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RESEARCH ARTICLE

# Effects of Different Time Schedules for Regrouping on Socio-Positive Behaviors in Group-Housed Rabbit Does

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**Abstract**

Many studies have demonstrated that group housing of does often results in aggression and sometimes lesions due to biting. However, the positive interactions among reproducing does in group housing systems is less clear. The present descriptive study used video material of a part-time group housing system to examine socio-positive behaviour of does after postpartum separation of various lengths. The existing video records were collected from does which were kept in a part-time group housing system in a commercial farm. Each pen consisted of individual cages and two common areas. Three different time schedules/treatments for regrouping were applied in the study. Eight does were grouped on either day 12, 18 or 22 post-partum after insemination on day 8 post-partum. The does were individually marked using distinctive livestock spray markings. A previously developed of ethogram of sociopositive behaviors and photos were used to identfy the behavior. Individual behavior of does, its length and location were coded from 3.00 to 6.00 am and from 15.00 to 18.00 pm for every treatment. There were significant differences for the behaviour of locomotion, sharing the same feeder and lying in the common area among the groups ($P<0.05$). There were no significant effects of daytime and treatment on the total number of behaviors and on the locations where any behaviour observed in the groups. As a conclusion; it was determined that the group housed rabbit does exhibit meaningful socio-positive behaviours. Lying in the common areas, running or walking were the most expressed positive behaviour by does in every treatment.

**Keywords:** Rabbit does, Part-time group housing, Positive behaviour

## Introduction

In commercial rabbit production, the group housing system has been considered due to the public's concerns about rabbit' welfare. In terms of the social nature of rabbits [1,2], a group housing system has the potential for socio-positive interactions between the does and potentially increase their welfare [3]. However, aggression and serious behavioural problems among rabbits sometimes might be common in group housing systems [4,5]. In addition, there might be a direct aggressive attack between kits and other does resulting injuries or death of kits. This is a crucial problem in terms of animal health and welfare in commercial production despite various efforts in practice to solve aggression among females.

Scientific research is looking for a balance between welfare and productivity through new housing designs, prioritizing the ethology of the species. Rabbit owners should be encouraged to meet the need for rabbits to be housed with an appropriate conspecific in a suitably large, sheltered enclosure [6]. Effects of different types of flooring, cage sizes, densities, and group sizes are studied depending on the physiological and psychological needs of the productive stage of the animal [7]. In some studies [8-10], it has been stated that rabbits show lots of initiative to establish social contact, and this can help improving the wellbeing of the animals during their productive life and thus is an aspect of positive welfare.

Rabbit does are highly territorial, sensorial, and hierarchical animals and they rely on olfactory communication among each other [11]. A part-time group housing system allows the animals to express a wider spectrum of socio-positive behaviour and it provides an alternative for continuous group housing systems which have low production. Regrouping female rabbits in group-housing systems after the birth of their kits is common management practice

in rabbit production. But, the regrouping of female rabbits can lead to injuries and chronic stress [12], thereby compromising both animal welfare and production. Previous studies about group housing of female rabbits focused on agonistic behavior that may occur between the animals when hierarchy was established [13,14]. Rabbits in group housing can display a wider range of behavioural patterns, such as running, walking, and exploration [15]. Part-time group housing systems have proven to have potential but cannot yet be recommended in farms until major problems of increased aggression and injuries among does and kits are solved [16].

In recent years, there has been a new approach to exploring positive experiences for animals in their environment [17]. In contrast to previous studies focusing on the negative effects of re-grouping on rabbit welfare [18,19], very little attention has been given to the positive behavior of rabbit does. This study was conducted to determine the socio-positive behaviours of group housed rabbits after parturition, an area that has received insufficient exploration in the existing literature. Another aim of this study was to determine the location selected for behaviour and length of some positive indicators of rabbit does.

## Material and Methods

### Ethical Statement

Since the data were obtained from video recordings and no live animals were used in this study, ethical approval was not required.

