ELECTRONIC FEEDER TO RECORD INDIVIDUAL FEED INTAKE ON RABBITS RAISED IN COLLECTIVE CAGES

Sánchez J.P., Perucho O., Pascual M., Rafel O., Piles M.

Institute for Food and Agriculture Research and Technology, Torre Marimon s/n, 08140 Caldes de Montbui, Spain
*Corresponding author: juanpablo.sanchez@irta.es

ABSTRACT

Individual recording of feed intake of animals raised in groups is essential to improve feed efficiency in breeding programs and also for research on nutrition, feeding behaviour, health and animal welfare. We have designed and manufactured 30 pieces of devices allowing such recording. In this work, we present the device, showing the type of raw data it produces as well as how this information is edited. Raw visits recorded are merged to meals at a rate of approximately 0.6-0.65 (meals/visits), and approximately 40-45% of the declared meals have associated null feed intake records. Thus, the relatively high proportion of visits with misidentification (25%) actually do not have serious consequences since they involve short meals with actually no intake. In spite of the fact that we are already working with the described device, the software for editing information provided by the feeder is still under development and improvement to increase the quality of the feed intake recorded information.

Key words: feed efficiency, electronic feeder, feed intake recording, rabbits.

INTRODUCTION

Up to date, there is no device for individual recording of feed intake in rabbits housed in groups as it exists for other species such as pigs (Eissen *et al.*, 1998). Nonetheless, having such device would be highly relevant both to implement selection programs based on direct measurements of feed efficiency of animals in groups, and to conduct research activities regarding feeding behavior, nutrition or welfare. Drouilhet *et al*. (2016) have conducted two successful selection experiments to improve feed efficiency on animals on restricted or *ad libitum* feeding regimes housed in individual cages. However, Piles *et al.* (2017) have shown that social interaction effects between cage mates contribute largely to the total heritable variance of average daily gain when growing rabbits are raised under restricted feeding in groups, as it is the case of many production farms (Gidenne *et al*., 2012). Ignoring those effects in a breeding program for increasing rabbit growth or other traits is likely to have negative consequences on the productive performance of growing rabbits and eventually on animal well-being, especially when the amount of food is limited. Therefore, it is important to select animals under the same conditions of feeding and housing as those applied on production farms for rabbit meat production. With this aim, we have designed and developed an electronic feeder that allows individual recording of feed intake of group raised animals. In this communication, we show this device to the rabbit research and breeding communities, describing how it works and the information it provides.

MATERIALS AND METHODS

Electronic feeder design description

Figure 1 presents a picture of the electronic feeder installed in polyvalent cages. The device is placed in the nest area, and it provides food to animals from two connected cages. The feeder has two components, an external part formed by a hopper with an electronic screw in its base to direct the food to the trough that is fixed to a cell load. The access to the trough is through a polycarbonate tunnel. In

Figure 1. Placement of the electronic feeder in a polyvalent cage

the tunnel there are two sensors: i) a movement cell to detect the animals entering or leaving the trough and ii) a radio frequency antenna used to read the RFID (Radio Frequency Identification) tag that each animal wears in the ear.

Animals and experimental design

At IRTA's rabbit farm we have 30 electronic feeders, and they have been in use since early 2017. In this period we have controlled feed intake of around 4,500 kits and conducted different modifications both in hardware and structure of the device, as well as on the different software programs involved in device management, data collection and data edition. For the present study we analyze and present results from records obtained in the last two controlled batches, October - November 2019 using animals from three different populations. In the first batch, half of the cages included 6 kits per cage and the other half of the cages had 7 mates, and all the animals were fed *ad libitum.* In the second batch, all the cages included 6 kits, but half of them were fed *ad libitum*, while the other half were fed under restriction. The feed restriction can be applied by setting the electronic feeder to not provide food during certain period of the day, in this case from 6 am to 6 pm. In both batches commercial pelleted feed was used and the control period elapsed 18 d, from 42 to 60 d of age, at these two ages individual body weight was manually recorded to assess body weight gain. In addition, we have also manually recorded group feed intake during the control period.

