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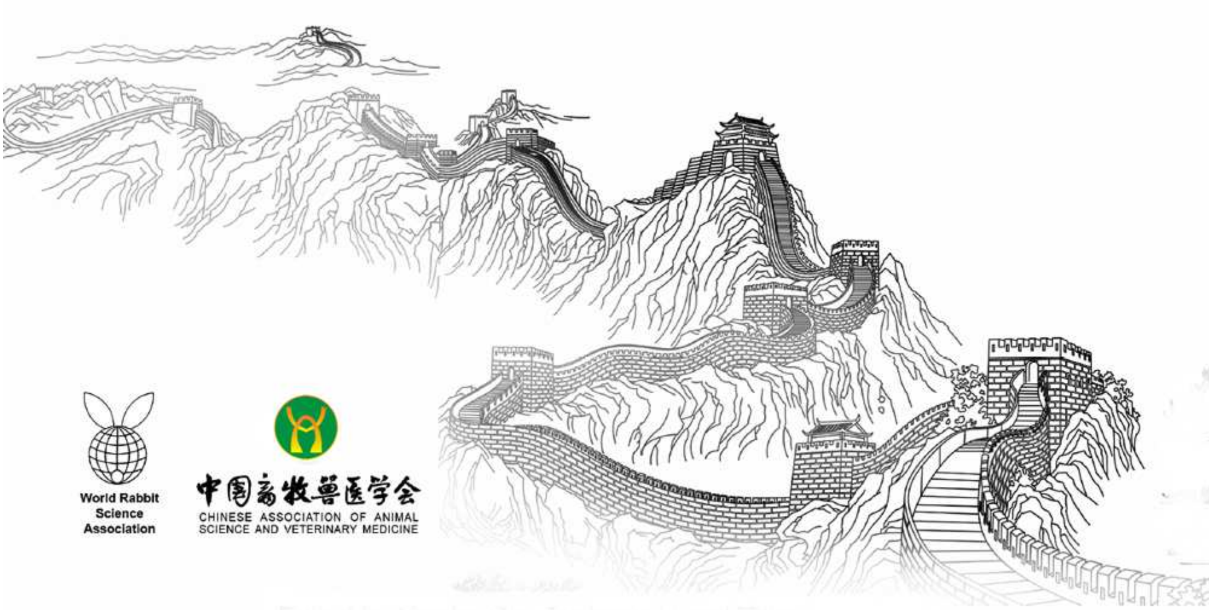

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EFFECT OF FEEDING PROGRAMME ON GROWTH AND BODY BALANCE OF MEAT RABBITS

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ABSTRACT

Two feeding systems (L, *ad libitum vs*. R, feed restriction) were combined with three feeding plans (HH, MM, MH) to evaluate the effects on performance, slaughter results and nitrogen balance of 300 commercial crossbred rabbits kept individually from weaning to slaughter (34-70 d of age). Feed restriction ranged from 80% to 100% of *ad libitum* intake from the beginning of the trial until the end of the 3rd week. The three feeding plans were: 1) HH, H diet with high digestible energy content, 11.1 MJ DE/kg, during the whole trial; 2) MM, M diet with moderate DE, 10.6 MJ/kg, during the whole trial; 3) MH, M diet during the first three weeks and H diet during the last two weeks. Feed restriction did not affect health status, nutrient digestibility, growth rate and slaughter results, but improved feed conversion (2.96 *vs*. 2.89 in L and R rabbits, respectively; P<0.01) and reduced N excretion (2.15 *vs*. 2.07 g excreted N/d, in L and R rabbits; P<0.05). At the end of the first period (55 d), R rabbits showed lower empty body protein, lipid, and gross energy gains than L rabbits, but differences disappeared within the end of the trial. The high-energy feeding plan (HH) improved feed conversion (2.89 *vs*. 2.93 and 2.97 for HH, MH and MM, respectively; P<0.05), but increased excreted N (2.17 and 2.12 *vs*. 2.03 g/d; P<0.001) because of the higher DP/DE ratio of H diet. In conclusion, a moderate feed restriction during post weaning improved feed conversion and reduced N excretion without negative effects on growth or slaughter results. Besides, N excretion was confirmed to depend largely on dietary nitrogen content.

Key words: Feed restriction, Growth performance, Body composition, Nitrogen excretion.

INTRODUCTION

In commercial farms, growing rabbits are traditionally fed *ad libitum* (Maertens, 2010), but in some countries (e.g., France, Italy) feed restriction is mostly used during the post-weaning period to avoid the risks of an excessive feed intake and the possible negative consequences on intestinal health. Studies on feed restriction started years ago with the aim of improving feed efficiency and standardizing growth curves in rabbits as well as of evaluating the effects on growth performance, carcass and meat traits (Cavani et al., 2009).

