

Differences between the part-time system and individual cages for housing of breeding rabbit does in health, behaviour and management aspects

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ABSTRACT

The group housing system for rabbit does is a new trend that considers aspects of welfare, a subject highly searched in current days. However, there is a lack of scientific knowledge that supports the production efficiency of these animals in more social systems. In order to evaluate the influence of the semi-group housing system on aspects of health, behaviour and management, 48 rabbit does were distributed in collective cages (six does per cage) or in individual cages. The aspects related to elimination rate, death, occurrence of skin injuries, pododermatitis, dirtiness, behaviour after regrouping, location place of kits, corticosterone levels and management were evaluated. The elimination of does was mainly associated with their behaviour ($P = 0.0292$). It was observed high frequency of skin injuries from agonistic behaviour, mainly in first cycle. A higher frequency of pododermatitis was observed in does from individual cages in 4th cycle. The first 30 minutes after regrouping was a critical time and the agonistic behaviour was performed mainly by dominant does. After 24 hours of regrouping, all kits were already mixed, and the does did not distinguish their own offspring for suckling. The corticosterone level

was higher in the first cycle than in the fourth cycle (71,2 vs 39,8 ng/g, $P=0.0001$) and in general higher values were measured in the part-time system, mainly in the period before kindling. The handling time for palpation was greater in part-time systems and can contribute to the increased costs of production. In general terms, the semi-group housing system negatively affected aspects of health, behavior and management, requiring further research that seeks to minimize the effects related to agonistic interactions between rabbit does.

Keywords: animal welfare, cuniculture, rabbit science

RESUMO

O sistema de alojamento coletivo para coelhas é uma nova tendência que considera aspectos de bem-estar, assunto muito pesquisado na atualidade. No entanto, existe uma carência de conhecimento científico que sustente a eficiência da produção desses animais em sistemas mais amigáveis. A fim de avaliar a influência do sistema de alojamento em semi-grupo sobre aspectos de saúde, comportamento e manejo, 48 coelhas foram distribuídas em gaiolas coletivas (seis coelhas por gaiola) ou em gaiolas individuais. Foram avaliados os aspectos relacionados à taxa de eliminação, óbito, ocorrência de lesões de pele, pododermatite, sujidade, comportamento após reagrupamento, localização dos láparos, níveis de corticosterona e manejo. A eliminação de coelhas foi associada principalmente ao seu comportamento ($P=0,0292$). Observou-se alta frequência de lesões de pele decorrentes de comportamento agonístico, principalmente no primeiro ciclo. Uma maior frequência de pododermatite foi observada em coelhas alojadas em gaiolas individuais no 4º ciclo. Os primeiros 30 minutos após o reagrupamento foram um período crítico e o comportamento agonístico foi realizado principalmente por fêmeas dominantes. Após 24 horas de reagrupamento, todos os filhotes já estavam misturados, e

as coelhas não distinguem sua prole para lactação. O nível de corticosterona foi maior no primeiro ciclo do que no quarto ciclo (71,2 vs 39,8 ng/g, $P=0,0001$) e em geral valores mais altos foram medidos no sistema de semi-grupo, principalmente no período anterior ao parto. O tempo de manejo para palpação foi maior nos sistemas de semi-grupo e pode contribuir para o aumento dos custos de produção. Em linhas gerais, o sistema de alojamento em semi-grupo impactou negativamente aspectos de saúde, comportamento e manejo, sendo necessárias novas pesquisas que busquem minimizar os efeitos relacionados às interações agonísticas entre as coelhas.

Palavras-chave: coelhas, sistema de semi-grupo, comportamento, saúde, manejo, bem-estar animal

RESUMEN

El sistema de alojamiento colectivo para conejas es una nueva tendencia que considera aspectos de bienestar, un tema muy investigado en la actualidad. Sin embargo, falta conocimiento científico para sustentar la producción eficiente de estos animales en sistemas más amigables. Para evaluar la influencia del sistema de alojamiento en semi grupo sobre aspectos de salud, comportamiento y manejo, se distribuyeron 48 conejas en jaulas colectivas (seis hembras por jaula) o en jaulas individuales. Se evaluaron aspectos relacionados con la tasa de eliminación, lesiones cutáneas, pododermatitis, suciedad, comportamiento después de la reagrupación, ubicación de los gazapos, niveles de corticosterona y manejo. La eliminación de las conejas se asoció principalmente con su comportamiento ($P=0,0292$). Hubo una alta frecuencia de lesiones cutáneas debido al comportamiento agonístico, especialmente en el primer ciclo. Se observó una mayor frecuencia de pododermatitis en hembras alojadas en jaulas individuales en el 4º ciclo.

