PERFORMANCE, MORTALITY AND SLAUGHTER TRAITS OF GROUP–HOUSED RABBITS SUBMITTED TO DIFFERENT TIME-BASED FEED RESTRICTION PROGRAMS

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ABSTRACT

Growth performance, health and slaughter traits were measured in 320 crossbreed rabbits housed in 40 open-top pens (8 rabbits/pen) from weaning to slaughter (34–70 d of age) to evaluate the effects of the different feeding programs: **AL**, *ad libitum* feeding; **DF**, daylight access to feed with fast and complete refeeding; **NF**, night access to feed with fast and complete refeeding; **NS**, night access to feed with slow and complete refeeding; **NI**, night access to feed with very slow and incomplete refeeding. In restricted rabbits, the feeding time decreased from 14 to 9 h/d during the 1st week, remained stable (8 h/d) during the 2nd week, and increased from the beginning of the 3rd week according to three refeeding programs: *i*) fast until *ad libitum* (+4 h/d until 24 h/d); *ii*) slow until *ad libitum* (+1 h/d until 24 h/d); *iii*) very slow and still restricted until the end of fattening (+30 min/d until 12 h/d). In the restricted rabbits, feed intake (-3.7%) and feed conversion (–5.6%) were lower compared to AL ones (P<0.001) with the minimum values in the NI group. Diet digestibility increased in the restricted groups compared to AL and in the NI group compared to other restricted groups. Mortality was lower in AL rabbits compared to restricted ones (1.6% vs. 9.0% on average; P=0.04), whereas morbidity and health risk index did not change. Slaughter weight (2608 g), dressing percentage (60.2%), and carcass muscularity were not affected by the feeding program. In conclusion, the NI program represented the best strategy to optimize feed efficiency without impairing, growth, slaughter results and carcass traits in growing rabbits. The tested feed restriction programs did not succeed in enhancing rabbit health.

Key words: growth, feed intake, feed efficiency, diet digestibility, carcass quality.

INTRODUCTION

The application of feed restriction programs in growing rabbits is focused on two main aspects: 1) the improvement of animal health by reducing digestive troubles; 2) the increase in the global farm efficiency by enhancing diet utilization and feed conversion (Gidenne et al., 2012). According to Weissman et al. (2009), the feed efficiency could vary in rabbits restricted during light or night hours. Moreover, rabbits submitted to feed restriction can require longer fattening periods to reach adequate final live weights and slaughter yields compared to rabbits fed *ad libitum* (Xiccato, 1999), but the occurrence of digestive diseases during the refeeding phase remains an unsolved problem (Knudsen et al., 2017; Birolo et al., 2019).

Therefore, the present study aimed at evaluating the effect of different feed restriction programs and refeeding techniques on growth performance, health and carcass quality in growing rabbits.

MATERIALS AND METHODS

Animals and experimental design

At 28 d of age, 320 crossbreed rabbits of both genders were moved to the experimental facilities of the University of Padova. Rabbits were housed in 40 open–top pens (0.5 m^2; 8 rabbits per pen) and assigned to 5 experimental groups: AL, *ad libitum* feeding throughout the trial period; DF, daylight access to feed with fast refeeding until *ad libitum*; NF, night access to feed with fast refeeding until *ad libitum*; NS night access to feed with slow refeeding until *ad libitum*; NI, night access to feed with very slow refeeding and 12-h-restriction until the end of fattening. From 28 to 49 d, all rabbits were fed with a post–weaning diet (15.9% CP, 37.6% aNDF, 21.0% ADF, 10.7% starch, 10.8 MJ DE/kg) supplemented with antibiotics (Oxitetraciclin, 1,450 mg a.p./kg) and coccidiostat (Diclazuril, 1 mg a.p./kg). From 49 to 70 d, a fattening diet (16.0% CP, 36.6% aNDF, 19.6% ADF, 13.2% starch, 10.3 MJ DE/kg) without antibiotics and coccidiostats was provided. The feeding time for restricted rabbits decreased from 14 to 9 h/day during the 1st week of trial (28 to 34 d), remained stable (8 h/d) during the 2nd week (35 to 41 d) and increased from the beginning of the 3rd week (43 d) according to three refeeding programs: *i*) fast refeeding (+4 h/d) until 24/d of access to the feeders; *ii*) slow refeeding (+1/+2 h/d); *iii*) very slow and incomplete refeeding (+30 min/d until 12 h/d of access to the feeders) (Figure 1). Health and feed intake (DFI) of the animals were monitored daily. The individual live weight (LW) was recorded once a week. The nutrient apparent digestibility and nutritive value of post-weaning and fattening diets were evaluated *in vivo* in two digestibility trials at 36–40 d and 60–64 d of age (Perez et al., 1995). At 70 d, all rabbits reaching a minimal live weight of 2.2 kg were slaughtered to measure carcass traits (Blasco and Ouhayoun, 1996).

