



TVT
Veterinary Association for Animal Welfare



Specialist information

**from the Committee for Humane Laboratory
Animal Housing (GV-SOLAS) and the
Laboratory Animal Working Group (TVT)**

Species-specific housing of laboratory rabbits

Status March 2020 – translated March 2021

**Autoren: Paulin Jirkof, Sabine Chourbaji, Sibylle Ott, Max Busch,
Philipp Dammann, Karin Finger-Baier, Susanne Gerold,
Andreas Haemisch, Anja Osterkamp, Günther R. Warncke (Guest)**

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1. Introduction

The domestic rabbit is descended from the European wild rabbit (*Oryctolagus cuniculus*) and belongs to the order of *Lagomorpha*.

Wild rabbits are territorial animals and live in colonies of small mixed-sex groups. These groups comprise an adult male, several females and numerous young animals (Görner and Hackethal 1988). Male offspring are ousted from the group when they reach sexual maturity. Hence, the kinship and solidarity between the males of a group are less than between the females. The females in a group are usually sisters or mothers with their own daughters. Aggressive conflicts are much more common between males than between females.

Domestic rabbits do not differ from wild rabbits in their behavioural repertoire (Kraft 1979), but some behaviours do differ in terms of their intensity and frequency. In terms of housing conditions, the marked, but strain-specific locomotor behaviour is particularly important. Characteristic movements of adult animals are their long hops and also chasing and flight movements in the regulation of hierarchical relationships. Spontaneous, intensive bursts of movement are a part of the developmental process in young animals.

A biological peculiarity of rabbits is that, shortly before parturition, they dig a nest, which they line with hay, grass, and their own abdominal fur. The mother only suckles her young once in 24 hours, after which the nest hole is closed again. Domestic rabbits also show this behaviour if they are given the opportunity. This structure is defended against other females.

2. Husbandry-relevant aspects of rabbit biology

Rabbits are social animals by nature, but also relatively aggressive. They need sufficient space for shared housing with one or more social partners including cage enrichment, such as hiding places and elevated areas.

The floor space and height of the cage must allow the animals to make at least one or, if possible, several hops, to lie outstretched and to sit upright without the ears touching the top of the cage (Council of Europe 2006). Rearing up on the hind legs ("sitting up and begging") is not explicitly required but should be allowed if possible. Rabbits use elevated areas as "lookouts". Appropriate space must be provided to take account of the greater need of younger animals for movement.

3. Forms of housing

Cages without furnishing lead to boredom and stereotypy (Council of Europe 2006).

Screens, hiding places and elevated areas are particularly suitable for structuring purposes, these three elements usually being provided by an opaque plastic board with a cavernous space underneath. Each hiding place must have at least one or two exits to minimise any aggressive conflicts and ensure that all animals have the opportunity to move around. Especially beneficial cage models are those in which the board for lying on is fixed to the rear long side of the cage, allowing longer end-to-end runs to be created when the partitions are removed, which the animals make intensive use of. The environment can be created far more diverse and interesting for the animals in relatively large enclosures or boxes for group

housing. Such group housing enclosures or boxes may be installed both directly on the floor and also elevated on underframes. This is generally referred to here as “floor housing”.

In these “floor housing” installations, a variety of materials can be used to simulate dens with several entrances and exits, which can be fenced off by a screen and fitted with a flat roof providing a suitable area for sitting and lying at the same time.

With all forms of group housing, it is essential to avoid the creation of blind alleys in which subordinate animals could get trapped.

When it comes to cage housing, removable partitions between individual cages allow a smooth transition from single housing to pair or group housing. Rabbits need feed with a high raw fibre content, preferably well-structured hay (for hygienic preparation of hay, see section 7 “Feeding and drinking”). Where possible, group floor housing on large areas is preferred, because the animals can move around here more. Rabbits housed in groups with installations that encouraged them to leap over the structures showed evidence of a higher rate of muscle metabolism (Gondret et al. 2009).

Suitable materials for cage installations are wood (gnawing opportunity, but lack of hygiene), stainless steel or plastic. The plastics chosen must not be gnawable and must not contain any soluble chemicals, such as softening agents.

