EFFECT OF A PROGRESSIVE HOURLY FEEDING AND NUTRITIONAL LEVEL OF FEED ON PERFORMANCE AND FEED COST OF FATTENING RABBITS

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ABSTRACT

The aim of this study was to evaluate the effect of a progressive hourly feeding according to two nutritional levels of feed on performance and sanitary status of fattening rabbits and feed cost, in comparison with a constant hourly feeding. 378 Hyplus rabbits were assigned to 3 groups: the first group had a standard feed during 10h per day (10h STD), the second group had the same standard feed with a progressive hourly feeding, with 6h per day at the beginning of fattening period with an increase of one hour per week (6h+1 STD), and the third group had the same feeding plan than the second group but with a concentrated feed (6h+1 C+). The three groups had different average daily weight gain (ADWG) ($p=0.02$), average daily feed intakes (AFDI), feed conversion ratio (FCR) ($p<0.001$) and carcass yield ($p=0.05$). The final live weight of the 6h+1 STD group was similar to the 10h STD group weight (-37g). This group had also a lower ADFI during the first period of fattening (-15.2g/d), which significantly decreased the global FCR (-0.26 point), thus leading to a lower feed cost (2.36€ versus 2.60€/rabbit). The 6h+1 C+ group had similar growth performances than the 6h+1 STD group, and during the second period its ADFI decreased (-5.8g/d), revealing a regulation of rabbits hourly restricted according to the nutritional level of the feed. The 3% concentrate feed allowed to reduce not significantly by 2.7% the global FCR compare to 6h+1 STD and significantly by -10.6% in comparison with 10h STD allowing to reduce the feed cost (2.30 €/rabbit in comparison with 2.36 € and 2.60 €/rabbit for respectively the 2 other groups).

Key words: rabbit, hourly feeding restriction, feed concentration, feed conversion ratio, feed cost

INTRODUCTION

In France, feed restriction is commonly used in rabbit farms during the fattening period, for sanitary reasons (decrease of digestive disorders, especially those caused by the Rabbit Epizootic Entheropathy) and technical reasons (reduction of the Feed Conversion Ratio) (Tudela and Lebas, 2006). Three feed restriction methods exist : water restriction, little used because of its negative impact on animal welfare ; quantitative feed restriction which consists to give to rabbits a precise quantity of feed per day and that is widely applied ; and hourly feeding by reducing the access duration to the feed (Gidenne *et al.*, 2015). The latter restriction method is easy to set-up, but is not as convenient as the quantitative feed restriction for precisely managing feed intake of rabbits. Foubert *et al.*, (2007) showed that between 32 and 53 days old a 6h or 8h per day constant access to the feeder allows limiting mortality and morbidity risks. Moreover, in a stable sanitary context, a 10h per day constant access to the feeder optimizes animal performances. However, to our knowledge, no scientific work studied the effect of a progressive hourly feeding. Furthermore, Gidenne *et al.*, (2009) highlighted that with a quantitative feed restriction the feed concentration reduces negative effect of restriction on growth. This study aimed to check both the interest of a progressive hourly feeding, and the effect of feed concentration on performances and feed cost.

MATERIALS AND METHODS

Animals and experimental design

The trial was conducted at the experimental research station of Saint Symphorien (France). 378 Hyplus rabbits of 32 days old were assigned to 3 groups : 10h STD group - non medicated standard feed during 10h per day (from 7:30 am to 5:30 pm) for the whole fattening period, 6h+1 STD group – non medicated standard feed with a progressive hourly feeding (6h per day at the beginning of fattening period with an increase of one hour per week, from 7:30 am to 1:30 pm-2:30 pm-3:30 pm-4:30 pm-5:30 pm), and 6h+1 C+ group - non medicated concentrated feed (in average +3% for energy and protein supply in comparison with STD feed) with the same progressive hourly feeding than 6h+1 STD group (Table 1). 18 cages of 7 rabbits were allocated to each group according to individual weight, litter and previous feed. Live weight, average daily weight gain, average daily feed intake, feed conversion ratio and sanitary status (mortality and morbidity) were followed for the first fattening period (32 to 52 days old) and the second fattening period (53 to 72 days old). At 73 days-old, 20 rabbits (10 males and 10 females) per group with a live weight similar to the average live weight of their group were slaughtered in order to measure the carcass yield.