### Experimental Design

This study analyzed existing videos previously recorded on individual does for the study of agonistic behavior by Braconnier et al.[13] and Munari et al.[20]. The existing video records were collected from does which were kept in a part-time group housing system, including eight does per pen, on a commercial rabbit farm in Switzerland. They were reared according to a Swiss animal-friendly label programme, which requires group housing of females and a separated nest for each doe. In this part-time group housing system, the does were kept in groups with their kits during the lactation period.

Different postpartum (pp) regrouping schedules were used resulting in three different time schedules (treatments), which were applied in this study to evaluate their effects on socio-positive behaviors of does [13]: the first treatment group (T12) was group-housed at 12 days pp (day post-partum; dpp), the second one (T18) at 18 dpp and the third treatment group (T22) at 22 dpp after regrouping.

One day before parturition, the does were separated from each other. After artificial insemination applied 10 days after parturition (pp), the groups (T12, T18 and T22) were re-grouped on day 12, on day 18 and on day 22 pp, respectively, by removing the separating grids of the separable areas and giving the does access to all areas of the pen.

Each treatment group consisted of 8 female animals. To facilitate individual monitoring, the does were individually differentiated using distinctive livestock spray markings and named according to the marks on their coats.

### Housing Conditions and Feeding

Pen consisted of individual cages and two common areas. Common area one (Ca1) was situated on the ground level while common area two (Ca2), situated in front of the individual cages and food dispensers was located on the upper level. Common area one was covered with straw. The common area two consisted of two elevated platforms, one platform for each side, with a wooden floor where the (open) cages are situated. Each cage contained a nestbox with a feeder displayed outside on the common area and a nipple drinker. The boxes were open with free access to the common wooden platform during part of the breeding cycle. The does had ad libitum access to water, hay, and commercial rabbit pellets (UFA 925, UFA AG, Herzogenbuchsee, Switzerland).

### Video Recording and Analysis

Video recording in the first treatment group was conducted between day 12 and 13 postpartum (T12), the second treatment group was filmed between day 18 and 19 (T18) and the last treatment group was filmed between day 22 and 23 (T22), shortly after regrouping. The socio positive and locomotory behaviors of animals were determined by watching the existing videos of selected hours in three groups. The positive behaviour was coded between 3.00–6.00 and between 15.00 to 18.00 for every treatment. In total, we analysed 18 h of continuous video of rabbit does [21]. An ethogram and photos made previously by Gebhard-Henrich et al.[21] and Niedermann [9] were used to code doe behaviors *(Table 1)*. The ethogram was structured according to the behaviors displayed by does. All the activity that could be classified as positive behaviors were noted and coded according to the ethogram. All does were included in the analyses as focal animals. The behavior was registered in an excel table during the targeted time period. The activites that could be classified as positive behaviors (friendly interactions and non-aggressive locomotor exercise) were noted and coded as work-out, i.e. running or jumping (wo), sniffing (s), proximity (p), sharing the same box (sb), sharing the same feeder (fo) and lying in the common area (lca). The type of the behavior, location (in the lower, Ca1, or the upper level, Ca2, or both) and length of the state behavior were documented.

*Table 1. Ethogram describing the positive behavior observed in does in the study*

| Behavior | Description |
|---|---|
| Proximity | Two does sharing common space in close proximity/within one animal length |
| Sharing the same box | At least two or more does share the same box with or without young ones |
| Sharing the same feeder | One does eats from another doe's feeder or two does feed at the same feeder with or without interactions |
| Sniffing | Two does with their noses sniffing each other without touching |
| Lying in common area | Does lie alone or together with others in any of common area |
| Locomotion/work-out | Work-out like walking, running or jumping |

### Statistical Analysis

The average percentage of the behaviour according to treatment, daytime and locations were calculated in the groups and presented with the graphs. Length of certain behaviour was expressed as mean ± standard error for each treatment groups (T11, T18, T22) and time of day (am or pm). Two-way analysis of variance (ANOVA) was used to evaluate the effects of the treatment, time of day, and their interactions on the frequency of the behaviour after normality of data distribution [23,24]. Statistical analyses were conducted using SPSS software, version 28 [25], with a significance level of P<0.05 considered as statistically significant.