During the last 20 years, the appearance and diffusion of epizootic rabbit enteropathy (ERE) promoted the use of feed restriction and low-energy diets as feeding strategies to control the impact of the illness, but this strategy may largely affect productive results and farm efficiency (Gidenne et al., 2009, 2012; Knudsen et al., 2014).

Accordingly, the present trial aimed at evaluating if feed restriction combined with feeding plans based on diets with different energy value might affect growth performance, feed digestibility, body energy and protein balance and slaughter traits.

MATERIALS AND METHODS

At 34 d, 300 crossbred rabbits (953±110 g LW) of both genders were moved to the experimental facilities of the University of Padova. Rabbits were divided into six experimental groups, homogeneous in average live weight and variability, according to a bi-factorial arrangement, i.e. two restriction levels (L, *ad libitum vs*. R, feed restriction) and three feeding plans (HH, MM and MH) based on the administration of two diets with high (H diet) or moderate (M diet) digestible energy (DE) concentrations. The H diet contained 16.6% CP, 32.0% aNDF, 17.3% ADF, 13.8% starch, 11.1 MJ DE/kg; the M diet presented 15.5% CP, 34.4% aNDF, 18.5% ADF, 12.6% starch, 10.6 MJ DE/kg. The three feeding plans were: HH plan, rabbits fed H diet during the whole trial (5 weeks); MH plan, M diet during the first three weeks and H diet in the last two weeks; MM plan, M diet during the whole trial (5 weeks). Within the three feeding plans, half rabbits were fed *ad libitum* (L group) during the whole trial and half were restricted (R group) during the first three weeks and then fed *ad libitum* in the last two weeks. Feed restriction rate averaged 90% and ranged from 80% to 100% of the theoretical *ad libitum* intake from the beginning of the trial until the end of the 3^{rd} week. Rabbits received an antibiotic treatment (Tiamuline 12.5%, Tiamvet, CEVA Santé Animal, France) in water from 40 to 49 d of age. The *in vivo* nutrient apparent digestibility and the nutritive value of diets were evaluated on 48 rabbits at 47 d of age (Perez et al., 1995). To determine empty body (EB) weight, EB composition and nitrogen (N) balance, 12, 36 and 36 rabbits were sacrificed at the beginning of the trial, at 55 d and at 69 d, respectively, by the comparative slaughter technique (Xiccato and Trocino, 2010). At 70 d, the remaining animals were slaughtered to measure slaughter results and carcass traits (Blasco and Ouhayoun, 1996). The chemical compositions of diets, faeces and empty bodies were determined according to harmonized methods (Gidenne et al., 2001). The data of growth performance, digestibility coefficients, carcass traits, body composition and nitrogen balance were analysed by a two-way ANOVA, with feed restriction and feeding plan as main factors and by using PROC GLM (SAS, 2013). The Bonferroni t-test was used to compare means by feeding plan.

RESULTS AND DISCUSSION

One week after the beginning of the trial, ERE appeared and an antibiotic treatment was administered to control mortality (6.8% on average) and morbidity (4.0%) rates in the whole trial. During the first week, feed restriction significantly ($P<0.001$) reduced feed intake (107 g/d *vs*. 93 g/d in L and R groups; -13%) and growth rate (53.6 g/d *vs*. 46.8 g/d). During the second week, feed restriction was less effective on feed intake (134 g/d *vs*. 129 g/d; $P=0.05$; -4%) and did not affect growth rate because digestive disorders affected all rabbits. During the third week, feed intake was similar (150 g/d) and growth rate was even lower in L rabbits compared to R ones (48.3 g/d *vs*. 51.0 g/d, $P=0.05$). During the following weeks, growth rate and feed intake did not change according to the feeding level of the first period. In the whole trial, feed restriction decreased feed intake (139 g/d *vs*. 134 g/d in L and R groups; $P<0.05$) and improved feed conversion (2.96 *vs*. 2.89; $P<0.01$) in comparison with *ad libitum* regime, without effects on growth rate (Table 1). Feed restriction did not affect nutrient digestibility coefficients since the digestibility trial took place during the 3^{rd} week when R rabbits had rather high feed intake (95-98% *ad libitum*) (data not reported in table). In fact, several authors reported that feed restriction may improve feed conversion and increase nutrient digestibility (Bovera et al., 2013; Gidenne et al., 2012; Knudsen et al., 2014) depending on the restriction rate besides the restriction and re-feeding duration (Romero et al., 2011).