Table 1: Chemical composition (%) and digestible energy (kcal) of the experimental diets

	Diets[1]	
	STD	C+
Digestible energy[2] (kcal)	2325	2400
Crude protein (%)	15.0	15.4
Crude fiber (%)	17.0	16.7
Crude fat (%)	3.4	3.5

[1]STD: non medicated standard diet; C+: non medicated concentrated feed.
[2]Value calculated by formulation

Statistical Analysis

Data were compared using a general linear model followed by Tuckey's post-hoc comparison ($p<0.05$). All statistical analysis were performed using R software v3.6.0.

RESULTS AND DISCUSSION

First fattening period

Constant and progressive hourly feedings with two feed nutritional levels significantly modified all performance traits ($p<0.001$). The 10h STD group had a higher growth with an average daily weight gain (ADWG) of 52.8g/d, versus 45.7g/d for the 6h+1 STD group and 46.2g/d for the 6h+1 C+ group (Table 2). This result can be explained by a longer access to the feed (10h per day for the 10h STD group versus 6.7h per day in average for other groups) which allowed rabbits to have a higher average daily feed intake (ADFI): 133g per day for the 10h STD group versus 101.7g per day (6h+1 STD group) and 97.3g per day (6h+1 C+ group). However, the FCR of the 10h STD group (2.52) was significantly higher than that of the 6h+1STD group (2.23) and that the 6h+1 C+ group (2.11), which reflected an effect of the restriction level. The supply of a concentrated feed did not significantly reduce the ADFI during the first fattening period. However, the difference of ADFI was 4.3% while the energy intake difference was only 1.2%, suggesting that rabbits with hourly feeding adapted their ADFI according to the nutritional level of the feed. These results agree with Gidenne *et al.*, (2009) observations, who showed that for 2 weeks after weaning the adaption of rabbit ADFI to the energy level exists, but is small. For this period, there was no sanitary digestive event for the 3 groups.

Second fattening period

Final live weight ($p=0.02$), growth ($p<0.001$), feed consumption ($p<0.001$), feed conversion ratio ($p<0.001$) and carcass yield ($p=0.05$) significantly differed according to the dietary treatments. The ADFI of the 10h STD group (178.9 g per day) was similar to that of the 6h+1 STD group (181.4g per

day), due to an almost similar duration access to the feed (respectively 10h and 9.3h per day in average). By contrast, ADFI of the 6h+1 C+ group was significantly lower (174.2g per day). For this period, the 3 groups had a similar energy intake, which highlights the self-regulating feed consumption of animals according to the energy level of feed, as described for rabbits fed ad libitum (Gidenne *et al.*, 2009 ; Montessuy *et al.*, 2009). Despite a similar energy intake, ADWG of 3 groups were significantly different, respectively 43.1g/d, 49.0g/d and 46.8g/d. The progressive increase of the duration access to the feed for 6h+1 STD and 6h+1 C+ groups allowed a better feed valorization, contrary to animals fed 10h per day since weaning which had poor performances. Thus FCR of 10h STD group was significantly increased (4.16) in comparison with 6h+1 STD (3.70) and 6h+1 C+ (3.73) groups. For this period, there was no sanitary digestive event for the 3 groups.

Table 2: Performance and sanitary risk of rabbits from 32 to 72 days old fed with two experimental diets and two hourly feeding programs