Feed intake recording and data processing

Every second, each electronic feeder sends the status of the different sensors to a dedicated MySQL data base. i) The cell load sends the feed weight at the trough, ii) the RF reader send information on the last identified RFID tag as well as the value of a counter with the number of cumulated tag reads, iii) The movement sensor send a binary signal indicating whether the trough is occupied or not. This raw information is automatically processed every 24 hours in order to define the different individual visits to the trough during the last 24 hours and also to cumulate visit feed intake information to generate individual daily feed intake records. Due to the physical interaction between the rabbit and the feeder trough, the weight signal is not stable. Thus, for defining feed weight at the entrance and at the exit of one particular rabbit it is needed to identify the periods in which the trough is not occupied and weight signal is stable (with a measurement accuracy of 1 g). The definition of the individual visits to the trough is done in two steps. In one initial step, visits are defined just by the changes of the binary variable that generates the movement sensor, from "free" to "occupied" (start of a visit) and from "occupied" to "free" (the end of a visit). In a second step, those properly identified raw visits are aggregated when they consecutively belong to the same animal and between them the time interval is lower than 30 seconds, we name this aggregated visits as meals. Note that in this definition the intake level is not consider; thus, meals with null intake a likely to occur. The identifications of meals in which the read of RFID tag failed are predicted based on the probabilities associated to the different animals entering the trough, given that in the previous meal the feeder is occupied by one known animal. These probabilities are computed from information on consecutive meals having a proper RFID tag identification. In the final edition step, at the end of the control period, average individual feed intake over the control period is computed after removing outliers which are mainly the result from an incorrect use of the feeder (e.g. when kits put one leg into the trough). This is done by fitting a third-degree polynomial model of the date, nested within the population to which the animals belong, to the individual daily feed intake records, and then declaring outliers those records with an associated Cook's distance (Cook, 1977) greater than 4 times the average. This outlier detection procedure resulted in the declaration of 4-6% daily FI records as outliers in each batch (aprox. 100 out of 2,200). In a last step, before daily feed intake averaging, the value of daily records declared as outliers are predicted using a random regression model, with the same fixed structure as that used for outlier declaration, but also fitting an animal-specific third degree polynomial regression on the day of control.

RESULTS AND DISCUSSION

The mean number of total daily raw visits to each feeder trough when the animals are fed *ad libitum* ranged from 1,200-1,270 when 6 animals are reared in each cage to 1,500 when 7 kits are placed in each cage (Table 1). These figures were reduced to nearly 60% when they were edited, merging consecutive visits of the same animal to the trough into meals (Table 1). When the animals are fed under restriction the average number of daily raw visits is lower, about 1,100. Under this feeding regimen the number of edited meals is 65% of the total number of raw visits, a percentage larger than when the animal were fed *ad libitum* (57%). This difference reflects the fact that under restricted feeding a more dynamic use of the feeder is done, i.e. consecutive visits trend to belong to different animals more frequently when feed is provided under restriction that when feed is provided *ad libitum*.

Table 1. Count of raw visits and meals to the feeder trough, percentages of meals with different feed intake values and with valid identification

	Batch 1		Batch 2	
N of rabbits / cage - Feeding Regimen	**6-V**	**7-V**	**6-R**	**6-V**
N of raw visits per day	1271	1515	1091	1201
N of meals per day	722	889	717	683
Proportion meals to raw visits	0.58	0.59	0.65	0.57
Percentage of meals with FI (-1, 0]	42.2	41.5	45.8	40.0
Percentage of meals with FI (0,1]	27.7	29.5	30.8	30.5
Percentage of meals with FI (1,4]	17.3	16.9	13.7	17.7
Percentage of meals with FI (4,10]	6.6	6.1	4.5	6.4
Percentage of meals without identification	25.1	24.6	27.4	24.4

It is remarkable that 40-46% meals are recorded to have non-positive feed intake values. The maximum value for this percentage was observed when the animals are fed under restriction. About 30% of the meals have associated feed intake records between 0 and 1 g. The percentage of meals with feed intake between 1 and 4 g ranged from 13.7% to 17.7%. Only in 5-6% of the meals intake was greater than 4 g but smaller than 10 g. The relative high percentage of meals with unknown individual identification (between 24 and 27%) could be explained in association with the fact that 18% misidentified meals last less than 2 seconds, this percentage in visits with a proper identification is only 1.6%; thus, in these short visits the animal identification cannot be properly done. As the actual intake in these short-misidentified visits is expected to be low, their impact on the total daily intake computation would be just a slight downward bias. Nonetheless, as it has been stated in material and methods, we implement a procedure to predict the individual identification in these sort-time visits to the feeder when computing individual daily intakes.

