TIME FEED RESTRICTION REDUCES DIGESTIVE DISORDERS WITHOUT DECREASING GROWTH PERFORMANCES OF GROWING RABBITS IN ERE CONDITIONS.

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ABSTRACT

The aim of this study was to test the effects of feed restriction on health status of rabbits in Epizootic Rabbit Enteropathy (ERE) conditions. A control group (AL) fed ad libitum was compared to three other groups. The FR group was feed restricted (about 15%). Access to feed of AL12 and AL14 groups was time restricted: 12 or 14 hours per day respectively. The available quantity of feed in feeders was more than ad libitum intake. Rabbits were housed in collective cages (8 rabbits per cage). Live weight and feed intake were recorded at 34, 43, 50, 57 and 69 days. Mortality was checked every day and morbidity was controlled when rabbits were weighted. Rabbits of AL group showed a non significantly higher mortality rate compared to restricted groups, while morbidity was significantly higher at 50 days of age (12.5% vs. 57.5%). Feed restriction gave a non significant decrease in average daily gain (ADG) of 5% and a non significant decrease of 63g in live weight at slaughtering. Feed restriction by limiting the access to feed leaded to similar health status results as the FR group: reduction of the mortality (6.3% and 8.8% vs 15.0% in the control group) and significantly lowered morbidity. Respect to the control group, the feed intake was higher in AL14 group (145g/j vs. 137g/j, $P<0.05$), but was similar in AL12 group (138g/j). Average daily gain was improved in both AL12 and AL14 groups (+7 to 10%, $P<0.05$). In addition, AL12 and AL14 leaded to an increase of 10% in the number of slaughtered rabbits, an increase in average live weight at slaughtering of 5.4% and a better economic feed conversion ratio. Although AL12 and AL14 had the same feed intake as the control group during the first week of the fattening period, AL12 and AL14 showed far less health problems during the second week and later. This indicates that the improvement of the health status was due not only to feed restriction, but also to the fasting period during the day. AL14 group feeding strategy seemed to be a better one than a classical feed restriction program since it combines a positive effect on health status and it guarantees good growing performances.

Key words: Feed restriction, time access, ERE.

INTRODUCTION

Quantitative feed restriction is known to reduce health troubles due to digestive disorders (Gidenne *et al.*, 2003). Nevertheless it also decreases significantly growth performances and live weight at slaughtering. Mc Nitt showed that a restricted time access to feed of 15 hours per day did not decrease significantly average daily gain (Mc Nitt and Moody, 1991) and Salaun *et al.* (2011) showed that an access of 14 hours per day to the diet significantly improved viability of rabbits without decreasing live weight at slaughtering nor carcass yield (Salaun *et al.*, 2011). The aim of this work is to study the impact of a feed restriction either quantitatively or by limiting the time of access to the diet, on the health status and growing performances of fattening rabbits in ERE (Epizootic Rabbit Enteropathy) conditions.

MATERIALS AND METHODS

Animals and experimental design

320 rabbits were allocated at weaning (35 days of age) to four groups according to their live weight the day before weaning, their sex and their litter origin. Each group counted 80 rabbits housed in collective cages of 8 rabbits. The control group (AL) was fed ad libitum and had free access to the feed during 24h per day. The "Feed Restriction" group (FR) was fed at 85% of the ad libitum intake reference, once a day at 2:30pm. The groups AL12 and AL14 had ad libitum access to the feed only during 12 or 14 hours per day respectively. Group AL12 was fed at 4:30pm and group AL14 was fed at 2:30pm. Feed was removed automatically at 4:30am in both groups. All the groups had free access to water and consumed the same commercial diet containing 14.3% of crude protein and 15.4% of crude fibre (as fed basis, calculated from analysis on ingredients). The trial lasted from weaning till slaughter (69 days old; February 2011).