Los primeros 30 minutos tras el reagrupamiento fueron un período crítico y el comportamiento agonístico fue realizado principalmente por hembras dominantes. Después de 24 horas de reagrupamiento, los gazapos ya estaban mezclados y las hembras no distinguían a sus crías para la lactancia. El nivel de corticosterona fue mayor en el primer ciclo que en el cuarto ciclo (71,2 vs 39,8 ng/g, $p=0,0001$) y en general se midieron valores más altos en el sistema semi-grupo, principalmente en el período previo al parto. El tiempo de manejo para la palpación fue mayor en el sistema de semi-grupo y puede contribuir a aumentar los costos de producción. En términos generales, el sistema de alojamiento semigrupal impactó negativamente los aspectos de salud, comportamiento y manejo, lo que apunta la necesidad de más investigaciones que busquen minimizar los efectos relacionados con las interacciones agonísticas entre las conejas.

Palabras clave: conejos hembras, sistema semigrupal, comportamiento, salud, manejo, bienestar animal

Introduction

Rabbit breeding is an important source of high-quality meat besides taking agricultural by-products and using small areas. However, the pressure from society for animal-friendly systems is strong and nowadays new kinds of collective housing systems are being tested. Recently, the use of cages in Europe was prohibited and new housing

technologies are urgently needed (European Commission, 2021). Despite the intense artificial genetic selection, the domestic rabbit conserve most of its behavioural and physiological traits from natural selection. In their natural habitat, rabbits are social animals, living together to have cooperation and mutual protection with the formation of small groups. Here, the establishment of a

hierarchy between rabbit does is key for a harmonious cohabitation and utilization of space and resources (EFSA, 2005; Szendro and McNitt, 2012; Machado *et al.*, 2019). This social rank also influences the productive success and lifespan of does (Holst *et al.* 1999, Holst *et al.* 2002).

The collective pen system promotes a bigger area for animals and allows social contact which can improve animal welfare. Nevertheless, for the establishment of a hierarchy rank, some persecutions, fights, injuries and even deaths between does may occur (Trocino and Xiccato, 2006; Szendro and Dalle Zotte, 2011; Gerencsér *et al.* 2019). This agonistic behaviour was previously reported by various authors (Mugnai *et al.*, 2009; Rommers *et al.*, 2018, Braconnier *et al.*, 2020). Furthermore, when inside the cages, animals do not have many possibilities to escape. This situation increases the likelihood that severe bites, threats and attacks will

occur (Zomeño *et al.*, 2018; Braconnier *et al.*, 2020); and making the system to a difficult topic in animal welfare and ethics. In this sense, it is necessary to highlight that the behaviour of does may be closely related to the level of welfare, although this last one is influenced by several other factors (Broom, 2022).

Inside the development of collective pens, the semi-group system (or part-time system), where the does spend half of their time in individualized cages and another half collectively housed, can be highlighted. This procedure is necessary due to the high aggressiveness between the does in the days before and after parturition, although every time the does are placed in collective housing again, agonistic behaviour between them will occur (Graf *et al.*, 2011; Maertens and Buijs, 2013; Olivas *et al.*, 2016). Another worrying factor when does are kept collectively during parturition and lactation periods is related to the infanticide rate of kits,

which is also observed in free living rabbits, especially when considered same-age does (Rödel *et al.*, 2008). All these facts act negatively in the welfare promotion in farms.

Many researchers evaluated the productive aspects and behaviour of does, however only a small number evaluated their health status, level of corticosterone and management. The health status is crucial for animal welfare promotion and its optimization will be very important to reduce the does replacement rate, contributing to increase profits in a rabbit farm. On the other hand, animal management is a set of rational procedures that are very important for the success of a farm, and new systems need to be easy to conduct and present rationality (Cervera *et al.*, 2018a).

Stress response, associated with low social ranks can accelerate ageing and be the cause of earlier death in rabbit does (Holst *et al.* 1999, Holst *et al.*,

2002). The corticosterone level is related to stress and welfare and it can be measured in hair, blood or faeces (Buijs *et al.*, 2011; Prola *et al.* 2013; Trocino *et al.*, 2018). Hair and faeces are the most preferred as non-invasive methods which favor animal welfare (Buijs *et al.*, 2011; Prola *et al.*, 2013). A higher level of corticosterone is expected in young does that are housed collectively, mainly due to a greater stress response in lower-ranking animals (Holst *et al.* 1999, Holst *et al.*, 2002).