Suitable flooring includes a variety of systems with perforations, bars or plastic-coated slats (no wire mesh!) and also closed floors. In the case of perforated floors, the perforation size or gap width must be commensurate with the age and size of the animals. Systems that have proved successful are plastic perforated floors, which protect the paws and are much quieter than steel sheets when rabbits make their characteristic warning thumps with their feet. All floors must be easy to clean and disinfect, smooth and non-slip and should not vibrate. Experience shows that rabbits prefer smooth floors to lie on and spaces littered down for defecation and micturition.

Floor areas do not have to be littered down, but it is practical at least to litter down the areas for excretions and for drinking.

3.1. Single housing

Rabbits should be housed in groups as far as possible. However, adult males and incompatible females must be housed singly because of the potential for aggressive conflicts.

Singly housed rabbits should at least have olfactory, visual and acoustic contact with conspecifics (Baumans 2005).

3.2. Group and pair housing

For animals that form groups, a social partner is not only the most enriching factor, but also the only factor in which the animals do not lose interest as a result of acclimatisation (Stauffacher 1995, Baumans 2005).

Young and female rabbits should be housed in stable harmonious groups. Appropriate group sizes range from 5 to 20 animals in enclosures or boxes of suitable dimensions.

Young animals, in particular, have a pronounced need for movement.

Early socialization of the animals (before the age of 3 – 4 months) minimises aggressive conflicts. Males must be separated before reaching sexual maturity. Group housing of animals from the same litter is especially beneficial. There is no evidence of increased stress or immunosuppression in subordinate group members. On the whole, animals in group housing are calmer.

Stable groups are desirable for breeding, but this is often not practicable because of increased aggressiveness among pregnant and suckling females. The temporary removal of pregnant females until the young are weaned at 7-10 weeks is generally tolerated.

If group housing is not possible, the animals should at least be kept in pairs (in practice two females) (Baumans 2005). Animals in pair housing spend about 90% of the time in a shared compartment of the cage, 20% of this time with physical contact (Huls 1991, Brooks et al. 1993).

Pair housing can reduce the variability of various parameters (e.g., growth rate), but animals must frequently be separated before reaching sexual maturity because of conflicts (Nevalainen et al. 2007). Since rabbits establish individual relationships, the replacement of animals must be avoided as far as possible when they are housed in pairs.

The castration of male animals facilitates housing in groups. In Germany's Animal Welfare Act (*Tierschutzgesetz* 2020 castration for housing reasons is expressly permitted (§6 (1) 5.). For experiments, intact animals are usually required, but group housing of castrated males would be possible for the antibody production frequently performed in rabbits.

3.3. Practicability of group housing

It must be considered that there is insufficient knowledge about how the various forms of housing impact different physiological variables (hormone levels, circulatory parameters, body fat, locomotor behaviour etc.). Equally unknown is the impact of a change from single to group housing or vice versa, even if no obvious disturbances are discernible. It is therefore recommended to plan studies in a way that at least avoids any such change shortly before or during the study. Study groups (including control groups) must be treated in the same way.

3.4. Breeding

Since rabbits visit their young only once a day in the wild, the female must be able to completely separate herself from them. This is achieved by means of a nest box attached to the outside of the cage or through the use of an open nest box (e.g., a type IV cage tray) in a double cage, so that the mother can withdraw into her own cage through an opening in the wall and the litter is not disturbed by the mother's movements. The nest box and suitable nest material (cellulose, if necessary, hay and straw) should be available at least 3-4 days before the young are born.

At the age of 2 weeks, the young begin to leave the nest and try to suckle as often as possible. The mother must now be able to withdraw so that she is not accessible to her young. An elevated space should be provided for this purpose and/or a hole high up in the wall that leads into the adjacent cage.

The litter siblings should be weaned at the age of about 7 weeks, depending on the breed-specific maturity, and housed together until the onset of sexual maturity, which is likewise highly breed-specific (from about 2 months, NZW 20 weeks). It is recommended that the mother is removed and the young stay in the breeding cage.

4. Space requirements

Even if the recommendations for certain spaces and group sizes are ultimately political decisions, there are good scientific reasons for specifying minimum space requirements that provide animals with sufficient opportunities to move around and to retreat and also allow suitable enrichment.