Experimental reproduction of ERE

The trial was conducted in ERE conditions. ERE was experimentally reproduced by the inoculation of one additional rabbit in each cage with 500µl of TEC 2.1 (Duperray *et al*., 2011). In total, 40 additional rabbits were inoculated the day after weaning and were removed at 57 days of age in order to reproduce and spread the disease by contact with the other rabbits. Inoculated rabbits were not considered in results. Rabbits were considered as suffering from ERE when they showed one or more ERE characteristic symptoms: weak diarrhoea, rumbling noise, distended abdomen, excretion of mucus.

Measurements

Mortality was controlled every day. Live weight, feed intake and morbidity were controlled at 43, 50, 57 and 69 days of age. Average daily gain was calculated from live weight data and sanitary risk index (SRI) was calculated from mortality and morbidity results (SRI % = (dead rabbits + morbid rabbits) *100 / initial rabbits). A rabbit was considered as morbid when it showed any signs of ERE (see above).

Statistical Analysis

Mortality and morbidity results among groups were analyzed by a frequency comparison with a Chi^2 test. Results of live weight, live weight gain, feed intake and feed conversion ratio of the four groups were analyzed according to a general linear model using ANOVA.

RESULTS AND DISCUSSION

Results presented in the paper concern only non inoculated rabbits. Inoculated rabbits were used only to contaminate the other rabbits.

Health status

As shown on Figure 1, mortality started 10 to 14 days after inoculation. Mortality rate reached 15.0% in AL group showing a correct reproduction of ERE confirmed by necropsy results.

Rabbits fed freely (AL group) showed a non significantly higher mortality rate compared to restricted groups (table 1). Restricted daily feed access of 12h or 14h led to similar mortality rates. Few rabbits showed digestive troubles at 43 days of age, and morbidity peaked around 50 days of age, when mortality started to increase. Morbidity rate were reduced with the feeding strategy, since it decreased from 57% in AL group to 12% in FR group ($P<0.001$, table 1). Restricted-time access also decreased significantly morbidity compared to ad libitum feeding: from 57% in AL to 21% and 20% in AL12 and AL14 groups respectively. Similar results were observed on morbidity at 57 days of age. Sanitary Risk Index had a similar trend. These results suggested the efficacy of our two feeding strategies on digestive disorders, through a limited daily feed quantity or a time limited access to feeders.

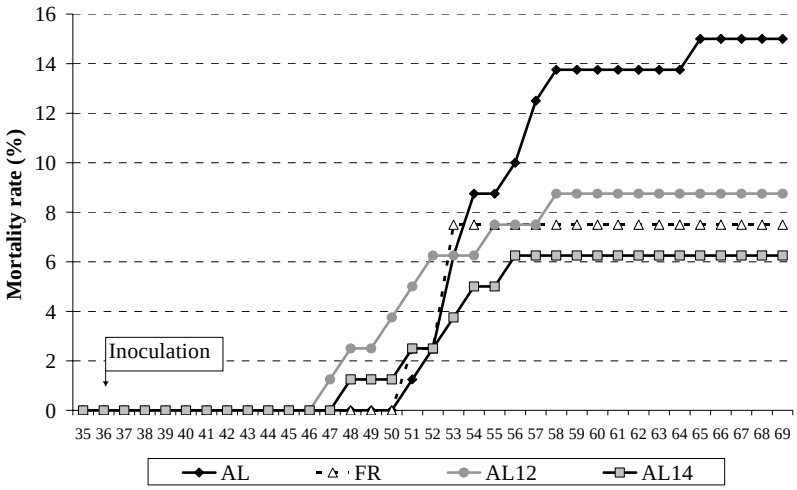

Figure 1: Cumulative mortality rate (%) evolution according to feeding level and strategy

Table 1: Mortality, morbidity and sanitary risk index (SRI) according to feeding level and strategy

