

## PREFERENCE OF RABBIT DOES AMONG DIFFERENT NEST MATERIALS

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**Abstract:** Nest quality is important for the survival of new-born rabbits. Nesting material in rabbit farms generally consists of wood shavings, which is completely different from the dry grass used by the European wild rabbit (*Oryctolagus cuniculus*). The aim of the experiments was to examine which nest materials are preferred by rabbit does when building their nest. In experiment 1, the choice of multiparous rabbit does (n=37) among nest boxes bedded with different nesting materials was monitored. In each pen (1.0×1.83 m) 1 doe and 4 nest boxes (0.37×0.23×0.31 m) with different nest materials (meadow hay [H], wheat straw [S], fine fibre material [Lignocel®, L] or wood shavings [W]) were placed 3 days before the expected parturition (gestation length is about 31 d in the Pannon White breed). Some 48.6% of the does kindled in nest boxes that contained pure materials (L: 40.5%, S: 5.4%, H: 2.7%), and 51.3% of the does kindled in nest boxes where the nest materials of different nest boxes were mixed by the does (S with L: 21.5%, S with L and H: 5.4%, W with L: 8.1%, L with H and S: 5.4%). Does preferred kindling in the nest box bedded with L, and most of them refused the nest box with W. In experiment 2/a (n=32 does) and 2/b (n=25 does), each pen (1×0.91 m) was equipped with 3 and 2 hay racks and filled with H, S or L, and H or S, respectively. The experiments lasted from the 27<sup>th</sup> day of pregnancy until the day of parturition and 24-h video recordings (10 does/experiment) were evaluated throughout the experiment. The events of carrying the nest materials from the hay racks were registered. In experiment 2/a, the frequency of nest material carrying was highest on the day of parturition. The preferred nest material was L (compared to H and S) on each experimental day except day 30 of pregnancy. At the day of kindling, 87.5, 6.3 and 6.3% of the nests contained pure L, mixed L-H and L-S, respectively. In experiment 2/b, the frequency of nest material carrying (mostly S) was highest on the day of parturition, and on days 27 and 30 of pregnancy. More does built nests with only S (72%) than H (16%), and in 12% of the cases the S and H were mixed. For the purpose of nest building, material S was the most frequently used (72%) compared to other possibilities (H: 16%, S-H: 12%). It can be concluded that rabbit does showed the following clear preferences for specific nest building materials: L>S>H>W.

**Key Words:** rabbit does, nest material, hay rack, preference, parturition.

## INTRODUCTION

Pre-weaning mortality of rabbit kits occurs to a large extent during the first 12 h after parturition (54%) (Gualterio *et al.*, 1988) and until the end of the 1<sup>st</sup> wk (70%) (Partridge *et al.*, 1981). On farms, nest quality is important for the survival of new-born rabbits (Zarrow *et al.*, 1963; Delaveau, 1982; Verga *et al.*, 1987; Borka and Ádám, 1988; Matics *et al.*, 2002), as the main role of the nest and nesting material is to protect the sensitive hairless kits from cold (Verga *et al.*, 1978; Baumans, 2005; Blumetto *et al.*, 2010). An adequate microclimate in the nest box is essential for the kits (Mahmoud and Tulip, 2004), as hypothermia is the second highest frequent cause of death (17%) during the postnatal period (Rossel, 2005). European wild rabbit does (*Oryctolagus cuniculus*) leave their kits alone after kindling and after the brief daily nursings (Hudson and Distel, 1982; Rödel *et al.*, 2012; González-Mariscal *et al.*, 2013). Therefore, the entrance of the hole is closed by does suddenly after parturition in nature (Deutsch, 1957; Lloyd and McCowan, 1968; Hudson and Distel, 1982; Broekhuizen and Mulder, 1983). The kits eat from the nest material (Hudson *et al.*, 1996).