Group housing in boxes or enclosures is preferred. For practical reasons, the enclosures should have greater width than depth. There must be a sufficient number of hideaways and elevated areas.

If rabbits are housed in cages, they should be large enough for the animals to lie outstretched on one side (not diagonally) and to take several hops one after the other.

ETS 123 requires a minimum floor space of 3500 cm² for an individual animal or pair or a mother animal weighing less than 3 kg bodyweight (bw) with a litter and an additional separate nest box of 1000 cm² (Table 1-2). Mother animals weighing 3-5 kg are allowed 4200 cm², plus a nest box of 1200 cm².

The minimum height is 45 cm for animals of less than 5 kg bw.

Animals over 5 kg bw require cage space of 5400 cm², with a height of 60 cm.

Young animals require a relatively large amount of space because of their need for exercise. The space provided should be guided by the end weight of the animals. After litter siblings have been weaned, they should remain together in their rearing cage for as long as possible. For young animals aged less than 10 weeks, a minimum space of 4000 cm² is required, with 800 cm² provided for each animal. The cage height should be at least 40 cm (Table 3).

From the age of 10 weeks, the animals should be provided with an elevated area that can be used for hiding, lying and also as a lookout. This board should measure 55 x 25 cm for animals weighing less than 3 kg and 55 x 30 cm for animals weighing up to 5 kg and must be installed at a height of about 25 cm (Table 4).

The elevated area should not cover more than 40% of the floor space.

If there are compelling reasons that make it impossible to provide an elevated area, the cage floor space should be increased by 33% in the case of single housing and 60% in the case of pair housing.

5. Enrichment

The European convention of 2006 expressly calls for various enrichment measures, measures include the opportunity for social interaction, space, structures and not least the possibility for

the animal to exert a certain control over the environment (Baumans 2005, European parliament 2010).

While the requirements stipulated in Directive 2010/63/EU Annex III (European parliament 2010) are worded in general terms, they are extensive. Measures such as extending “the range of activities available to the animals and increase their coping activities including physical exercise, foraging, manipulative and cognitive activities, as appropriate to the species” or adapting them to the “individual needs of the animals concerned“ are only implemented to a certain degree today at best.

Rabbits should be able to satisfy their basic needs, such as social contacts, typical locomotor patterns (hopping, sitting upright), resting, hiding, exploration and gnawing, and also make use of elevated areas to observe their surroundings (Gerold 1993, Baumans 2005, Council of Europe 2006). According to Council of Europe (2006), rabbits do not have to be able to sit upright on the elevated areas – but they do this if they have the opportunity. Young rabbits from the age of 10 weeks in particular need sufficient space and opportunities for activity.

Aside from when it is used for running and playing, extended floor space is only used when it is suitably structured. If rabbits are given the opportunity, they keep areas for excretion, resting and feeding separate. It is a good idea to leave some old bedding material in the excretion area, unless hygiene requirements do not allow this.

Housing in a cage or box does not allow the animals to dig and build burrows, but pregnant rabbits must be provided with the possibility for building nests.

Activity options available, bearing in mind the relevant hygiene conditions, include straw, hay and gnawing sticks. Gnawing sticks should preferably be of soft wood (e.g., poplar or aspen) to prevent inflammation of the alveolar sockets. Suitable gnawing sticks can have a preventive effect against gingival bleeding and inflammation (Princz et al., 2008). The use of steel rattles is discouraged from, because these can lead to tooth fractures and injuries to the mouth/lip region of the animals (Boehmer 2011, Warncke and Kluge 2015).

Rabbits enjoy gnawing on wooden sticks jammed between the wire bars of the cage. They do not slip out of place, even when gnawed intensively, and cannot become soiled.

Supplemental food (carrots or apples) is suitable as enrichment in principle, but are prohibited in most laboratory animal facilities for reasons of hygiene, diet and also standardization. Distributing food over the floor to provide the animals with the opportunity for foraging is probably more practicable, at least in the case of floor housing, provided it is not forbidden by hygiene rules (Baumans 2005).

Since rabbits quickly lose interest in new objects, the enrichment provided should be varied where possible (Young 2003).