	AL	FR	AL12	AL14	Prob.	AL	FR	AL12	AL14	Prob.	AL	FR	AL12	AL14	Prob.
	Mortality %					Morbidity %					SRI %				
At 43d	0.0	0.0	0.0	0.0	NS	3.8	0.0	1.3	1.3	NS	3.8	0.0	1.3	1.3	NS
At 50d	0.0	0.0	2.5	1.3	NS	57.5^{c}	12.5^{a}	20.5^{b}	20.3^{b}	<0.001	57.5^{b}	12.5^{a}	22.5^{a}	21.3^{a}	<0.001
At 57d	10.0	7.5	7.5	6.3	NS	33.3^{b}	12.2^{a}	18.9^{a}	12.0^{a}	0.002	40.0^{b}	18.8^{a}	25.0^{ab}	17.5^{a}	0.003
At 69d	15.0	7.5	8.8	6.3	NS	0.0	0.0	0.0	1.3	NS	15.0	7.5	8.8	7.5	NS

Means with different letters on the same row differ significantly (Chi² test). NS : Not significant (P>0.05)

Feed intake

Feed intake of AL rabbits was reduced because of their poor health conditions induced by ERE. FR rabbits were restricted at 87% of AL on average over the whole fattening period (P<0.001), but varied during the fattening period. The feed restriction level during the first week, when rabbits were the most sensitive to digestive disorders, was 72% of AL, leading to a significant decrease in health troubles. Feed intake of AL12 rabbits was similar to AL rabbits in ERE conditions. Feed restriction was around 4% during the first week, but rapidly the rabbits were able to compensate for the intake despite of the limited time of access to feeders. In a similar way, rabbits from group AL14 ate as much as the control group during the first week of fattening, and about 6% more during the whole fattening period. Nevertheless, they showed good health conditions contrary to the AL group. Feed intake in AL12 and AL14 groups did not follow the same evolution as in AL group since rabbits were in better health conditions. As rabbits on AL, AL12 and AL14 had similar intakes, even on the first week of the fattening period, the difference in mortality and morbidity could be due to the existence of a fasting period during the day.

Live weight and average daily gain

Feed restriction induced a little live weight decrease of 63g on average at the end of the fattening period (AL vs FR groups, P>0.05, table 3), and average daily gain (ADG) were not significantly affected in ERE conditions. AL12 rabbits had a similar live weight compared to AL one (2487g vs 2404g, P>0.05 resp.). Rabbits fed during 14 hours reached a higher live weight at 69 days (+131g, P<0.05) than AL group (2535g vs 2404g resp.). The lower live weight in AL group was mainly due to poorer health status and higher morbidity in the second week, as shown by the low ADG from 43 to 50 days (6.4 g/d) compared to higher ADG in AL12 and AL14 groups (40.7, 38.7 and 35.4g/d resp.). Whole ADG (34-69d) in AL12 and AL14 groups were higher than in AL group (+6.8% and +10.2% resp., P<0.001).

Table 2: Feed intake results (g/day/rabbit) according to feeding level and strategy

	AL	FR	AL12	AL14	*Prob.*
35-43 days	116 [a]	84 [b]	111 [a]	116 [a]	<0.001
43-50 days	73 [b]	103 [a]	107 [a]	107 [a]	<0.001
50-57 days	123	122	135	142	NS
57-69 days	196 [a]	149 [c]	176 [b]	183 [b]	<0.001
35-69 days	137 [b]	119 [c]	138 [ab]	145 [a]	<0.001

Means with different letters on the same row differ significantly (Fisher test). NS: Not significant (P>0.05)

Economic feed conversion ratio

An economic feed conversion ratio was calculated knowing the global feed quantity eaten per group (including the feed consumed by dead rabbits) and the total weight gain of each group (total slaughtered live weight – total weaned live weight). The economic feed conversion ratio was 4.69, 3.83, 4.05 and 3.95 for AL, FR, AL12, AL14 groups resp.. Total slaughtered live weight was increased by 5.1, 10.0 and 15.4 % with FR, AL12, AL14 groups respectively respect to the AL group.

Table 3: Live weight and average daily gain results.