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In most rabbit farms, wood shavings are commonly placed into the nest boxes because it is cheap and easy to purchase. European wild rabbits, however, mainly use dry grass to build their nest in the warren (Hudson *et al.*, 1996). Straw and hay are similar to the materials which are used in nature (grass and plant material, Hudson *et al.*, 2000), but wood shavings and dry grass have very different characteristics. Rabbit does are not able to build a proper nest from wood shavings (Deutsch, 1957, Hudson *et al.*, 1996), as they are composed of small pieces. Efficient raising of kits requires adequate nest material and fur (pulled from the body of the rabbit does) (Zarrow *et al.*, 1963, Verga 1978). According to some experiments (Farooq *et al.*, 1963; González-Mariscal *et al.*, 1994; González-Mariscal and Rosenblatt, 1996; González-Mariscal *et al.*, 1998; Negatu and McNitt, 2002), nest building behaviour is under hormonal control. During the last third of the gestation period, the levels of estradiol and progesterone are high and nest-building begins by digging the burrow (with a peak between days 25 and 27 of pregnancy). When the progesterone level is withdrawn (at about 3 d before parturition), the straw-carrying behaviour which is the second stage of nest building begins (González-Mariscal *et al.*, 1994, 1996). Hair-plucking (preceded by the loosening of body hair) occurs from the day of parturition into lactation days 3-4, when progesterone levels are negligible and high levels of testosterone and prolactin are observed (González-Mariscal, 2004).

A number of different nest materials were tested in several studies; barley straw by Blumetto *et al.* (2010), rice straw by Mahmoud and Tulip (2004), and Tifton hay and chopped newspaper by Oliveria *et al.* (2014).

In commercial rabbit farms, the choice of nesting material depends on the country and the possibilities available. The commonly used materials are wood shavings, hay and straw (possibly also wool or cotton waste) (Blumetto *et al.*, 2010). Furthermore, the examination of another nest material from wood, called Lignocel® could be interesting, as it is widely used and popular for pet rabbits. The aim of the experiments was to examine if the rabbit does showed preference among the available materials (wood shavings, hay, straw or Lignocel®) in the nest building process. The materials were selected either because they are commonly used in rabbit farms (wood shaving) and for pet animals (Lignocel®), or because they resemble the material available in nature (hay, straw).

## MATERIALS AND METHODS

### *Animals and experimental design*

The preferences of rabbit does among different nest materials were examined in 3 independent experiments. The experiments were conducted at the nucleus farm of the Kaposvár University with multiparous Pannon White rabbit does between the 3<sup>rd</sup> and 5<sup>th</sup> parturition. On our farm, wood shavings are the commonly used nest material, so all does and their kits were born in nest boxes bedded with wood-shavings until the experiment. The room temperature was 15-18°C and the lighting period applied was 16L/8D. The rabbit does received commercial pellet *ad libitum* and water was available from nipple drinkers. In all experiments the suckling mortality was registered from 0-21 d of lactation.

### *Experiment 1*

Each doe was housed in a 1.0×1.83 m sized open top pen (n=37) equipped with 4 nest boxes (0.37×0.23 m and 0.31 m height) with 7 cm thick layer of different nesting materials: meadow hay (H), width: 1-6 mm, thickness: 0.1-2 mm, length: 240-400 mm; wheat straw (S), width: 2-7 mm, thickness: 2-5 mm, length: 150-300 mm; wood shavings (W) or long, thin fibrous wooden material (Lignocel® [nesting small], J. Rettenmaier & Söhne GmbH, L), width: 2 mm, thickness: 0.2 mm, length: 250-420 mm, 90 L=3 kg. The nest boxes were placed in the pens in random order (Figure 1). The boxes were checked daily and filled up with nesting materials when necessary.

Does were transferred to the experimental pens on the 27<sup>th</sup> day of pregnancy, so the available time for building the nest was at least 3 d (the length of gestation is around 31 d in the Pannon White breed). For each doe it was recorded which nest box was chosen for kindling and also if its nest material was pure material or mixed (when 10% or more nesting material originated from another nest box).



Figure 1: Pen with four nest boxes, and the nest materials in the nest boxes; 1=Lignocel®, 2=meadow hay, 3=wood shavings, 4=wheat straw.

### Experiment 2

Each doe was housed in a 1.0×0.91 m sized open top pen equipped with an empty nest box (0.37×0.23 m and 0.31 m height) and with 3 or 2 hay racks (0.30×0.125×0.40 m) filled with 400 g nesting materials: H, S or L (in random order) in experiment 2/a (n=32 does), or with H or S in experiment 2/b (n=25 does), respectively. The hay racks were made of wire mesh (hole size: 5.0×25.0 cm; Figure 2).