## Results

Frequency of total positive behaviors observed per hour between 03:00 and 06.00 am and pm are presented in *Fig. 1*. There were no significant effects of time of day (P<0.316) and treatment (P<0.446) on the total number of behaviors observed in the groups while time of day x treatment interaction for the total number of behaviour was found not to be significant (P<0.434).

The total number of every positive behaviour as they occurred between am and pm period, including all treatments, are showed in *Fig. 2*. There were significant differences for the percentage of locomotion, sharing the same feeder and lying in the common area among the groups (P<0.05).

The average length of some positive behaviours lasting longer than 50 sec. in all groups in selected time periods are presented in *Table 2*. There were no significant effects of day-time or treatment on the behaviour of sharing the same feeder and lying in the common area. No significant day time x treatment interactions was observed for sharing

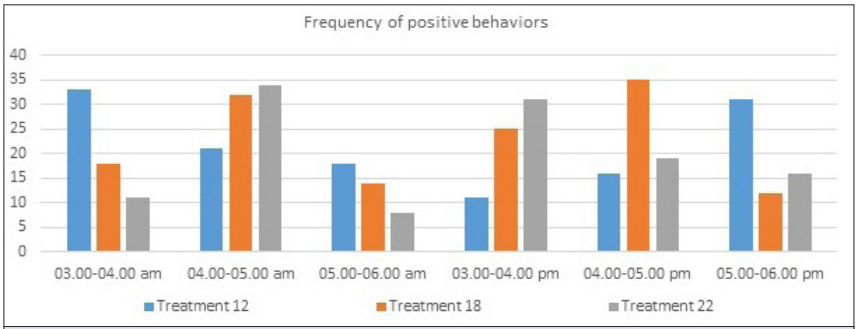


**Fig 1.** Frequency of total positive behaviors from 03:00 to 06.00 am and pm. The bars show the total number of positive behaviors, per hour. All the coded behaviors for each treatment (T12, T18, and T22) were summed together

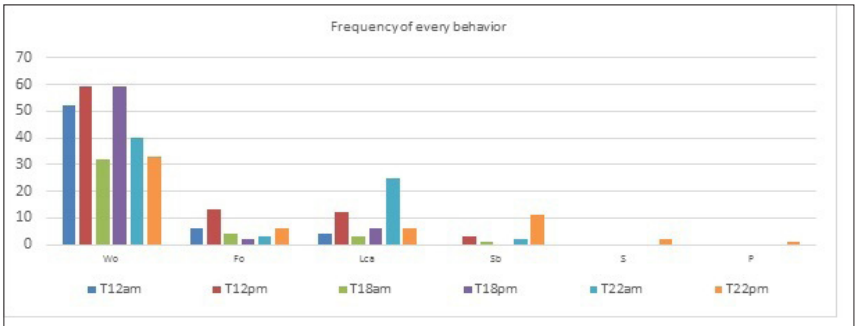


**Fig 2.** Distribution of every positive behavior per am or pm/per treatment (T12, T18, T22). The bars show the number of every positive behavior occurring between 03.00 to 06.00 am and 03:00 to 06.00 pm, per hour (Wo: Locomotion/work out, Fo: sharing the same feeder, Lca: lying in the common area, Sb: sharing the same box, S: sniffing, p: proximity)

