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Increasing the digestible energy intake under a restriction strategy improves the feed conversion ratio of the growing rabbit without negatively impacting the health status

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ABSTRACT

Post-weaning feed restriction strategies have proved to reduce mortality and morbidity, but result in decreased growth and lower slaughter yield. To compensate for those deleterious effects without negatively impacting the health parameters, we have studied the possibility of increasing the dietary energy level of the feed. Four treatments differing in dietary digestible energy content ("low" energy content, LE = 9.08 MJ/kg *vs* "high" energy content, HE = 10.13 MJ/kg), and feeding level (*ad libitum* or restricted at 75%) were formed in a 2×2 factorial arrangement. Animals were fed the experimental diets from weaning (32–36 days of age) to slaughter age (70–74 days of age), and feed restriction was applied from weaning to 63–64 days of age. Digestive efficiency was assessed during feed restriction and after one week of *ad libitum* feeding in 48 animals housed in individual cages. A performance experiment was carried out in four different sites involving a total of 1888 animals housed in collective cages, including carcass and meat quality measurements in 400 animals. Feed restriction and the HE diet improved the faecal digestibility of organic matter (+0.04 and +0.06 respectively; $P < 0.001$), crude protein (+0.05 and +0.05; $P < 0.001$) and NDF (+0.06 and +0.07; $P < 0.001$). When returning to an *ad libitum* feeding, no effect of the previous feeding level was observed while the effect of the diet was similar to that observed during feed restriction. Restricted feeding reduced the growth by 7% during the whole fattening period ($P < 0.001$), and the slaughter yield by 1.1% ($P < 0.001$). It improved the feed conversion ratio by 9% ($P < 0.001$), while the HE diet improved it by 11% ($P < 0.001$). A 25% reduction in feed intake reduced the health risk index (HRi) in both good and poor health conditions (2.7% *vs* 7.1%, $P < 0.01$ and 36.2% *vs* 44.3%, $P < 0.05$ respectively). The use of a high energy diet increased the morbidity (4.6% *vs* 2.5%,

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$P<0.05$) in good health conditions and had the opposite effect in poor health conditions (17.5% *vs* 22.4%). Calculations of the gross margin confirmed the economic advantage of feed restriction in growing rabbits (+0.06 €/kg), while the use of a restricted fed high energy diet was profitable only when mortality and morbidity was low.

1. Introduction

Post-weaning feed restriction has been used in French rabbit breeding systems for over ten years as an efficient method to reduce the incidence of digestive disorders in the growing rabbit (for review, Gidenne et al., 2012). A reduction of the feed intake greater than 20% reduces the post-weaning mortality and morbidity (Gidenne et al., 2009b). Moreover, feed restriction improves feed efficiency during the restriction period and especially when animals return to an *ad libitum* feeding. However, restricted feeding reduces growth and can alter slaughter yield (Xiccato, 1999). One way to overcome these deleterious effects could be to increase the energy level of the feed. The positive effects of a high-energy diet on digestive efficiency and growth performance in *ad libitum* fed animals are well known (Maertens, 2010), but the effects upon feed restricted animals are scarcely documented. The source of energy is known to impact on the health and growth of the rabbit (Gidenne et al., 2010). The incidence of digestive disorders is, for instance, reduced when the ratio of digestible fibre to starch is increased (Perez et al., 2000). Thus, the Groupe d'Experimentation Cunicole (GEC) network, comprising four experimental facilities, conducted the present study. The aim was to optimise the growth and the slaughter yield through the use of a diet rich in digestible energy while preserving the favourable effects of feed restriction upon the post-weaning digestive health. Special attention was given to development of diets with equivalent ratios of digestible fibre, starch and fat on digestible energy in order to study the effect of the energy concentration independently from the contributing nutrients. The experiment was conducted at four experimental sites on 1936 animals to assess the variability of the field conditions and evaluate the effects of our feeding strategies on the digestive health.

2. Material and methods

2.1. Experimental design, animals, housing and feeding

A bifactorial design was used with two levels of feed intake, *ad libitum* feeding *vs* restricted feeding at 75% of *ad libitum* (respectively named 100 and 75), and two diets differing in digestible energy (DE) concentration: a "low" DE feed (LE) formulated with 9.08 MJ DE/kg, and a "high" DE feed (HE) formulated with 10.13 MJ DE/kg according to the European Group on Rabbit Nutrition (EGRAN) tables (Maertens et al., 2002). The LE diet was formulated to be slightly below the minimal DE recommendation for a post weaning diet whereas the HE diet was formulated to be slightly below the maximum recommendation for a finishing diet (Gidenne, 2000). Four treatments were consequently formed: LE100, LE75, HE100 and HE75. The diets were formulated to meet with the nutritional requirements of the growing rabbit (De Blas and Mateos, 2010) (Table 1) without any antibiotics or coccidiostats. Moreover, special attention was given to obtain a theoretical deviation of 1 MJ DE/kg between the diets with the constraint of obtaining similar ratios of digestible fibre, starch and fat on digestible energy between the two diets.

Table 1
Ingredients and chemical composition of the experimental diets.

	LE[a]	HE[b]
Ingredients (g/kg)		
Wheat	50	150
Barley	34	20
Wheat bran Milurex®	130	20
Pea	20	24
Rapeseed meal	32	110
Sunflower meal	157	223
Alfalfa	225	30
Wheat straw	70	59
Sugarbeet pulp	108	208
Grape pulp	63	40
Apple pomace	20	50
Cane molasses	60	30
Rapeseed oil	5	17
Dicalcium phosphate	5	0
Calcium carbonate	1	2
Methionine 15%	3	1
L-Lysine 25%	6	5
Threonine 10%	1	2
Vitamin premix	10	10
Chemical composition (g/kg)		
Dry matter	873	874
Crude ash	75	59
Crude protein (N X 6.25)	147	160
Digestible protein[c]	97	110
Starch	102	118
Total sugars	65	58
Crude fat	28	37
Crude fibre	176	171
Total dietary fibre (TDF)	413	407
Neutral detergent fibre (NDF)	360	346
Acid detergent fibre (ADF)	227	218
Acid detergent lignin (ADL)	71	66
Digestible fibre[d]	184	207
Soluble fibre (TDF-NDF[e])	11	27
Gross energy (MJ/Kg)	16.15	16.57
Digestible energy (MJ/Kg)[c]	9.08	10.13

[a] LE=Low energy diet.
[b] HE=High energy diet.
[c] Calculated according to tables of ingredients (Maertens et al., 2002).
[d] Calculated as the sum of (NDF-ADF) and water insoluble pectins according to tables of ingredients (Maertens et al., 2002).
[e] NDF corrected for ash and nitrogen.