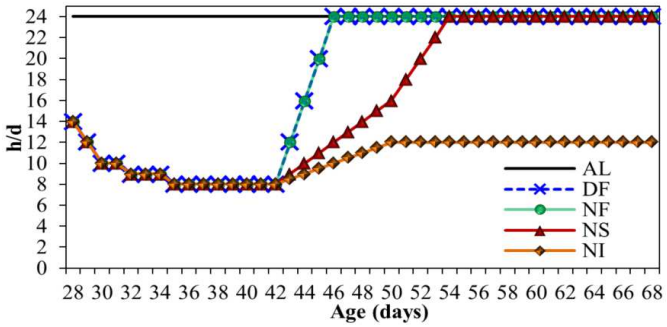

Figure1: Daily access time to feed for rabbits submitted to different feeding programs (AL: *ad libitum*; DF: daylight access to feed with fast refeeding; NF: night access to feed with fast refeeding; NS: night access to feed with slow refeeding; NI: night access to feed with incomplete refeeding.

Statistical Analysis

The individual data of LW, daily weight gain (DWG), slaughter and carcass traits were analysed by a two–way ANOVA using the PROC MIXED (SAS, 2013). The model included the experimental group as a fixed effect with the pen as a random effect. The cage data of DFI, feed conversion (FC) and digestibility coefficients were analysed by a two–way ANOVA using the PROC GLM of SAS. The model included the experimental group as a fixed effect. Mortality, morbidity and health risk index were analysed by the PROC GENMODE of SAS. The Bonferroni t-test was used to compare means.

RESULTS AND DISCUSSION

During the first two weeks of trial, the rabbits of NF, NS and NI groups reached a feeding level equal to 79% of AL, whereas DF group showed the lowest DFI (74% of AL). Consistently, other authors found that rabbits fed 8 h/d in the first two weeks after weaning achieved a feeding level around to 80% of *ad libitum* (Romero et al., 2010). With the start of refeeding, DF and NF rabbits exhibited a great peak of feed intake, overcoming the feeding level of AL group and then maintaining a higher feed consumption until the end of the trial (Figure 2). Indeed, rabbits can rapidly adapt their feeding

rate to the effective time available for feeding (Gidenne et al., 2010). On the other hand, the refeeding techniques in the NS and NI groups permitted to reach gradually the feeding level of AL group so avoiding abrupt changes in DFI.

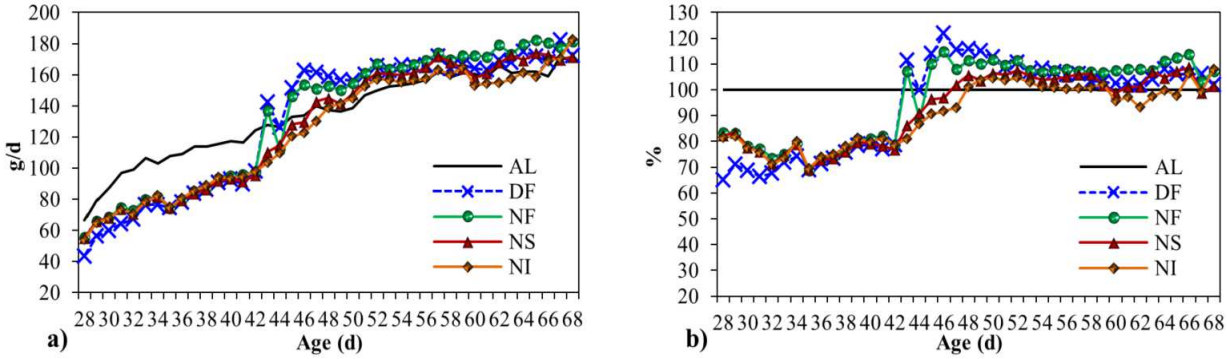

Figure 2: Daily feed intake (a) and feeding level (b) of the rabbits during the trial.