Both experiments (2/a and 2/b) started on the 27<sup>th</sup> day of pregnancy. During the preference test, the nesting material choice of the rabbit doe (for building a nest) was continuously recorded. In both experiments 24-h video recordings were made (10 out of 32 rabbit does in experiment 2a and 10 out of 25 rabbit does in experiment 2b) with infrared cameras (KPC-S50 NV, B/W CCD) and these recordings were assessed using a special software (GeoVision GV-800 System, Multicam Surveillance System 6.1). Evaluation of the recordings began on the 27<sup>th</sup> day of pregnancy at 9:15 am on the 1<sup>st</sup> d, and at 6:00 am subsequently (light switched on) until 6:00 am the next day. The last day's observation ended at the moment of parturition. Every event of nest material carrying from the hay racks to the nest box was recorded and the average number of occasions/h were calculated for each day. One nest material carrying event comprised collecting nest material in the mouth, taking it into the nest box and depositing it there, and then exiting the nest box. Carrying events from the floor and (pulling out and replacing the nest material) from the nest box was also recorded.

The nesting materials that were found in the nest box on the day of parturition were also recorded. According to the visual estimation, the nests which contained a minimum 10% of other nest material were assessed as mixed nests.

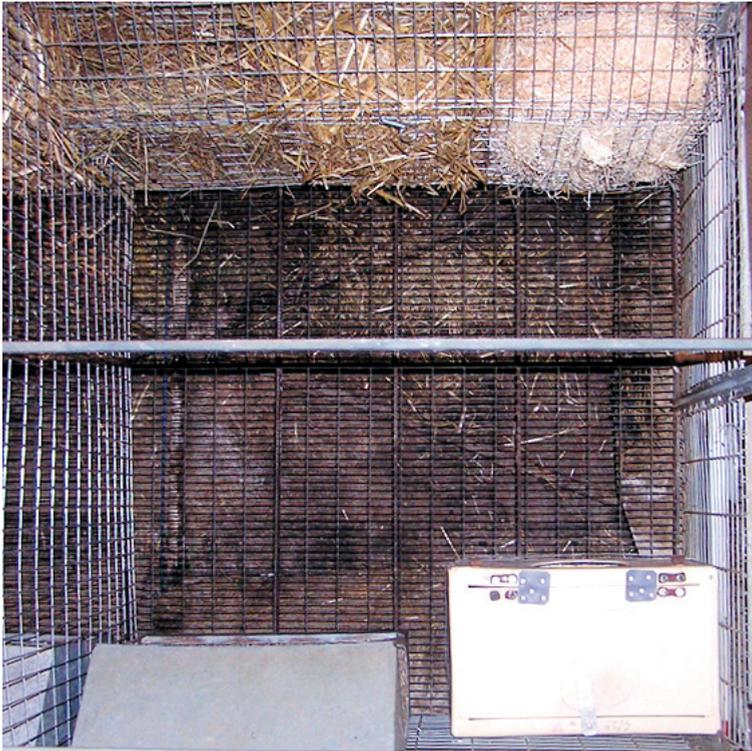


Figure 2: Pen with 3 hay racks filled with meadow hay, wheat straw and Lignocel®, respectively.

### **Statistical analysis**

The choice of does among nest boxes with different materials (Experiment 1) was evaluated by Likelihood Ratio test.

The number of carrying events/hour of nest materials from hay racks or floor and nest box were evaluated by one-factor ANOVA using the following model:  $Y_{ij} = \mu + N_i + e_{ij}$  or  $Y_{ij} = \mu + D_i + e_{ij}$ , where  $Y_{ij}$ : observation  $j$  in treatment  $i$ ;  $\mu$ : general mean;  $N_i$ : the fixed effect of the nest materials (Experiment 2/a:  $i=1-3$ : from the hay rack; 4: from the floor; 5: from the nest box; Experiment 2/b:  $i=1-2$ : from the hay rack; 3: from the floor; 4: from the nest box);  $D_i$ : the fixed effect of day (Experiment 2/a and 2/b:  $i=1-5$ );  $e_{ij}$ : random error.

