. The current recommendations for digestible protein (DP)/DE ratio for growing rabbits are of 10.5-11 g/MJ (Xiccato and Trocino, 2010).

According to Carabaño et al. (2009), although DP/DE values used in the current commercial diets could meet the requirements of growing rabbits with an ADG up to 45 g/d, these diets could be restricting the development of the animals with greater growth potential. For this reason, the aim of the

present work was to evaluate if a higher DP/DE ratio could contribute to improving the performance of growing rabbits from a line selected for ADG during the growing period.

MATERIALS AND METHODS

Diets

Two experimental diets were formulated: diet L, whose DP/DE ratio meets the current recommendations for growing rabbits (10.7 g/MJ; Xiccato and Trocino, 2010); and diet H, which was formulated to obtain a higher DP/DE ratio (12.2 g/MJ). Diet H was obtained from diet L by replacing soybean meal with soy protein concentrate, increasing both protein content and its digestibility. To lessen the effects of this change on fibre, the level of a fibrous concentrate was also increased to obtain iso-fibrous feeds. Table 1 shows the ingredients and chemical composition of experimental diets.

Table 1. Ingredients and chemical composition of the experimental diets[1].

Ingredients (g/kg)	Diet L	Diet H	*Chemical composition (g/kg)*	*Diet L*	*Diet H*
Barley grain	180	180	Dry Matter (DM)	903	907
Wheat grain	108	90	Ash	68.4	68.4
Wheat bran	280	280	Crude protein (CP)	166	182
Soybean meal 44%CP	46	0	Gross energy (MJ/kg DM)	18.4	18.5
Soy protein concentrate	19	80	Ether extract	27.2	27.8
Alfalfa hay	257	238	Neutral detergent fibre	356	360
Fibre concentrate (Arbocel)	75	96	Acid detergent fibre	186	193
Soybean oil	10	10	Acid detergent fibre	36.2	39.4
L-lysine HCl	1.3	1.41	Lysine	170	167
DL-methionine	1.52	1.97	Sulphur amino acids	150	155
L-threonine	0.19	0.47	Threonine	118	135
Calcium carbonate	3.73	4.79	Hemicellulose	170	167
Dicalcium phosphate	6.94	6.52	Cellulose	150	155
Sodium chloride	2.73	2.83	Digestible Protein (DP)[3]	118	135
Sodium bicarbonate	2.81	2.67	Digestible energy (DE, MJ/kg DM)[3]	11	11.1
Vitamin-trace element premix[2]	5	5	DP/DE ratio (g/MJ)	10.7	12.2

[1] 35ppm of valnemulin and 350 ppm of oxytetracycline were added to mitigate cases of epizootic enteropathy; [2] NR-310-R, Throw Nutrition. [3] Determined in a digestibility trial according to Perez et al. (1995).

The DE and DP contents of the diets were determined by a faecal digestibility trial, according to the methodology proposed by the European Group on Rabbit Nutrition (Pérez et al., 1995). Twelve animals per treatment were housed in metabolic cages at 42 days of age, and after an adaptation period of one week, feed intake and faeces excretion were controlled from 49 to 53 days of age.

Feeds and individual faeces were analysed following the procedures of AOAC (2002) to determine dry matter (DM; 934.01), crude protein (CP; 990.03, Dumas method, CN628 Elemental Analyzer, LECO, St. Joseph, USA) and ether extract (EE, 920.39). For the determination of gross energy (GE) an adiabatic bomb calorimeter (Gallenkamp Autobomb, Loughborough, RU) was used. Fibre fractions (neutral detergent fibre, acid detergent fibre and acid detergent lignin) were sequentially determined following the method of Van Soest et al. (1991), using pre-treatment with thermostable α-amylase and the nylon bag technique (Ankom, Macedon, USA).

Animals and experimental design

The experimental procedure was approved by the Animal Welfare Ethics Committee of the Universitat Politècnica de València (UPV) and carried out following the recommendations of the European Group on Rabbit Nutrition (Fernández-Carmona et al., 2005) and Spanish Royal Decree 53/2013 on the protection of animals used for scientific purposes. For this experiment, data were from 180 rabbits of the R line, out of a total of 342 initially introduced, from 28 to 63 days of age. The R line is a UPV paternal line selected for ADG during the growing period for 39 generations. Weaned rabbits were

housed in individual cages and randomly distributed between the two dietary treatments. All animals had free access to the corresponding diet (offered *ad libitum*) and water during the whole experiment. Body weight and feed intake were recorded weekly and health status (morbidity and mortality) daily until the end of the experimental period.

Statistical analysis

Growth traits were analysed using a MIXED model of SAS (2009), considering lack of homoscedasticity (different variance between animals and intra-animal covariance). The model included as fixed effects the diets (H or L), the week (1^{st} to 5^{th}), the litter, as well as the random effect of the animal and the residual error. Data concerning morbidity and mortality were analysed using a chi-square test.