Dry matter (65.2% *vs*. 62.9%), crude protein (78.4% *vs*. 76.0%) and energy digestibility (66.5% *vs*. 64.3%) coefficients were significantly higher ($P<0.001$) for H diet than M diet (data not reported in table) and the DP to DE ratio ranged from 11.9 g/MJ to 11.0 g/MJ from H diet to M diet. The use of H diet during the whole trial improved feed conversion (2.89 *vs*. 2.97, for HH and MM groups; $P<0.05$) thanks to the not significant reduction in feed intake and without differences in growth rate.

Neither feed restriction nor feeding plan affected slaughter results, even if a lower dressing out percentage was measured in rabbits submitted to the MH plan ($P<0.10$) (Table 1). Severe restriction rates, long restriction periods and short re-feeding phases are necessary to affect slaughter results (Tumova et al., 2006; Gidenne et al., 2012).

The EB gain and its composition between 34 and 69 d of age were not affected by feed restriction (Table 2). During the first period EB gains of protein (193 g *vs*. 180 g), lipid (111 g *vs*. 105 g), and gross energy (9.1 MJ *vs*. 8.5 MJ) were higher (P<0.001) in L rabbits than in R ones (data not reported in table); but during the second period the previously restricted rabbits showed compensatory growth and higher (P<0.05) EB gains of protein (121 g *vs*. 126 g), lipid (91 g *vs*. 97 g) and energy (6.8 MJ *vs*. 7.1 MJ). Accordingly, feed restriction decreased body N at 55 d and N ingestion (-3%; P<0.05) and excretion (-4%; P<0.05) in the whole trial (34-69 d), but N retention was similar (2.11 g/d on average) (Table 2). Similarly, Gidenne et al. (2013) found that feed restriction reduced N emission of rabbit farms. In the whole trial, the different feeding plans did not affect the composition of EB gain and body N content at 55 or 69 d of age (Table 2). However, the N intake and excretion were higher in rabbits submitted to the HH and MH feeding plans because of the higher DE/DP ratio of H diet in comparison with M diet (11.9 g/MJ *vs.* 11.0 g/MJ) that was not counterbalanced by a higher N retention.

Table 1. Effect of feed restriction and feeding plan on growth performance and carcass traits (LS means)

	Feed restriction (R)		Feeding plan (P)			Probability			RSD[1]
	ad libitum	Restricted	HH	MH	MM	R	P	RxP	
Initial live weight , g	950	942	953	942	943				107
Final live weight, g	2638	2618	2631	2634	2618				258
Growth rate, g/d	46.9	46.5	46.6	47.0	46.5				5.8
Feed intake, g/d	139	134	134	137	138	*			16
Feed conversion	2.96	2.89	2.89[a]	2.93[ab]	2.97[b]	**	*		0.21
Slaughter weight (SW), g	2585	2564	2579	2579	2564				247
Cold carcass (CC), g	1591	1582	1596	1582	1581				163
Cold dressing, %SW	61.5	61.7	61.9	61.3	61.6		0.07		1.5
Muscle/bone hind leg	6.24	6.29	6.46	6.22	6.11				0.63

[1]Residual standard deviation.

Table 2. EB weight gain composition and nitrogen balance (LS means) between 34 and 69 days of age

	Feed restriction (R)		Feeding plan (P)			Probability			RSD[1]
	ad libitum	Restricted	HH	MH	MM	R	P	RxP	
EBW gain, g	1504	1489	1491	1516	1483				187
EB gain composition									
Water, g	941	936	929	957	929				122
Protein, g	314	306	314	311	305				37
Lipid, g	202	203	204	201	203				22
Gross energy, MJ	15.9	15.6	15.9	15.9	15.5				1.8
Nitrogen balance									
Body N at 34 d, g	22.6	22.4	22.6	22.4	22.4				2.5
Body N at 55 d, g	53.5	51.2	52.8	52.1	52.2	***			5.2
Body N at 69 d, g	72.8	71.4	72.8	72.2	71.1				7.1
N ingested, g	125	121	126[a]	124[ab]	120[b]	*	*		4.8
N retained, g	50.2	49.0	50.2	49.8	48.7				6.0
N excreted, g	75.7	72.3	75.9[A]	74.1[A]	71.1[B]	*	**		9.9
N excreted, g/d	2.15	2.07	2.17[A]	2.12[A]	2.03[B]	*	**		0.28

[1]Residual standard deviation.

CONCLUSIONS

Growth performance, body balance and slaughter results were scarcely affected by a moderate feed restriction (on average 90% of *ad libitum*) during the post weaning period, but farm efficiency and environmental impact were largely improved in terms of reduced feed conversion and N excretion.

Similarly, growth performance, slaughter traits or nitrogen retention did not change with feeding plans based on high- and/or moderate-energy diets. Instead, nitrogen excretion was confirmed to depend largely on dietary nitrogen content.

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