	10h STD	6h+1 STD	6h+1 C+	p-value		RSD
				Group effect	Covariance effect	
Live weight (g)						
32 d (g)	1057	1059	1057			
53 d (g)	2166^{a}	2016^{b}	2028^{b}	<0.001	<0.001	40.0
72 d (g)	2985^{a}	2948^{ab}	2918^{b}	0.02	<0.001	69.1
Weight gain (g/d)						
32-53 d	52.8^{a}	45.7^{b}	46.2^{b}	<0.001	<0.01	1.9
53-72 d	43.1^{c}	49.0^{a}	46.8^{b}	<0.001	NS	2.3
32-72 d	48.2^{a}	47.2^{ab}	46.5^{b}	0.02	NS	1.8
Feed intake (g/d)						
32-53 d	133^{a}	101.7^{b}	97.3^{b}	<0.001	NS	10.0
53-72 d	178.9^{a}	181.4^{a}	174.2^{b}	<0.001	<0.01	5.3
32-72 d	154.8^{a}	139.6^{b}	133.8^{c}	<0.001	NS	5.6
Energy intake (kcal/d)						
32-53 d	6496^{a}	4969^{b}	4902^{b}	<0.001	NS	494
53-72 d	7906	8020	7941	NS	<0.01	240
32-72 d	14402^{a}	12989^{b}	12843^{b}	<0.001	NS	525
Feed conversion ratio						
32-53 d	2.52^{a}	2.23^{b}	2.11^{b}	<0.001	<0.05	0.22
53-72 d	4.16^{a}	3.70^{b}	3.73^{b}	<0.001	<0.01	0.14
32-72 d	3.22^{a}	2.96^{b}	2.88^{b}	<0.001	NS	0.14
Digestive sanitary risk	0	0	0	-	-	-
Carcass yield (%)	59.8^{a}	58.6^{b}	59.1^{ab}	0.05	-	1.5

Means with different letters on the same row differ significantly (p<0.05). NS: non-significant. RSD: residual standard deviation

Whole fattening period

We cannot conclude about the effect of a more intense feed restriction on rabbit health with hourly feeding as Boisot *et al.* (2003) did for quantitative feed restriction. We can however notice that using the most concentrated feed (C+ feed) did not deteriorate sanitary conditions.

The three groups had different ADWG (p=0.02), ADFI (p<0.001), FCR (p<0.001) and carcass yield (p=0.05). The progressive hourly feeding compared to a constant feeding duration did not significantly decrease the animal growth with only 37g of difference in the final live weight between 6h+1 STD group and 10h STD group. In accordance with literature on quantitative restriction (Bergaoui *et al.*, 2008), the degree of hourly restriction reduced the ADFI (respectively 139.6g/d and 154.8g/d between 6h+1 STD and 10h+1 STD), which led to significantly improved FCR (respectively 2.96 and 3.22), but decreased the carcass yield (respectively 58.6 and 59.8). Thus, the feed cost per rabbit was lower of -9% (Table 3).

With a progressive hourly feeding, the use of a concentrated feed reduced significantly the ADFI (respectively 139.6g/d and 133.8g/d for 6h+1 STD and 6h+1 C+ groups), which showed a self-regulating feed consumption of animals according to the nutritional level of feed. The same nutrient intake gave similar growth (respectively 47.2g/d and 46.5g/d), without significantly reducing the FCR (2.96 and 2.88 respectively). These results are different from Montessuy *et al.* (2009) which showed that, even though rabbits adapted their feed intake to the nutritional level of the feed, the feed

concentration allowed lowering FCR with similar growth. The reason can be that in this study, there was a difference of 140 kcal between diets whereas 75 kcal in our study. Despite non-significant differences, the lower FCR for the 6h+1 C+ group allows a lower feed cost compared to 6h+1 STD group (-3%).
When we compare to the 10h STD group, the 6h+1 C+ strategy reduced the feed cost of 12% due to a significantly improved FCR (2.88 versus 3.22), even if the final weight is lower (2918g versus 2985g). However, the use of a concentrated feed in this progressive hourly feeding allowed obtaining a similar carcass yield than the 10h STD group.

Table 3: Feed cost of rabbits from 32 to 72 days old fed with two experimental diets and two hourly feeding programs

	10h STD	6h+1 STD	6h+1 C+
Feed price (€/t)	270.40	270.40	273.34
Feed cost (€/rabbit)	2.60	2.36	2.30

CONCLUSIONS

This study shows that among hourly feeding strategies, there are new ways to manage feeding plans in order to optimize technico-economical performances of rabbit farms. In comparison with a constant 10h per day hourly feeding, applying a progressive hourly feeding from 6h to 10h per day gives similar growth performances, with a significantly improved feed conversion ratio. Moreover, the supply of a 3% concentrated feed in a progressive hourly restriction, allows a much more significant drop of the feed conversion ratio. For both progressive feeding strategies studied, the feed cost of rabbit was reduced and the health of the rabbits has been preserved.
It would be interesting to set-up a new trial with a more concentrate feed and with more challenging breeding conditions.

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