	AL	FR	AL12	AL14	Prob.		AL	FR	AL12	AL14	*Prob.*
	Live Weight (g)						Average Daily Gain (g/d)				
At 34 d	1060	1060	1060	1060	NS	34-43 [d]	46.6 [a]	31.5 [b]	45.4 [a]	46.8 [a]	<0.001
At 43 d	1487 [a]	1342 [b]	1469 [a]	1491 [a]	<0.001	43-50 [d]	6.4 [b]	40.7 [a]	38.7 [a]	35.4 [a]	<0.001
At 50 d	1510 [c]	1630 [b]	1734 [a]	1723 [a]	<0.001	50-57 [d]	40.8 [a]	31.5 [b]	37.3 [ab]	43.0 [a]	<0.001
At 57 d	1789 [b]	1841 [b]	1974 [a]	2019 [a]	<0.001	57-69 [d]	50.2 [a]	41.5 [b]	44.1 [b]	43.7 [b]	<0.001
At 69 d	2404 [bc]	2341 [c]	2487 [ab]	2535 [a]	<0.001	34-69 [d]	38.2 [b]	36.3 [b]	40.8 [a]	42.1 [a]	<0.001

Means with different letters on the same row differ significantly (Fisher test). NS : Not significant (P>0.05)

DISCUSSION

We confirmed the beneficial effects of a quantitative feed restriction in ERE conditions to reduce digestive disorders as shown by many other authors. Gidenne *et al.* (2003) showed that a feed restriction at 60% and 80% of AL led to a lower mortality rate. In ERE conditions, Boisot *et al.* (2003) showed that mortality rate decreased from 28% in ad libitum conditions to 26% and 19% when rabbits were feed restricted at 80% and 60% of ad libitum level.

Our strategy with a restricted time access to feed improved the health status of rabbits in ERE conditions compared to ad libitum feeding, whereas it did not significantly reduced feed intake before mortality appeared. This suggested, that under ERE conditions, it is not the feed quantity itself that induced the improvement of health status but the restriction in time spent consuming, and above all the presence of a fasting period during the day. The day was then divided in two periods: a period for feeding and a period for fasting and eating soft faeces. Salaun *et al.* (2011) also showed that an access of 14 hours to the diet reduced mortality from 6.3% to 1.7% (P<0.05) whereas feed intake was reduced by only 5.2%. Gidenne *et al.* (2008) showed that in ad libitum conditions a forbidden access to the diet from 10:30am till 4:30pm did not influence mortality rate, since a 4 hour starving period seemed not enough to see a beneficial effect on health. As shown by Prud'hon *et al.* (1975), rabbits fed ad libitum consumed a little bit over the all day even if the main feed consumption appears during night. A restricted time access to the feed induces a modification in rabbits' intake behaviour. Rabbits are able to eat the same quantity in a shorter time and to take profit of the fasting period. Further investigations could demonstrate if a quantitative feed restriction could be beneficial because of the reduction in feed intake or the presence of a long fasting period. A restricted access of 12h or 14h to the diet not only reduces mortality and morbidity due to digestive troubles but also avoids the loss in slaughtering weight due to a quantitative feed restriction. Hence, in ERE conditions, it combines the benefit of feed restriction without its detrimental effects. The lower weight gain observed in groups with restricted

time access to the feed compared to AL group was probably due to the poor health conditions of AL rabbits. In ERE conditions, feed intake of ad libitum rabbits strongly decreased during mortality and morbidity peak (from 100 to 20g/d, Boisot *et al.*, 2003). In good health conditions, a longer fasting period, leads to a loss in live weight at slaughter as described by Foubert *et al.* (2007). The live weight reached here was 2526g in ad libitum conditions and 2341g, 2413g and 2435g for an access to the diet of 6h, 8h and 10h respectively. Mc Nitt *et al.* (1991) showed that when feed was available during 24 hours or 15 hours, ADG did not change (45.3g/d and 44.8g/d resp.) whereas it decreased when feed was available only 9 hours (39.3g/d, $P<0.05$). As a conclusion, it seems that ADG might not been reduced if time access to the diet was at least 12 hours.

CONCLUSIONS

Under ERE breeding conditions, a restricted time access to the diet of 12 hours or 14 hours leads to a similar improvement of health conditions compared to a quantitative intake restriction program (85% of ad-libitum), but does not negatively impact live weight gain and feed intake . These results showed that a long fasting period (>10h) had a favourable effects on rabbits' health in ERE conditions.

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