***Table 2.*** *Average length of some behaviors observed in the groups (s)*

| Treatment | | Sharing the Same Feeder | Lying in Common Area |
|---|---|---|---|
| DayTime | am | 214.72±42.31 | 316.85±59.30 |
| | pm | 114.63±42.12 | 347.58±50.25 |
| Treatment | T12 | 181.87±36.16 | 324.13±64.87 |
| | T18 | 120.00±63.46 | 275.25±79.44 |
| | T22 | 192.17±51.81 | 397.27±55.44 |
| DayTime x Treatment | amxT12 | 214.50±59.82 | 428.75±112.35 |
| | amxT18 | 174.00±73.27 | 207.67±129.73 |
| | amxT22 | 255.67±84.61 | 314.13±46.85 |
| | pmxT12 | 149.23±40.65 | 219.50±64.87 |
| | pmxT18 | 66.00±103.63 | 342.83±91.73 |
| | pmxT22 | 128.67±59.82 | 480.40±100.49 |
| ANOVA | DayTime | 0.105 | 0.694 |
| | Treatment | 0.644 | 0.421 |
| | DayTimexTreatment | 0.877 | 0.080 |

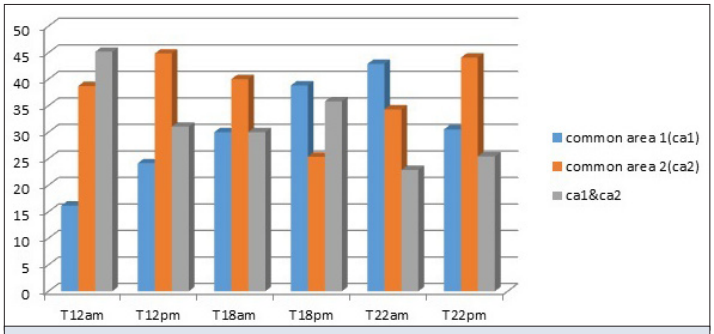


**Fig 3.** Distribution of locations where positive behavior of does were observed. The bars contain information for each period per treatment (T12, T18, T22) and represent the distribution of behaviors per location (ca1, ca2, ca1&ca2), expressed in percentage

the same feeder or lying in the common area behaviours of does.

Distribution of locations where positive behaviour was observed according to time of day is showed in *Fig. 3*. There were no significant effects of treatment (P<0.250) and daytime (P<0.185) on the locations where any behaviour observed. There were also no significant treatment x time of day interactions (P<0.239).

## Discussion

The welfare of rabbits is greatly influenced by the housing conditions in which they are kept. Group housing system allow breeding does to perform a wider behavioural freedom as running, jumping and social contact with other does [10]. In our study, a total of 385 activities described as positive behaviour was determined in group housed does. Of these positive behaviours, most of them occurred on day 12 and 18 of regrouping. Treatment 12 showed most positive events *(Fig. 1)*. In general, does were found to be least active between 05.00 to 06.00 am or pm. The lowest number of total behaviours was seen between from 05.00 to 06.00 am in T12 (11 activity in total) and T18 (8 activity) and from 04.00 to 05.00 pm in T18 (12 activity). Does in T12 were more active from 03.00 to 04.00 am and from 05.00 to 06.00 pm while does in T18 were showed more positive behaviour from 04.00 to 06.00 am and pm (56, in total) than at other times. Positive behaviours of does in T22 were the highest from 04.00 to 05.00 am (35 activity) and from 03.00 to 04.00 pm (31 activity). During the morning hours, the rabbits were less active, but during the afternoon they showed a tendency to interact with each other and move, except for treatment 22. In a study, Rooney et al.[26] reported that the mid-day period was the least active period for does.

As expected, workout (wo) like running and walking were the most expressed behaviours by does. It was found that

the frequency of locomotion in T12 pm and T18 pm was almost 58% of all total observed behaviours. Whereas, lying down was the most observed rabbit behaviour when housed in single cages [27]. Workout behaviour was followed by lying in the common area (lca), sharing the same feeder (Fo), and sharing the same box (Sb) behaviours for all groups. In general, feeding behaviour of rabbits varies along the day and approximately 60% of the solid ingestion takes places during the dark period [28]. Sniffing (s) and proximity (p) were only observed in T22. Di Vincenti and Rehring [29] reported that exploratory behaviour including sniffing, was found to be highest in group-housed rabbits in pens.