RESULTS AND DISCUSSION

Mortality and morbidity recorded throughout the experiment were relatively high for both dietary treatments (on average of 31 and 13%, respectively) despite the antibiotic supplementation, as the trial was conducted during an outbreak of rabbit epizootic enteropathy. No significant differences between treatments were found. Some studies have reported a positive relationship between dietary protein level and digestive disorders incidence (Carabaño et al., 2009), usually associated with an increase of ileal N flow. However, when the protein increase is obtained by using high digestible raw materials, the sanitary risk does not seem to be affected.

Table 2. Effect of dietary digestible protein (DP) to digestible energy (DE) ratio on growth performance (n=180).

	Diet L	Diet H	P-value
Feed intake (g/d)			
28 to 35 d of age	72.12 ± 1.76	80.77 ± 1.82	0.0002
35 to 42 d of age	105.79 ± 2.27	120.21 ± 2.32	<.0001
42 to 49 d of age	134.38 ± 2.78	149.66 ± 2.83	0.0001
49 to 56 d of age	166.31 ± 3.00	180.58 ± 3.04	0.0007
56 to 63 d of age	192.33 ± 3.20	202.14 ± 3.25	0.0284
Total	134.19 ± 2.15	146.67 ± 2.20	<.0001
Average daily gain (g/d)			
28 to 35 d of age	43.28 ±1.15	51.43 ±1.17	<.0001
35 to 42 d of age	53.28 ±1.14	61.33 ±1.16	<.0001
42 to 49 d of age	54.10 ±1.15	59.08 ±1.16	0.0020
49 to 56 d of age	58.73 ±1.23	60.47 ±1.24	0.3073
56 to 63 d of age	58.24 ±1.00	56.66 ±1.01	0.2481
Total	53.53 ±0.70	57.80 ±0.72	<.0001
Feed conversion ratio (g/g)			
28 to 35 d of age	1.70 ±0.03	1.60 ±0.03	0.0347
35 to 42 d of age	2.01 ±0.03	1.96 ±0.03	0.2088
42 to 49 d of age	2.50 ±0.04	2.54 ±0.04	0.4487
49 to 56 d of age	2.86 ±0.04	3.01 ±0.04	0.0111
56 to 63 d of age	3.32 ±0.05	3.59 ±0.05	0.0003
Total	2.48 ±0.02	2.54 ±0.02	0.0248

Diets: Diet L, low DP/DE ratio (10.7 g/MJ); Diet H, high DP/DE ratio (12.2 g/MJ).

Although the rabbits showed a similar weight at weaning (618 g), rabbits fed with diet H already had a higher body weight at the first week of trial (+79 g), being this difference higher at 63 days of age (+166 g). As it can be seen in Table 2, rabbits fed with diet H showed greater feed intake throughout the whole growing period (+12.5 g/d; P <0.001), and consequently a higher ADG (+4.3 g/d; P <0.001) than those fed with diet L, especially during the first three weeks (+7.1 g/d; P <0.001). Although the main factor controlling consumption is the dietary energy level, there are other nutrients that can also affect intake, such as an appropriate protein level and a good amino acid balance (Tome, 2004). Despite having a higher protein content, diet H would be more balanced and could encourage a higher

feed intake, favouring growing rabbits selected for ADG. Besides, higher ADG means higher body weight and an increase in maintenance energy requirement, which involves higher feed intake. Fraga et al. (1983), in a study where animals showed a growth rate of up to 36 g/d, recommended a PD/DE ratio of 10 g/MJ. More recently, Xiccato and Trocino (2010) recommended a ratio between 10.5 and 11 g/MJ for growing rabbits to maximise growth performance. In this work, using animals with high growth rate (>55 g/d), a higher ratio (12.2 g/MJ) could improve the growth of these animals.

However, the results related to the FCR were not consistent along the growing period. Hence, animals fed with diet H showed better FCR during the first week of growing (–0.10; $P<0.05$), but worse results during the last two weeks of the trial (+0.17; $P<0.05$), perhaps partially related to the higher maintenance requirements associated to their higher body weight. As it is well-known, protein requirements decrease with the age (Xiccato and Trocino, 2010), and may be advisable the use of two diets with the current high-growth rate rabbits, a starter diet with a higher PD/ED ratio and another finisher diet with a lower ratio. This would allow to optimize growth performance and feed efficiency.

CONCLUSIONS

The results obtained in this study seem to indicate that it is possible to enhance the growth performance of high-growth rate rabbits by increasing the DP/DE ratio. According to our findings, the use of a diet with a ratio of 12.2 g/MJ during the first weeks of the growing period could be beneficial, since it allows a clear improvement in ADG of the current growing rabbits, without compromising their digestive health status.

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