Therefore, the aim of this work was to evaluate the health status, the behaviour after regrouping and management in a part-time system versus individual cages, as well as the levels of corticosterone in faeces for a better understanding of the conditions of does housed in both systems.

Material and methods

Animals and housing

This research was carried out in the Universitat Politècnica de València (Spain), between September 2015 and May 2016 and in the experimental rabbitry the average temperatures were of 16,1 and 21,4°C (minimum and maximum, respectively). The light program was 16L/8D and the building was artificially ventilated. The experimental proceedings were approved by the Ethics Committee of the Universitat Politècnica de València (UPV), and all animals were handled according to the principles of animal care published by the Spanish Royal Decree 53/2013 (BOE, 2013).

A total of 48 rabbit does (16 weeks of age, crossbred of maternal lines H and LP, UPV), one month before their first artificial insemination, were allocated randomly into two different housing systems: part-time system (collective pens, 24 does, four pens, six does/pen) and individual cages (n=24 does, one doe per cage). The does were

evaluated during the first four reproductive cycles. Collective cages were 240 x 100 x 80cm (width, length and height) and individual cages were 38 x 71 x 57cm with a wire mesh platform (26 x 38cm) installed at 24 cm height. All cages had a plastic footrest to prevent the occurrence of footpad injuries.

In part-time system the individualization of the does was done three days before kindling, adding wire walls to divide the collective pen in individual spaces. At this moment, the nests were placed to all pregnant does in both housing systems. After 18 lactation days, wire walls were removed in the part-time system, transforming the place into a collective pen again. At this age, kits are more independent and there is less probability to be affected by agonistic behaviour between does. Inside this collective pen, a number of four to six does were housed with their kits until 28 lactation days were completed (this variation in group size

was due to the fact that not all does became pregnant simultaneously).

The does cycle was divided into four periods, being from 27th day of pregnancy to kindling (27P-K), from kindling to 18 d of lactation (K-18L), from 18 d of lactation to weaning at 28 d (18L-W) and from weaning to 27th day of pregnancy (W-27P).

The animals had *ad libitum* access to fresh water through automatic drinkers and a commercial pellet food (composition: 91% dry matter, 8% ash, 17% crude protein, 34% NDF, 17% ADF and 3.2% ADL). The reproductive rhythm adopted was 42 days in which the does were artificially inseminated 11 days after kindling with terminal R line semen (UPV).

During all the experimental procedures, the number of does eliminated or dead for reasons of behaviour (aggressiveness or severe injuries), accidents and health, as well as the ones discharged due to reproduction

failure (if they did not get pregnant after three consecutive inseminations) were registered. The remaining does stayed on the essay until they completed four cycles.

Experimental procedure

The health status of does was recorded by evaluating three types of events: pododermatitis, skin injuries and dirtiness. The level of pododermatitis was measured by adapting the scale from Rommers and De Jong (2011): 1-patch of bald, callused skin; 2-cracked callus; 3-opened wound. Skin injuries were assessed with the following score: 1-scratched, 2-injuries and 3-injuries with presence of abscesses or other kinds of serious wounds. For dirtiness, the does were classified as dirty or not dirty. Does were considered dirty if they had any visible dry residue of faeces on their coat. These evaluations were made by the experimental team and were performed after kindling, at day 18 and

at day 28 of lactation. However, skin injuries were assessed daily and treated with antibiotic spray as soon as their occurrence was noticed.

Corticosterone levels were measured in faeces and samples were taken at day 28 of pregnancy (first day of individualization) and day 17 of lactation (one day before regrouping in part-time systems) in the first and fourth cycles of all does. Faeces were collected during 24 hours, then being frozen (-20°C) until their analysis, where they were dehydrated and grounded. The analytical procedure for corticosterone was made as indicated by Tallo-Parra et. al., (2015).

Three researchers participated in direct observations of doe's behaviour after regrouping. This evaluation was focused on the repertoire of activities of the does in part-time systems and the frequencies of the following behaviours were recorded during the first 30 minutes after regrouping:

- Exploring: does displacing on the common zones of the cage.
- Approaching to nest (own or other): does approaching to the their own nest or other's and placing at least its head to recognize the nest.
- Feeding: does staying in front of feeder and starting to feed.
- Aggressive interactions: does starting or receiving an attack or fighting each other.

