PROCEEDINGS OF THE 12th WORLD RABBIT CONGRESS
Nantes (France) - November 3-5, 2021
ISSN 2308-1910

Session
FARMING & ECONOMY

Rebours G., Raffin J., Vastel P., Reys S.
EFFECT OF A PROGRESSIVE HOURLY FEEDING AND NUTRITIONAL LEVEL OF FEED ON PERFORMANCE AND FEED COST OF FATTENING RABBITS

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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 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

<table>
<thead>
<tr>
<th>Diets¹</th>
<th>STD</th>
<th>C+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digestible energy² (kcal)</td>
<td>2325</td>
<td>2400</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>15.0</td>
<td>15.4</td>
</tr>
<tr>
<td>Crude fiber (%)</td>
<td>17.0</td>
<td>16.7</td>
</tr>
<tr>
<td>Crude fat (%)</td>
<td>3.4</td>
<td>3.5</td>
</tr>
</tbody>
</table>

¹STD: non medicated standard diet; C+: non medicated concentrated feed.
²Value 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

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

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

<table>
<thead>
<tr>
<th></th>
<th>10h STD</th>
<th>6h+1 STD</th>
<th>6h+1 C+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed price (€/t)</td>
<td>270.40</td>
<td>270.40</td>
<td>273.34</td>
</tr>
<tr>
<td>Feed cost (€/rabbit)</td>
<td>2.60</td>
<td>2.36</td>
<td>2.30</td>
</tr>
</tbody>
</table>

**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.

**REFERENCES**


Effect of a progressive hourly feeding and nutritional level of feed on performance and feed cost of fattening rabbits

World Rabbit Congress
Nantes, November 2021
Introduction

- Feed restriction is commonly used in rabbit fattening period, for sanitary and technical reasons,
- Three main feed restriction methods exist:
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**Water restriction**

Limiting water access

- Significant water restriction necessary
- Negative impact on animal welfare.
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- Precise quantity of feed per day
- Progressive feeding programs
- Positive impact on health and FCR
- Negative effects on growth and yield minimized by feed
Feed restriction is commonly used in rabbit fattening period, for sanitary and technical reasons.

Three main feed restriction methods exist:

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- **Quantitative feed restriction**
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- **Hourly restriction**
  - Specific feed access time per day
  - Easy to set-up but difficulties to manage feed intake
  - Constant duration access programs that reduce mortality
Introduction

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- Until this trial, no scientific work studied the effect of a **progressive hourly feeding**,
- This study aimed to check both the **interest of a progressive hourly feeding**, and the **effect of feed concentration** on performances and feed cost.
Material and Methods

- **Place**: French experimental station
- **Groups**: 378 rabbits, 32 to 72 days old, assigned to 3 groups:
Material and Methods

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<table>
<thead>
<tr>
<th>Hourly feeding plan (h/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10h STD</td>
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**Diets**

<table>
<thead>
<tr>
<th></th>
<th>STD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated DE (kcal)</td>
<td>2325</td>
</tr>
<tr>
<td>Crude Protein (%)</td>
<td>15.0</td>
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  ![Hourly feeding plan](image)

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<th>10h STD</th>
<th>6h+1 STD</th>
<th>6h+1 C+</th>
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<tbody>
<tr>
<td>0</td>
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<td>4</td>
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### Diets

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Material and Methods

- **Place**: French experimental station
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![Hourly feeding plan](image)

- **Measures**:
  - Average Daily Feed Intakes (ADFI) of P1, P2 and P total
  - Body weight (32, 53, 72 days) and carcass yield,
  - Average Daily Gain (ADG) and Feed Conversion Ratio (FCR) calculated,

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  - Average Daily Gain (ADG) and Feed Conversion Ratio (FCR) calculated,

- **Remarks**:
  - No medication in feed or drinking water,
  - The good sanitary conditions of breeding didn’t entail mortality and morbidity between groups.
Results and Discussion

**Period 1** (32 - 52 days):

- **ADFI (g/d)** - $p<0.001$
  - 10h STD
  - 6h+1 STD
  - 6h+1 C+
  - Lower ADFI (less duration access) and ADG

- **ADG (g/d)** - $p<0.001$
  - 10h STD
  - 6h+1 STD
  - 6h+1 C+
  - But better FCR

- **FCR** - $p<0.001$
  - 10h STD
  - 6h+1 STD
  - 6h+1 C+
  - Lower FCR

**Effect of restriction level**: 10h STD vs 6h+1 STD

- Lower ADFI (less duration access) and ADG
- But better FCR
Results and Discussion

**Period 1** (32 - 52 days):

- **Effect of restriction level**: 10h STD vs 6h+1 STD
  - Lower ADFI (less duration access) and ADG
  - But better FCR

- **Effect of feed concentration**: 6h+1 STD vs 6h+1 C+
  - Non significant difference of ADFI
  - Tendency to a better ADG and FCR (-0.12)
Results and Discussion

**Period 2** (52 - 72 days):

- **Effect of restriction level**: 10h STD vs 6h+1 STD
  - Similar ADFI (≈ duration access to feed: 10h vs 9.3h/d).
  - But higher ADG and lower FCR (compensatory growth).
Results and Discussion

**Period 2** (52 - 72 days):

- **Effect of restriction level** : 10h STD vs 6h+1 STD
  - Similar ADFI (≈ duration access to feed: 10h vs 9.3h/d).
  - But higher ADG and lower FCR (compensatory growth).