Behaviors of sharing the same feeder and lying in the common area lasted longer than 50 sec in every group. Although locomotion was the most common positive behaviour in the study we present the length of time for all these behavior. Because locomotion or work-out can be acceptable as event behaviors, because they lasted less than 1-4 s, sharing the same feeder and lying in the common area can be acceptable as state behaviors, because they lasted longer than 1-4 sec [30,31]. No significant differences for these behaviors between the groups were found in terms of daytime or treatment effects.

In general, the elevated common area (Ca2) was the most used location with 146 positive activities. The lowest ratio of positive behaviours in T12 was observed in ca1 (10 activities, in total) in both observation period. The amount of positive behaviours observed in all common areas was the highest in T12 during am and pm period (149 activities). The does in T22 preferred the ca1 during the morning period while they showed most positive behaviour in Ca2 during the afternoon. Ca1&Ca2 means that the does displayed the behaviour in both areas without interrupting. The most active does observed in both places at the same time was in T12 am.

In general, most results in our study were found to be consistent with the previous study of Niedermann [9]. This study is probably the first in terms of determining positive behaviour of group housed rabbit does but it has several limitations. Behavioural observations were only performed during the selected hours so some behaviours may have been missed [32]. The frequency of positive behaviour was found to be differed among individuals. It was much higher in two does and one of the other does did not display any of the positive behaviors during the observation period.

As conclusion, the group housed rabbit does exhibit meaningful socio-positive behaviours, suggesting that social interactions can play a beneficial role in their overall welfare. Lying in the common areas, running or walking were the most expressed positive behaviour by does in every treatment. The data obtained from this study will contribute to understand assessment of common positive welfare and behavioural indicators of group housed rabbit does and select methods suitable for on-farm use. Furthermore, the findings will provide recommendations for the inclusion of aspects of positive welfare in farm animal welfare assessment schemes, esp. for group-housed does.

## Declarations

**Availability of Data and Materials:** Datasets used in this experiment are available from the corresponding author on request.

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**Competing Interest:** The authors have no conflict of interest to declare in regard to this publication.

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**Author Contributions:** Conceptualization: MP & SG, Data curation: MP & SG, Formal analysis: MP, Funding acquisition: MP & SG, Investigation: MP, Methodology: MP & SG, Project administration: MP & SG, Resources: SG, Software: SG, Supervision: SG, Validation: MP & SG, Visualization: MP & SG, Writing - original draft: MP, Writing-review and editing: MP & SG

## References

**1. DiVincenti L Jr, Rehrig AN:** The social nature of european rabbits *(Oryctolagus cuniculus). J Am Assoc Lab Anim Sci,* 55 (6): 729-736, 2016.

**2. Bill J, Rauterberg SL, Herbrandt S, Ligges U, Kemper N, Fels M:** Agonistic behavior and social hierarchy in female domestic rabbits kept in semi-groups. *J Vet Behav,* 38, 21-31; 2020. DOI: 10.1016/j.jveb.2020.03.004

**3. Cano, C, Carulla P, Villagrá A:** Welfare, behavior, and housing of rabbits. **In,** Simões J, Monteiro JM (Eds): Veterinary Care of Farm Rabbits. Springer, Cham, 2024. DOI: 10.1007/978-3-031-44542-2_8

**4. Szendro Z:** Housing and welfare of growing rabbits. Part I: Groups size, space requirement and floor type. Lohman Information. https://lohmann-breeders.com/files/downloads/PUBLICATIONS/LI/2024/LOHMANN-INFORMATION-housing-welfare-rabbits-EN.pdf *Accessed:* October 08, 2024.