During the 30 minutes of observation, the dominant doe was identified by observing its behaviour along with the other does, focusing in agonistics and submission signs. The number of not dominant does in each group varied between three and five, according to the size of the group. For does identification during the period of observation, the team considered the tattoo on the ear of each doe. The allocation of the kits after regrouping was also assessed by identifying the kits

per doe with spray colours and counting the number of kits that remained in their own nest, in another nest or outside the nest, both 30 minutes and 24 hours after regrouping. The total number of litters assessed was 55, being this evaluation made randomly in different dates and cycles.

The management evaluation was made with does and kit groups, chosen randomly, by recording the time needed to do the routine activities such as kits weaning (16 groups of litters from part-time system and 18 groups of litters from individual cages) and ventral palpation (22 groups of does from part-time system and 26 groups from individual cages). These groups of kits or does varied in size and it referred to those animals which were necessary for handling execution. The average time needed per kit and per doe inside each group was then calculated. The recording of time for kits weaning and ventral palpation began when the cage

was opened and ended after closing the cage. Weaning handling consisted of picking up the kits and placing them in a transport equipment. The handling of palpation consisted of removing the doe, placing it on the cage, performing the ventral palpation diagnosis and returning it to its cage.

Statistical Analysis

Management data and corticosterone levels were analysed by ANOVA considering the housing system (part-time system and individual cage), physiological status (pregnancy and lactation) and cycles (one, two, three and four). Regarding behaviour, it was analysed using ANOVA considering cycle and the hierarchy (dominant and non-dominant). Allocation of kits was analysed by ANOVA considering two different times (30 minutes and 24 hours). For analysis of these all parameters, the Statgraphics© Centurion 19 program was used (StatPoint

Technologies, 2020) and the value of 5% ($P < 0.05$) was considered as the level of significance.

Elimination causes was analysed by chi-squared test, considering housing system. Dirtiness was analysed by chi-squared test, considering housing system, cycles and periods inside cycle (27P-K, K-18L, 18L-W and W-27P). Skin injuries and pododermatitis were analysed by non-parametric test Mann-Whitney, considering housing system, cycles and periods. For analysis of these all parameters, the Wilcoxon test of Stats R package (R Core Team, 2020) was used and the value of 5% ($P < 0.05$) was considered as the level of significance.

Results and discussion

A total of 12 does had to be removed in the part-time system (48%) and six does in individual cages (24%). The main cause in the part-time system was behavioural problems (eight does), which did not appear as a cause in

individual cages. Among these does, one of them was eliminated because it suffered paralysis of its hind limbs due to a hierarchical fight. The elimination of does was mainly associated with their behaviour ($P = 0.0292$). These behavioural problems were mainly related to fights among conspecifics. The rest of the elimination causes were similar in both systems: death (one doe in the part-time and three does in individual cages), reproductive causes (two does in part-time and two does in individual cages), and health causes (one doe in part-time and one doe in individual cages).

Most of the eliminated does were removed from the experiment during the first cycle due to agonistic behaviour. Similar causes of elimination were reported by Rommers *et al.*, (2014), although they had a lower replacement rate and noted that hiding places were important to decrease the number of injured animals. In the current study, no

hiding places were included in the design of the pens, which could have contributed to decrease the elimination rate. In the present experiment, a level of 48% losses was reached at the end of the fourth cycle. Similar loss rates in the part-time system were found by Pérez-Fuentes *et. al.*, (2018), but in their case, a 60% level of removed does was reached at the end of the fifth reproductive cycle.

In reference to the health status parameters, a higher occurrence of skin injuries in the part-time system was observed, especially during the first cycle ($P=0,0040$), when does were still

adapting to this housing system (average value of 0.47, according to skin injuries scale). Most of the skin injuries observed during the essay were graded as level one and the average value of these parameters in the entire experiment was 0.24. However, at the fourth cycle, only a low amount of does presented any kind of skin injury (average value of 0.06). This represents a reduction of 87%, suggesting adaptation to the part-time system. Nevertheless, days 0 of the first cycle ($P=0,0104$) and 28 of the remaining cycles need to be highlighted as being critical, since a higher level of skin injuries were presented (Figure 1).