Table 1: Effect of the feeding program on growth performance, health, and slaughter results

	Feeding program						RMSE
	AL	DF	NF	NS	NI	Prob.	
Rabbits, no.	46	40	42	37	41		
Live weight 28 d (g)	647	633	638	638	634	0.785	66
Live weight 49 d (g)	1753^{A}	1619^{B}	1694^{AB}	1661^{B}	1666^{B}	0.001	150
Live weight 69 d (g)	2696	2645	2727	2645	2673	0.279	202
Post weaning period (28 to 49 d)							
Weight gain (g/d)	52.5^{A}	46.9^{C}	50.4^{AB}	48.6^{BC}	49.0^{BC}	<0.001	5.3
Feed intake (g/d)	112^{A}	97^{B}	98^{B}	93^{C}	92^{C}	<0.001	3
Feed conversion	2.12^{A}	2.10^{AB}	1.93^{C}	1.96^{BC}	1.88^{C}	<0.001	0.11
Fattening period (50 to 69 d)							
Weight gain (g/d)	47.2^{B}	51.3^{A}	51.7^{A}	49.2^{AB}	50.4^{AB}	0.001	5.6
Feed intake (g/d)	157^{C}	167^{AB}	170^{A}	164^{B}	159^{BC}	<0.001	5
Feed conversion	3.34	3.29	3.30	3.32	3.14	0.207	0.18
Whole period (28 to 69 d)							
Weight gain (g/d)	49.9	49.1	49.7	48.9	51.0	0.164	4.2
Feed intake (g/d)	134^{A}	131^{AB}	133^{AB}	128^{BC}	124^{C}	<0.001	3
Feed conversion	2.68^{A}	2.71^{A}	2.60^{AB}	2.63^{AB}	2.50^{B}	<0.01	0.10
Mortality[1] (%)	1.6	3.1	12.5	10.9	9.3	0.137	-
Morbidity (%)	26.6	34.4	21.9	29.7	26.6	0.612	-
Health risk index[2] (%)	28.2	37.5	34.4	40.6	35.9	0.665	-
Slaughter weight (g)	2628	2621	2643	2574	2574	0.261	173
Cold carcass (g)	1588	1572	1600	1550	1546	0.172	119
Cold dressing (%)	60.4	60.0	60.6	60.2	60.0	0.525	1.9
Muscle/bone hind leg	5.65	5.44	5.57	5.44	5.64	0.542	0.47

Means with different letters on the same row differ significantly (Bonferroni test). [1]Contrast: AL vs. DF + NF + NS + NI; P=0.04. [2]Calculated as Mortality + Morbidity (Gidenne et al., 2009).

In the post weaning period, feed restriction decreased DFI (-15%) and DWG (-7.2%) compared to the AL program (P<0.001), leading to a lower LW at 49 d (-3.4%; P=0.001) (Table 1). However, FC improved in restricted rabbits compared to the AL ones (-7.2%; P<0.001). Indeed, the feed restriction enhanced (0.01<P<0.001) the digestibility of DM (61% vs. 63%), CP (77% vs. 81%), EE (81% vs. 84%) and fibre fractions compared to the AL program, without differences among daylight and night feeding programs (data not in tables). In the fattening period, the DWG was higher in previously restricted rabbits than in AL ones (+7.3%; P=0.001) mainly because of the increase in DFI (+5.1%; P<0.001). The digestibility coefficients of DM (60% vs. 61%) and CP (72% vs. 74%) of fattening diet were higher (P<0.05) in NI group compared to groups submitted to complete refeeding techniques (data not in tables). In the whole period, the NI rabbits achieved the lowest DWG and the best FC (Table 1). In accordance with our findings, other authors reported that feed efficiency improved in

feed-restricted rabbits thanks to an increased diet digestibility during the restriction phase and to a compensatory growth during refeeding (Knudsen et al., 2014, 2017). In the whole trial, a lower mortality rate (especially due to digestive disorders) was detected in AL rabbits compared to restricted ones (P=0.04), without differences on morbidity and health risk index among groups. In fact, the protective effect of rationing programs on gut health disappears when animals return to *ad libitum* feeding (Birolo et al., 2019). Slaughter and carcass weights as well as dressing percentage and muscle to bone ratio of hind leg were not significantly affected by the feeding program.

CONCLUSIONS

In conclusion, a feed restriction program characterized by a night access to feed and a very slow and incomplete refeeding (up to 12 h/d of access to feed) represented the best strategy to reduce feed conversion without impairing growth performance, and slaughter and carcass traits in growing rabbits. However, in this study, feed restriction was not effective in reducing mortality due to digestive disorders.

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