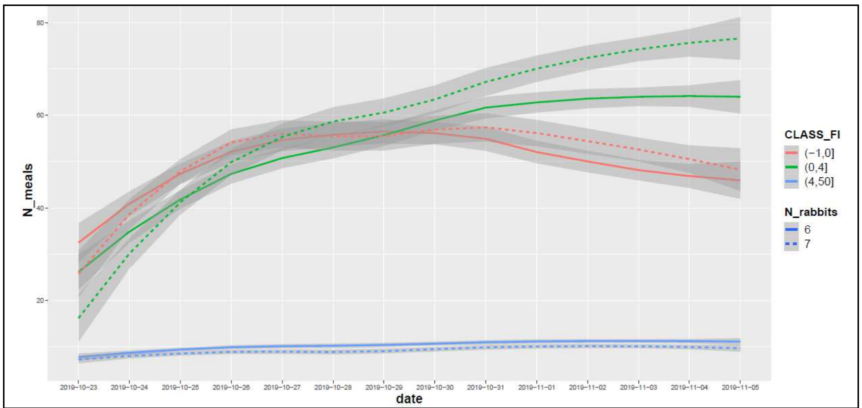

Figure 2.- Number of meals per animal along the control period for three different levels of meal intake (red = (-1,0] g/meal, green =(0,4] g/meal, blue=(4,50] g/meal) and number of cage mates (solid=6, dotted=7).

Non-linear trends were observed along the control period for the number of meals per animal without intake (FI=(-1,0]); and also with regard to those with a feed intake lower than 4 g ((FI=(0,4])) . (Figure 2). In the first four days of the control period, an increasing

pattern is observed in the number of meals with either non positive or lower than 4 grams feed intake, reaching both 50-60 meals per day. For the rest of the control period the number of meals with non-positive feed intake, i.e. zero FI, showed a slight reduction for both density levels. On the contrary, for meals having between 0 and 4 grams of intake a positive trend was observed, and this trend is stronger for animals in groups of 7 than for groups of 6 kits. In the former case, at the end of the fattening period, between 70-75 visits per day are recorded, while in the second this figure is only about 65.
Overall, the observed correlation coeffiients between manually recorded cage daily feed intake, and the cage average, defined from the individual daily feed intake recorded with the electronic feeder was 0.71, in the first case the average was 172.7 g/d and in the second 171.9 g/d. Given the limited number of cages by treatment (aprox. 15), it is not possible to get accurate enough correlation estimates for each treatment. Nonetheless, we can affirm that daily growth when 7 animals are raised per cage got penalized by 3.3 g/d with respect to the growth of animals in cages having 6 cage-mates (41.1 vs 44.4 g/d), daily feed intake was accordingly reduced, from 189 g/d in cages with 6 kits, to 183 g/d in cages with 7 kits. Daily growth under restricted feeding in the second batch was 32.2 g/d while the growth of animals raised under full feeding in the same batch was 41.5 g/d. This difference is consequence of a feed restriction of approximately 15% (1-(143/166))*100) obtained by only allowing feed provision during only 12 hours per day.

CONCLUSIONS

An electronic feeding device has been designed, manufactured, and it is currently in use in our selection farm to obtain individual records of feed intake in rabbits raised in groups. The software to edit the information recorded by the device is still under improvement and development, but until now a large amount of information has been obtained. The number of raw visits to the feeder is importantly reduced when they are merged to meals, *i.e*. consecutive visits of the same animal to the trough. Even after this merging, the majority of meals declared are not relevant since they comprise null FI values. The consequences of a relative large proportion of misidentified visits are not important since they are majorly associated to short meals with null feed intake. Both cage density and feeding regimen have important consequences for meal distribution patterns and final animal performances.

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