**5. Krunt O, Zita L, Kraus A, Moravcsíková Á, Frühauf Kolářová M, Bartoš L:** Effects of genotype and housing system on rabbit does' aggressive behaviors and injuries in smallholding conditions. *Animals (Basel),* 13 (8):1357, 2023. DOI: 10.3390/ani13081357

**6. Burn C, Shields P:** Do rabbits need each other? Effects of single versus paired housing on rabbit body temperature and behaviour in a UK shelter. *Anim Welfare,* 29 (2): 209-219, 2020. DOI: 10.7120/09627286.29.2.209

**7. Garcia AV:** Housing and rabbit welfare in breeding does. **In,** Argente MJ, Pardo MLGP, Dalton KP (Eds): Lagamorpha Characteristics. Open access peer-reviewed chapter. https://www.intechopen.com/chapters/71955, 2019. *Accessed:* January 20, 2025.

**8. Dal Bosco A, Cartoni Mancinelli A, Hoy S, Martino M, Mattioli S, Cotozzolo E, Castellini C:** Assessing the preference of rabbit does to social contact or seclusion: Results of different investigations. *Animals (Basel),* 10

(2):286, 2020. DOI: 10.3390/ani10020286

**9. Niedermann H:** Sociopositive behavior in female breeding rabbits inpart-time group housing. *Master's Thesis,* University of Zurich, 2022.

**10. Van Damme LGW, Ampe B, Delezie E, Rommers J, Tuyttens FAM:** Social behaviour and personality profiles of breeding does housed part-time in group. *App Anim Behav Sci,* 267:106064, 2023. DOI: 10.1016/j.applanim.2023.106064

**11. Crowell-Davis S:** Rabbit behavior. *Vet Clin Exot Anim,* 24, 53-62, 2021. DOI: 10.1016/j.cvex.2020.09.002

**12. Hube D, Bill J, Knop ES, Herbrandt S, Kemper N, Fels M:** Physical injuries and hair corticosterone concentration in rabbit kits from single- and group-housed does kept on a commercial farm. *Animal,* 13 (2):196, 2023. DOI: 10.3390/ani13020196

**13. Braconnier M, Gomez Y, Gebhardt-Henrich SG:** Different regrouping schedules in semi group-housed rabbit does: Effects on agonistic behaviour, stress and lesions. *App Anim Behav Sci,* 228:105014, 2020. DOI: 10.1016/j.applanim.2020.105024

**14. Braconnier M, González-Mariscal G, Wauters J, Gebhardt-Henrich SG:** Levels of testosterone, progesterone and oestradiol in pregnant-lactating does in relation to aggression during group housing. *World Rabbit Sci,* 29, 247-261, 2021. DOI: 10.4995/wrs.2021.14897

**15. Ozella L, Sartore S, Macchi E, Manenti I, Mioletti S, Miniscalco B, Crosetto R, Ponzio P, Fiorilla E, Mugnai C:** Behaviour and welfare assessment of autochthonous slow-growing rabbits: The role of housing systems. *PLoS One,* 19 (7):e0307456, 2024. DOI: 10.1371/journal.pone.0307456

**16. Szendro Z, Trocino A, Hoy S, Xiccato G, Villagra A, Maertens L:** A review of recent research outcomes on the housing of farmed domestic rabbits: Reproducing does. *World Rabbit Sci,* 27 (1): 1-14, 2019. DOI: 10.4995/wrs.2019.10599

**17. EU CA 21124 Cost Action LIFT:** Lifting Farm Animal Lives - laying the foundations for positive animal welfare. https://liftanimalwelfare.eu/,2022. *Accessed:* December 23, 2024.