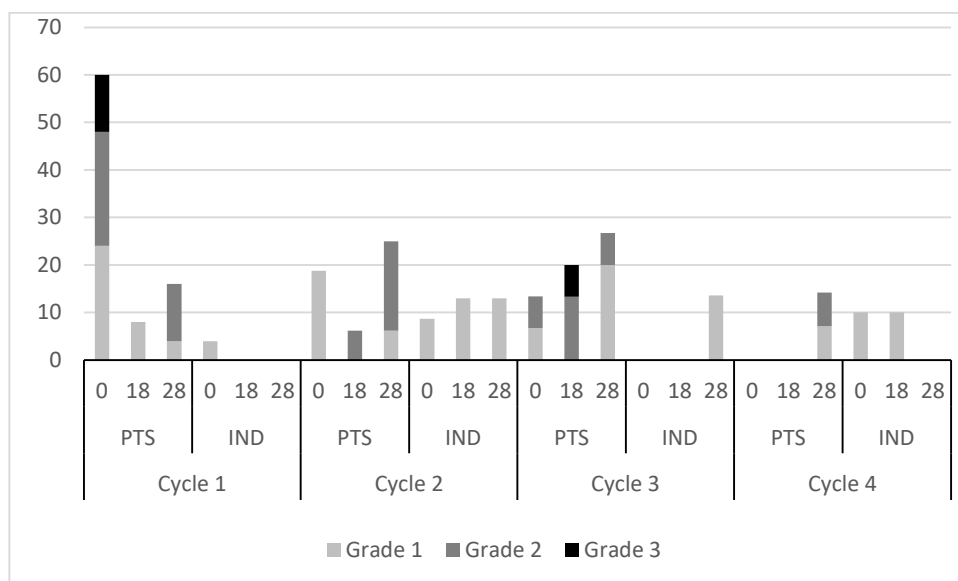


Figure 1 – Occurrence of skin injuries in rabbit does (%) housed in the part-time system (PTS) and individual cages (IND) at kindling (0), 18 days of lactation (18) and weaning (28), during four cycles.

According to these results, the aggressiveness is higher at the beginning of the first cycle, being critical at day 0 (kindling day) of the first cycle, when the does were still young and adapting to the part-time system. This difference between the beginning day and other days in the cycle was less severe in the following cycles, suggesting adaptation of animals to these conditions, as noted also by Rommers *et. al.* (2006). A better definition inside the hierarchical rank and a greater stability may also have contributed to this reduction.

The period after regrouping is critical, as evidenced by the high frequency of injured animals at day 28 in part-time system ($P=0,0392$). A similar trend was also observed by Graf *et. al.* (2011), Buijs *et. al.* (2015), Maertens and Be Bie (2017), and Zomeño *et. al.* (2018). The main reason for aggressiveness is the establishment of

the hierarchy, being necessary to reach stability within the group.

The high amount of skin injuries can also be attributed to the limited space that does had available and low efficiency of nests to provide hiding places, although Rommers *et. al.* (2018) did not achieve reduction in the incidence of wounds when were used nest box panels and PVC tubes in different positions to provide hiding places. Although evaluating a shorter period of time, Graf. *et. al.* (2011), verified fewer skin injuries in does housed in bigger cages as the ones used in this research, also providing environmental enrichment. Most wounds were grade one (Figure 1), superficial scratches or wounds which signalled that an attack was performed, though less intense when compared to deeper wounds. This situation was also evidenced by Rommers *et. al.* (2014), Rommers *et. al.*, (2018) and Zomeño *et.*

al. (2018). Maertens and Be Bie (2017), and Cervera *et al.* (2018b) that also noticed an increase in injuries in does housed in the part time system, mainly after regrouping.

Zsendro *et. al.* (2016) reported that in a closed environment, where the does have the same age, disputes to establish hierarchy are more intense. In our essay, all the does housed together before their first insemination were of the same age, which may have contributed to the increase in the number of skin injuries, as observed in Figure 1. Thus, as all authors who have worked with this type of housing system, there is an agreement that aggression remains as the biggest problem of this system and it needs to be further studied (Olivas *et. al.*, 2016). Therefore, aggression causes damages in animal welfare, health status and economic aspects, due to the elevated rate of does replacement which has a highly negative impact on the profit of rabbit breeding.

Does housed in the part-time system presented greater occurrence of dirtiness and higher values were observed on the second ($P=0.0027$) and the third ($P=0.0071$) cycles and for the periods 0 ($P=0.0117$), 18 ($P=0.0074$) and 28 ($P=0.0253$). The main cause of dirt in does kept in part-time system was related to the accumulation of faeces on top of the nests, given that these had been designed in the shape of a box with a lid, and the does had free access to this place. The lid was cleaned by the team when evidenced. There were no differences in the fourth cycle due to a high incidence of dirty animals also in the individual cages ($P=0.2864$), as some cages presented accumulation of faeces in the corner due to a small spacing between the floor wires (11mm). This greater accumulation of faeces was seen in periods of high feed intake by does and is the main reason why they were dirty. The worst hygiene condition of the animals has a negative impact on health

(Cervera et al., 2017) and so, adjustments in these pens and cages would be needed to solve this problem.