In principle, all enrichment measures must be constantly evaluated.

Contact with humans (handling, training, socialization) also serves as a substantial enrichment element, improving the cognitive skills of the rabbits and allowing positive interaction between the animals and people involved (Baumans 2005). Good handling and familiarization of the

animals with the conditions of the experiment can reduce variation in experimental results (Verwer 2009).

The fear that rabbits could become shy if greater space and opportunities for hiding are provided, has not been confirmed.

On the subject of hideaways and elevated areas for lying and use as lookouts, see section 3. Forms of housing.

6. Physical environment

6.1. Light conditions

In the wild, rabbits are mostly crepuscular and nocturnal animals, but may also leave their burrows during the day (Görner and Hackethal 1988).

In the laboratory animal facility, the photoperiods must be regulated (usually 12/12h). The use of twilight periods is contentious and only permitted if the experimental conditions do not militate against it.

Light intensity should be kept relatively low. Albino rabbits in particular must be protected from high light intensity levels.

The possibility of a relatively dark place of retreat must be provided.

Windows with natural light are only acceptable if the experimental conditions permit this and the photoperiod is not extended as a result.

6.2. Climate

The values applicable for ventilation are the standard values used in laboratory animal facilities (15-20 air changes/hour, or 8-10 with low stocking density, no draughts). Rabbits should be kept at cooler temperatures on average than small laboratory rodents in view of their dense fur and limited thermoregulation via the ears. Ambient temperature should lie between 15°C and max. 21°C. It is absolutely essential to protect the animals from overheating.

Relative humidity should be 45–65%.

6.3. Noise

Rabbits are sensitive to sounds between 2 and 16 kHz and can hear sounds up to 42 kHz (Heffner 1980). Noise levels in the sensitive range must be kept to a minimum. Ultrasound, which may be emitted as secondary noise by washing machines, air conditioning systems, computers and so on, can cause stress in animals. Sudden noise in particular, e.g. when entering a room, must be avoided. The radio which is frequently used to reduce the startle response to noises can cause stress itself at high sound levels (O'Donoghue 1993). In principle, noise exposure in animal rooms should be less than 60 dB at resting times and less than 70 dB during working hours. Noise peaks must not exceed 85 dB. Alarm systems in the animal facility should not be audible for animals.

Table 5 provides a summary of the reference values for environmental factors in the animal room.

7. Fütterung und Tränke

Ad-libitum feeding leads easily to overweight, especially in animals that are housed singly and therefore exercise less. A restrictive administration of pelleted feed (not loose raw feed) is to be preferred. In this case, it is better to feed the animals in the afternoon rather than the morning (Krohn 1999). Experience shows that restrictive feeding on concentrated feed is also possible in group housing, even if the animals cannot feed at the same time. The animals do not prevent each other from feeding in a sustained manner. Any hay should be made available *ad libitum*, and regular weight checks are recommended. A separate booklet is available on the feeding of rabbits (Warncke and Kluge 2015).

All materials brought into rabbit housing facilities behind barriers should in principle be sterilized. However, raw feed loses its structure as a result of autoclaving or pelleting (“hay cobs”), making it practically useless both physiologically and as an enrichment factor. Depending on the level of hygiene, consideration must be given to whether heat treatment of the raw feed (80 °C/4h) is inadequate; irradiation is also possible as a means of sterilization, and hay treated in this way is also commercially available. Good hay is very important, especially in breeding and for young animals.

While the use of watering bottles is still widespread in cage housing, automated watering systems are usually used in floor housing. These systems generally require more time and effort for monitoring (blockages, microbial contamination) than bottles.

When automated watering systems are used, the containers and tubing system must be appropriately treated at regular intervals to ensure adequate hygiene. Biofilms and other deposits in pressure-resistant tubes made of stainless-steel (V2A) can be effectively removed by mechanical means using shock waves (pulse method) (Warncke, oral communication, 2019). The watering system can be disinfected using acetic or citric acid (0.5%) or special disinfectants. After chemical disinfection, very thorough rinsing is always necessary (Hagelschuer 2016). The complete watering system should be rinsed with water at least twice a week. The drinker nipples must be checked daily to ensure there are no blockages.