- **Effect of feed concentration** : 6h+1 STD vs 6h+1 C+
  - Lower ADFI and ADG
  - Similar FCR due to similar energy intake → self-regulating, as with rabbit ad libitum
Results and Discussion

**Total period** (32 - 72 days):

- **ADF\(\text{I (g/d)}\) - p<0.001**
  - 15.2 g/d

- **ADG (g/d) - p<0.001**
  - 1 g/d

- **FCR - p<0.001**
  - 0.26

**Effect of restriction level**: 10h STD vs 6h+1 STD

- Lower ADF\(\text{I (≈ lower duration access)},\)
- Tendancy to lower ADG, but significant lower FCR
Results and Discussion

- **Total period** (32 - 72 days):
  - **Effect of restriction level**: 10h STD vs 6h+1 STD
    - Lower ADFI (≈ lower duration access),
    - Tendency to lower ADG, but significant lower FCR
  - **Effect of feed concentration**: 6h+1 STD vs 6h+1 C+
    - Lower ADFI (regulation with concentration level)
    - Tendency to lower ADG, with non significant improvement of FCR
Results and Discussion

- **Total period** (32 - 72 days):

  - Carcass yield (%): 10h STD vs 6h+1 STD
    - Lower carcass yield
    - But better feed cost margin per rabbit thanks to FCR

  - Feed price (€/t):
    - 10h STD: 270.4
    - 6h+1 STD: 270.4

  - Feed cost (€/rabbit):
    - 10h STD: 2.60
    - 6h+1 STD: 2.36
    - Feed cost margin (€/rabbit):
      - 10h STD: 1.84
      - 6h+1 STD: 1.90
      - +0.06
Results and Discussion

**Total period** (32 - 72 days):

<table>
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<tr>
<th>Carcass yield (%)</th>
<th>p=0.05</th>
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<tr>
<td>10h STD</td>
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<td>6h+1 STD</td>
<td>59.3</td>
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<tr>
<td>6h+1 C+</td>
<td>60.0</td>
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</tbody>
</table>

- **Effect of feed concentration**: 6h+1 STD vs 6h+1 C+
  - Tendancy to better carcass yield
  - Better feed cost margin per rabbit thanks to FCR

<table>
<thead>
<tr>
<th>Feed price (€/t)</th>
<th>10h STD</th>
<th>6h+1 STD</th>
<th>6h+1 C+</th>
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<tr>
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<tr>
<th>Feed cost margin (€/rabbit)</th>
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<th>6h+1 STD</th>
<th>6h+1 C+</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>+0.06</td>
<td>+0.04</td>
<td>+0.10</td>
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</tbody>
</table>

**Effect of restriction level**: 10h STD vs 6h+1 STD
- Lower carcass yield
- But better feed cost margin per rabbit thanks to FCR
Conclusions

Compared to constant hourly feeding of 10h/day, **progressive hourly feeding** from 6h to 10h/day gives:

- **Similar growth performances**
- With significant **improvement of feed conversion ratio**.
- Which leads to an **improvement in feed cost margin**

In progressive hourly feeding, the supply of a **concentrated feed**:

- Reduces the average daily feed intake, showing a **feed consumption regulation** of rabbits
- Without significantly impacting growth and carcass yield
Conclusions

- Compared to constant hourly feeding of 10h/day, **progressive hourly feeding** from 6h to 10h/day gives:
  - Similar growth performances
  - With significant improvement of feed conversion ratio.
  - Which leads to an improvement in feed cost margin

- In progressive hourly feeding, the supply of a **concentrated feed**:
  - Reduces the average daily feed intake, showing a feed consumption regulation of rabbits
  - Without significantly impacting growth and carcass yield

- The use of both **progressive hourly feeding and concentrated feed** is economically interesting.

- The good sanitary conditions didn’t allow to observe a beneficial effect of a progressive hourly restriction on animals’ health. We can however note that using most concentrated feed didn’t entail sanitary problem with this strategy of restriction.

- This study shows that among hourly feeding strategies, there are different ways to manage feeding plans in order to optimize technico-economical performances of rabbit farms.
Effect of a progressive hourly feeding and nutritional level of feed on performance and feed cost of fattening rabbits