In general, there was a balance in the occurrence of pododermatitis in the housing systems, although in the fourth cycle, the occurrence was higher in individual cages ($P=0.0435$) (Figure 2). This difference seems to be related to the thickness of the wire used in the floor of individual cages and part-time system.

The temporal trend was related to the heavier does at last cycles and was also reported by Mikó *et al.* (2014) and Buijs *et al.* (2014). These authors verified similarity between housing systems when wire floor was adopted for individual cages and collective pens. On the other hand, Cervera *et al.* (2018b), found that the use of collective pens provides elevated pododermatitis rates.

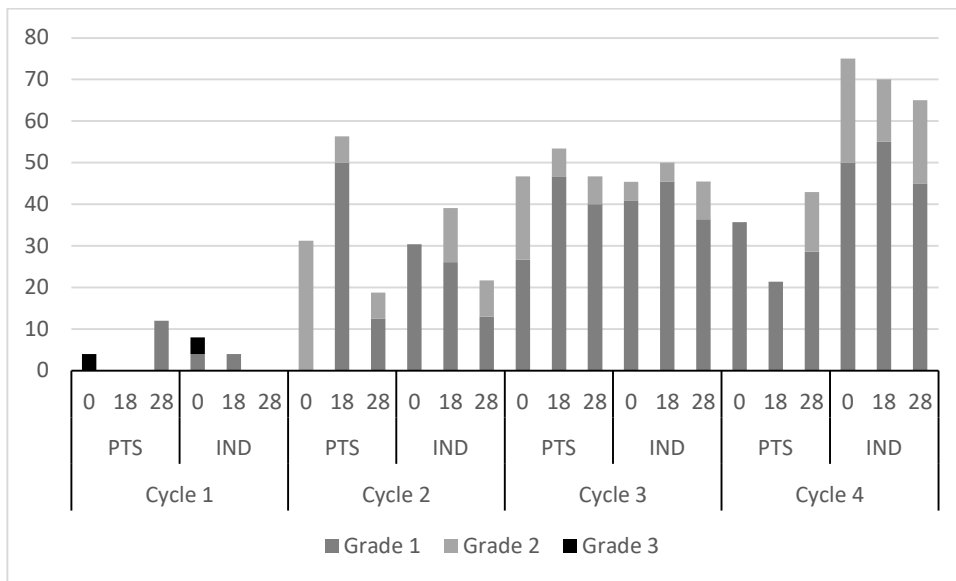


Figure 2 – Occurrence of pododermatitis in rabbit does (%) during four cycles, housed in part-time system (PTS) and individual cages (IND) at partum (0), 18 days of lactation (18) and weaning (28).

Corticosterone (CS) levels in faeces are displayed in Table 1 and Figure 3. As it can be observed, the level of CS decreased throughout the

experiment, reaching the minimum levels at the fourth cycle (71,1 vs 39,9 ng/gDM). Furthermore, the levels were greater for does housed in the part-time

systems (P=0,0156). These findings are in agreement with those mentioned by Trocino et. al. (2014), which confirmed higher CS levels in rabbits housed in the collective system. The part-time system increases the agonistic interactions between animals, suggesting more stressful conditions. Perez-Fuentes *et. al.*

(2018), observed higher levels of haptoglobin (early biomarker in stress processes) in the fifth cycle (last one) and a higher number of does eliminated in the part-time system, suggesting that higher levels of stress prevail when does are housed in this alternative housing system.

Table 1 – Corticosterone levels in faeces of pregnant and lactating rabbit does housed in individual cages (IND) and the part-time system (PTS) at cycles one and four.

	<i>PTS</i>	<i>IND</i>	<i>SE</i>	<i>P group</i>	<i>Pcycle</i>	<i>P PS</i>	<i>P gxc</i>	<i>P gxp</i>	<i>P cyp</i>	<i>P gxcyp</i>
Average level (ng/gDM)	60,7	50,4	7,56	0,0156	0,0000	0,0000	0,0972	0,4575	0,0013	0,5509

Ng/gDM: nanograms per gram of dry matter; SE: standard error; P group: PTS vs IND; P cycle: one vs four; PS: physiological status pregnant vs lactation; P gxc: probability of interaction between groups and cycles. P gxp: probability of interaction between groups and physiological status; P gxc: probability of interaction between cycles and physiological status and P gxcyp: probability of interaction between groups, cycles and physiological status.