The choices of does among the different nest materials (Experiment 2/a and 2/b) were evaluated by Likelihood Ratio test.

All statistical analyses were conducted using the SPSS 10.0 software package.

## **RESULTS**

The average kit mortality rates were 14.7, 25.9 and 11.6% in experiments 1, 2a and 2b, respectively. Due to the low number of nests built from nest material other than Lignocel®, the mortality of kits in case of different nest materials is not comparable.

### **Experiment 1**

The rabbit does showed significant preference among nesting materials (Table 1). Most rabbit does kindled in nest boxes bedded with pure L. Fewer does chose the nest boxes with H or S, and none of them kindled into the nest box

**Table 1:** Preference of rabbit does among nest boxes bedded with different nest materials in Experiment 1.

Nest material	Choice of nest material (%)
n	37
Nests from pure materials	
Lignocel®	40.5 <sup>d</sup>
Straw	5.4 <sup>ab</sup>
Hay	2.7 <sup>ab</sup>
Wood shavings	0.0 <sup>a</sup>
Nests from mixed materials	
Straw and at least 10% Lignocel®	21.6 <sup>cd</sup>
Hay and at least 10% Lignocel®	10.8 <sup>bc</sup>
Wood shavings and at least 10% Lignocel®	8.1 <sup>abc</sup>
Straw and at least 10-10% Lignocel® and hay	5.4 <sup>ab</sup>
Lignocel® and at least 10-10% hay and straw	5.4 <sup>ab</sup>

Lignocel®: is a fine, long fibre material made of wood.

<sup>a,b,c,d</sup> Proportions marked with different letters differ significantly ( $P < 0.001$ ).

containing only W. In 51.4% of cases, rabbit does also collected nesting material from other nest boxes. L was found in each mixed nest: L was partly carried into the boxes that contained S or H, but in other cases S or H were carried into the boxes that contained L. In 2 nest boxes 3 nesting materials (S, L and H) were found. Being a highly preferred material, L was found in 91.9% of the nest boxes (pure or mixed). It was observed that rabbit does consumed from H. Only 8.1% of the nests contained W, and all of them were mixed with other materials. It seems that W is not preferred material for building suitable nests. Hair pulling events were observed especially on the day of parturition.

### Experiment 2/a

Significant differences were recorded for the nest material carrying events, depending on the nesting materials, on every day except on day 30 of pregnancy (Table 2). The carrying events from L hay rack were more frequent than from H or S racks on days 27, 28 and 30 of pregnancy. Some amount of nest material (especially L) piled up on the floor and it was also carried to the nest box. In several cases, rabbit does pulled out and replaced the nesting materials from the nest box. Over the whole experimental period, the nest material carrying events were significantly more frequent for L than for H and S. Carrying nest material from the floor also mainly targeted L. Compared to other periods, L was more frequently carried on days 27 and 28 of pregnancy and on the day of the parturition. The nest carrying occasions were significantly higher only on the day of parturition from the floor and from the nest box than on other days (Table 2).

**Table 2:** Number of nest carrying events/hour from 27<sup>th</sup> day of pregnancy until parturition in Experiment 2/a.

Days of gestation	Frequency of nest material carrying, events/h					SE	P-value
	From hay rack			From the floor	From nest box		
	Lignocel®	Hay	Straw				
27	0.52 <sup>9</sup> <sup>ab</sup>	0.007 <sup>aA</sup>	0.011 <sup>aA</sup>	0.013 <sup>aA</sup>	0.070 <sup>aA</sup>	0.025	<0.001
28	0.307 <sup>bb</sup>	0.012 <sup>abA</sup>	0.019 <sup>abA</sup>	0.228 <sup>bb</sup>	0.080 <sup>aA</sup>	0.019	<0.001
29	0.042 <sup>ab</sup>	0.001 <sup>aA</sup>	0.005 <sup>aA</sup>	0.005 <sup>aA</sup>	0.068 <sup>ab</sup>	0.006	<0.001
30	0.000 <sup>aA</sup>	0.000 <sup>aA</sup>	0.026 <sup>ba</sup>	0.096 <sup>abb</sup>	0.000 <sup>aA</sup>	0.007	<0.001
Day of parturition	0.378 <sup>bb</sup>	0.023 <sup>ba</sup>	0.000 <sup>aA</sup>	0.468 <sup>bb</sup>	0.478 <sup>bb</sup>	0.041	<0.001
SE	0.034	0.002	0.002	0.028	0.029	-	-
P-value	<0.001	0.001	0.001	<0.001	<0.001	-	-

Lignocel®: is a fine, long fibre material made of wood.