8. Individual identification

In group housing, individual unalterable identification of the animals is usually necessary.

Non-invasive, non-permanent methods are coat markings, e.g., using colours or shaving.

Invasive methods are transponders, tattoos and ear tags. The implantation of transponders (microchipping) is considered the method of choice today; the stress caused by implantation of the chip is minimal in animals of this size, while readouts are reliable and simple. If tattooing is used, brief anaesthesia is strongly advised. Ear tags are not recommended because of the pain involved in the procedure and the risk of injury.

9. Diseases

Floors that are not perforated predispose to re-infections with coccidia, while perforated floors ensure that invasive stages are barely accessible. Under unfavourable conditions, coccidia can cause severe, life-threatening diarrhoea in young animals (aged up to 12 weeks), whereas estimations as to the seriousness of coccidia in older rabbits differ (Kühn et al. 1995).

Coccidia management varies widely among facilities. It ranges from prophylaxis through treatment based on findings to non-treatment despite invasion in young animals as long as they remain asymptomatic.

While it is practically impossible to eliminate coccidia through medical treatment, this is not necessarily a problem with group floor housing. With group and/or floor housing there are also no particular hygiene problems in other areas (e.g. drinking water). Nevertheless, it is recommended that group floor housing undergo frequent monitoring for microorganisms including parasites.

If there are frequent conflicts in a group, bite injuries may occur, leading to abscesses. And if adjacent groups are not completely separated because the mesh widths of the partitions are too wide, bite injuries may also be inflicted by animals from an adjacent group especially on unwary young animals as they rest their extremities or ears on the mesh of the partition or even poke them through the mesh (Gerold and Iglauer 1994).

With floor housing, paw injuries may occur on old perforated stainless-steel sheets or very rough floors. Wet floors predispose the animals to such injuries (Warncke, oral communication, 2019). On the other hand, floors that are too smooth may cause rabbits to develop postural problems (splayed front legs, authors' observations).

Both the incisors and the molars may grow too long in the event of a malalignment and hamper feeding as a result. Overgrowth of the molars may lead to the formation of a bridge that entraps the tongue. For this reason, the molars must be examined, e.g. using an otoscope, at the latest when the body weight is checked (Boehmer 2011).

Epidemics of myxomatosis and rabbit haemorrhagic disease (RHD) are repeatedly occurring in wild and domestic rabbits. These diseases are also a danger to laboratory animal populations. Feeding on fresh hay and private housing of rabbits pose an additional risk. Vaccination of rabbit populations is recommended as a matter of course (Myxo-RHD combination annually, possibly also with RHD2). If an experiment involves technical procedures that militate against regular vaccination, a sufficient number of vaccine doses should be stockpiled in the event of emergency vaccinations becoming necessary.

10. Tables

Tables 1-4: from Directive 2010/63/EU (European Union 2010): minimum dimensions for cages.

Table 1: Rabbits over 10 weeks of age

Final body weight (kg)	Minimum floor area for one or two socially harmonious animals (cm ²)	Minimum height (cm)
less than 3	3500	45
from 3 to 5	4200	45
over 5	5400	60

Table 2: Doe with litter

Doe weight (kg)	Minimum floor area (cm ²)	Addition for nest boxes (cm ²)	Minimum height (cm)
less than 3	3500	1000	45
from 3 to 5	4200	1200	45
over 5	5400	1400	60

Table 3: Rabbits less than 10 weeks of age

Age	Minimum floor area (cm ²)	Minimum floor area / animal (cm ²)	Minimum height (cm)
Weaning to 7 weeks	4000	800	40
From 8 to 10 weeks	4000	1200	40

Table 4: Optimum dimensions for raised areas for sitting and lying

Age (weeks)	Final body weight (kg)	Optimum size (cm x cm)	Optimum height from cage floor (cm)
over 10	less than 3	55 x 25	25
	from 3 to 5	55 x 30	25
	over 5	60 x 35	30

Table 5: Reference values for environmental factors in rabbit housing rooms

Air change / hour	15 to 20*
Temperature °C	15 to 21*
Rel. humidity %	≥ 45 %*
Noise dB	< 60 [#]

*Council of Europe 2006

Heine 1998

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