In this study, the effect of physiological status (pregnancy vs lactation) on CS levels was also assessed, and pregnant does presented higher levels than lactating does (65,8 vs 45,2 ng/gDM). Higher levels of corticosterone in pregnant does near the kindling day was also observed by Prola et. al. (2013). The days before kindling are more stressful for most mammals when compared with the lactation days. The measurement of corticosterone

levels in faeces is an alternative method to better understand the levels of stress that animals present in a certain period of life. In this sense, it was verified that the part time system contributed to raising the stress load of the does, and it seemed to contribute to the elevation of the stress levels when one rabbit doe feels threatened by another and does not find a possibility for hiding or escaping. At the end of the fourth cycle, both groups displayed similar corticosterone levels

(41,6 vs 38,3 ng/gDM). This could support the fact that the part-time does adapt to the housing system. These values are very close to those observed by Trocino *et. al.* (2018). The obtained data shows that the differences between

the corticosterone levels are more pronounced at the beginning of the research, when the animals observed in the part-time system are younger and only starting to adapt to their life within a group.

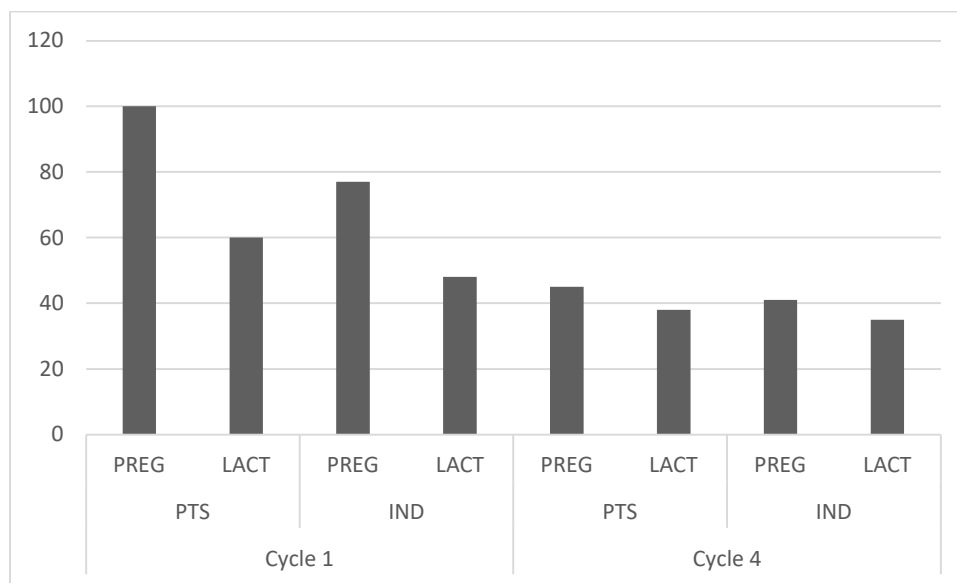


Figure 3 – Corticosterone levels (ng/gDM) in faeces of pregnant and lactating does, housed in part-time system (PTS) and individual cages (IND) at cycles one and four.

The analysis related to behavioural assessment after regrouping showed that there was influence from order of cycles and hierarchy (Tables 2 and 3). All does presented exploratory behaviour in the first 30 minutes after regrouping but only 21% showed fight-related behaviour. Among these animals, 44% initiated at least one attack and 67%

were attacked at least once. The dominant does showed higher frequency of eating and aggressive behaviour and were less attacked. The higher frequency of ingestion performed by does from second and third cycles, seems to indicate habituation of the animals to the part-time system. Rommers *et. al.* (2014) and Buijs *et. al.* (2015), also indicated

that the highest frequency of feed ingestion occurs immediately after regrouping.

Table 2 – Behaviour of rabbit does in the part-time systems during the first 30 minutes after regrouping, considering the first three cycles.

Cycle	Behaviour (frequency)				
	Approaching own nest	Approaching others' nest	Eating	Aggressive behaviour	Being attacked
First	0,78	1,22	0,72B	1,94	1,55B
Second	1,19	0,69	1,18A	3,25	3,75A
Third	1,57	0,71	1,85A	4,14	4,14A
e.e.	0,61	0,57	0,29	1,40	1,00
P value	0,516	0,543	0,007	0,359	0,029

Mediums with different letters in the column are significantly different (P <0.05).
 E.E: error standard

Table 3 – Behaviour of dominant and not dominant does in the part-time systems during the first 30 minutes after regrouping.