**18. Da Silva KG, Borges TD, Costa LB, Dalmau A, Sotomaior CS:** Rabbit welfare protocols under Brazilian conditions: The applicability of welfare protocols in rabbit farms for different purposes - First results. *J Vet Behav,* 54:36-53, 2022. DOI: 10.1016/j.jveb.2022.06.002

**19. Coda KA, Fortman JD, García KD:** Behavioral effects of cage size and environmental enrichment in New Zealand white rabbits. *J Am Assoc Lab Anim Sci,* 59 (4): 356-364, 2020. DOI: 10.30802/AALAS-JAALAS-19-000136

**20. Munari C, Mugnai C, Braconnier M, Toscano MJ, Gebhardt-Henrich SG:** Effect of different management protocols for grouping does on aggression and dominance hierarchies. *Appl Anim Behav Sci,* 227:104999, 2020. DOI: 10.1016/j.applanim.2020.104999

**21. Alfonso-Carrillo C, Martin E, De Blas C, Ibanez MA, Garcia-Ruiz AI, Garcia-Rebollar P:** Development of simplified sampling methods for behavioural data in rabbit does. *World Rabbit Sci,* 25, 87-94, 2017. DOI: 10.4995/wrs.2017.3627

**22. Gebhardt-Henrich GS, Braconnier M, Niedermann H:** Profitieren Zuchtkaninchen von der Gruppenhaltung? **In,** Düpjan S, Erhard M, Kemper N, Rauch E, Reiter K, Waiblinger S (Eds): Aktuelle Arbeiten zur artgemäßen Tierhaltung. 14-22, KTBL, Darmstadt, 2022.

**23. Snedecor GW, Cochran WG:** Statistical Methods. Eighth ed., Iowa State University Press, USA, 1989.

**24. Starbuck C:** Analysis of differences. **In,** The Fundamentals of People Analytics with applications in R. Springer, Cham. Springer, Switzerland, 2023.

**25. IBM Corp:** IBM SPSS Statistics for Windows, Version 28.0. Armonk, NY: IBM Corp, 2022.

**26. Rooney NJ, Baker PE, Blackwell EJ, Walker MG, Mullan S, Saunders RA, Suzanne DE:** Run access, hutch size and time-of-day affect welfare-relevant behaviour and faecal corticosterone in pair-housed pet rabbits. *App Anim Behav Sci,* 162:105919, 2024. DOI: 10.1016/j.applanim.2023.105919

**27. Huang Y, Breda J, Savietto D, Debrusse AM, Bonnemere JM, Gidenne T, Combes S, Fortun-Lamothe L:** Effect of housing enrichment and type of flooring on the performance and behaviour of female rabbits. *World Rabbit Sci,* 29, 275-285, 2021. DOI: 10.4995/wrs.2021.15848

**28. Gidenne T, García J, Lebas F, Licois D:** Nutrition and feeding strategy: Interactions with pathology. **In,** De Blas C, Wiseman J (Eds): Nutrition of the Rabbit. 179-199, Wallingford: CAB International, 2010.

**29. DiVincenti L Jr, Rehrig A:** Social behavior of adult male New Zealand white rabbits housed in groups or pairs in the laboratory. *J Appl Anim Welf Sci,* 20 (1): 86-94, 2017. DOI: 10.1080/10888705.2016.1247352

**30. Ferreira VHB, Simoni A, Germain K, Leterrier C, Lansade L, Collin A, Mignon-Grasteau S, Le Bihan-Duval E, Guettier E, Leruste H, Calandreau L, Guesdon V:** Working for food is related to range use in free-range broiler chickens. *Sci Rep,* 11:6253, 2021. DOI: 10.1038/s41598-021-85867-2

**31. Lehner PN:** Sampling methods in behavior research. *Poult Sci,* 71, 643-649, 1992. DOI: 10.3382/ps.0710643

**32. Mykytowycz R, Rowley I:** Continuous observations of the activity of the wild rabbit during 24 hour periods. *CSIRO Wildlife Res,* 3, 26 -31, 1958. DOI:10.1071/CWR9580026