Hierarchy	Behaviour (frequency)				
	Approaching own nest	Approaching others' nest	Eating	Aggressive behaviour	Being attacked
Dominant	0,25	0,5	1,75A	5,75A	1,13B
Not dominant	1,27	1,03	0,93B	2,12B	3,27A
e.e.	0,55	0,52	0,28	1,22	0,96
P	0,106	0,373	0,015	0,011	0,050

Mediums with different letters in the column are significantly different (P <0.05).
 E.E: error standard

As can be observed in Table 2, aggressiveness did not decrease with the cycle's order, instead, it even increased. A possible explanation could be due to the housing system itself, with several does housed together, as suggested by Zomeño *et. al.* (2018), that noticed a decrease in the levels of aggression when only two does were housed together as

compared to four does. The number of housed does seems to impact directly on the level of aggression. Moreover, the collective pen used in the present research has no hiding places, escaping area nor doors dividing the initial space of each doe, which could also contribute to decrease aggressiveness as verified by Zomeño *et. al.* (2018). In the present

study, the level of isolation between animals was practically null and this contributes to the increase in aggressiveness.

The allocation of kits (Table 4) was influenced by time elapse after regrouping. A low frequency of exchange of animals between the nests was observed during the first 30 minutes, while at 24 h most of the kits were inside another nest. Some nests were empty after 24 h whereas other nests had more than 20 kits. The amount of kits outside the nest doubled after 24 h, although it should be noted the low quantity of kits that were outside the nest, mainly

because the evaluation was carried out in the morning period, when the animals had already been suckled and the temperature was lower. It is important to remark that rabbit kits were mixed inside the nests and the does did not select their offspring during suckling, as previously reported by other authors such as Zomeño *et. al.* (2018), and Braconnier *et. al.* (2020), which has important positive productive implications. Although Braconnier *et. al.* (2020) reported bites in kits, in the present essay, the occurrence of these signals was not observed.

Table 4 – Allocation in percentage (%) of 18 days kits at 30 minutes and 24 hours after regrouping in a part-time system.

Elapsed time	Outside the nest (%)	In its own nest (%)	In another nest
30 minutes	6.9B	77.4A	15,7B
24 hours	15.0A	21.2B	63,8A
e.e.	2.4	3.9	4,2
P	0.01	<0,001	<0,001

e.e.: error standart

Part-time systems increased the required time for the palpation to diagnose pregnant does, but it did not affect the necessary time for weaning the

kits (Table 5). This fact contributes to the reduction of the efficiency of the labour in rabbit farms. In addition, when the physiological status of does (lactating or

pregnancy) was considered, the time spent for palpation was similar. Considering the does' handling, Cervera *et. al.* (2018b) documented worsening in time for weaning, insemination, palpation and nests revision procedures.

It is clear that the design of the collective pens as well as greater difficulty to reach the animals contributes to the increase need for labour, which in consequence increases the production costs.

Table 5– Necessary time in seconds (s) during weaning and palpation to handle rabbits in part-time systems (PTS) and individual cages (IND)

<i>Parameters</i>	<i>PTS</i>	<i>IND</i>	<i>e.e.</i>	<i>P</i>	<i>P cycle</i>	<i>P physiological</i>	<i>P</i>	<i>P</i>	<i>P</i>
				<i>group</i>		<i>state</i>	<i>gxc</i>	<i>cxls</i>	<i>gxcxls</i>
Palpation time (s)	46.1	29.7	1.98	<0.0001	0.0733	0.4874	0.2122	0.0865	0.2907
Weaning time (s)	4.27	4.16	0.35	0.8004	0.2206	-	0.5911	-	-

e.e.: error standard

P grupo: probability inside group (individual vs part-time system)

P: cycle: probability inside cycles (one, two, three and four)

P: physiological state: probability inside physiological state (pregnant vs lactating does)

P gxc: probability of interaction between group and cycle

P gxls: probability of interaction between group and physiological state

P gxcxls: probability of interaction between group, cycle and physiological state

Normally, the evaluation of time necessary to perform the animal management is not considered in the development and evaluation of new housing systems, which should provide simplicity, efficiency, functionality and optimize the labour. Thus, the increase in the necessary time to do the palpation can be interpreted as an inconvenience for adoption of the part-time system in the collective pen. The evaluation of

other parameters related to the management is necessary for further clarification of this issue.

Conclusion

In brief, the part-time system increases the management time, level of corticosterone and the replacement of does, being this last one occurred mainly due to injuries from fighting. New

collective systems need to consider and search to solve these problems.

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