<sup>A,B</sup>Different superscripts within a row show significant differences ( $P < 0.001$ ).

<sup>a,b</sup>Different superscripts within a column show significant differences ( $P < 0.001$ ).

SE: standard error of the mean.

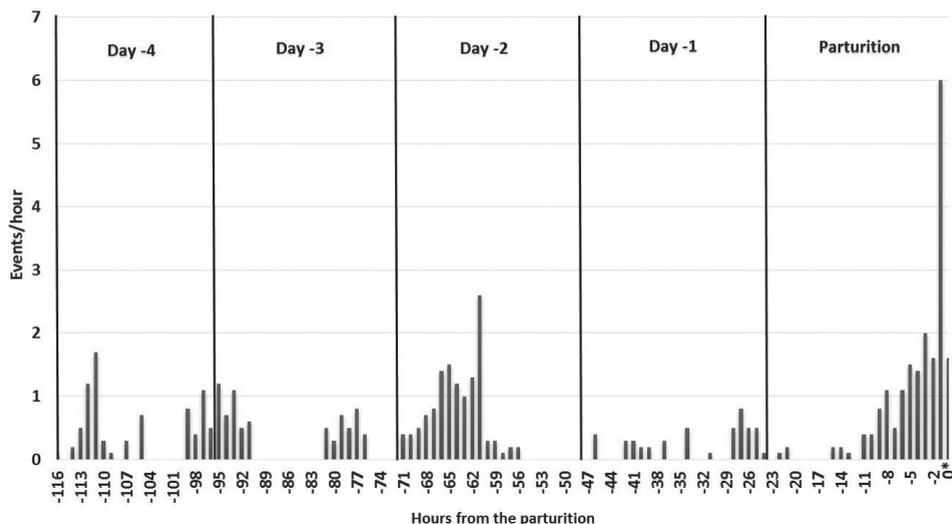


Figure 3: Frequency of nest material carrying in Experiment 2/a back from the parturition, events/h. 0\*: Time of parturition.

The frequency of nest material carrying events was variable throughout the experimental period. Higher frequencies (events/hours) were recorded in the late afternoon and early evening, but the highest was registered at some hours before parturition (Figure 3).

Significant differences were found in nesting materials in the completely built nest boxes after parturition (Table 3). Each nest contained L, so it was greatly preferred material. Only 12.6% of the nests contained H or S, but they were mixed with L. L was mixed with hay or straw with the same frequency. No nests made of pure straw and hay without Lignocel®, or hay mixed with straw without Lignocel®, were observed.

Table 3: Presence of carried nest materials in the nest boxes after parturition in Experiment 2/a.

Nest materials	Choice of nest material (%)
	Lignocel <sup>®</sup> , hay, straw
n (doe)	32
Nests from pure materials	
Lignocel <sup>®</sup>	87.5 <sup>b</sup>
Hay	0.0 <sup>a</sup>
Straw	0.0 <sup>a</sup>
Nests from mixed materials	
Lignocel <sup>®</sup> and at least 10% hay	6.3 <sup>a</sup>
Lignocel <sup>®</sup> and at least 10% straw	6.3 <sup>a</sup>
Hay and at least 10% straw	0.0
Straw and at least 10% hay	0.0
P-value	< 0.001

<sup>1</sup>Lignocel<sup>®</sup>: is a fine, long fibre material made of wood;

<sup>a,b</sup> Means with different letters differ significantly ( $P < 0.001$ ).

### Experiment 2/b

The number of nest material carrying events/hour was very low till the day of parturition (Table 4; Figure 4).

Generally, S was carried significantly more frequently, and on day of parturition the carrying events of S was 15 times more than that of H (Table 4). Scattered nest materials were also collected from the floor.

Among the completely built nests, the occurrence of the pure S material was 4.5 times higher than H (Table 5). In 12% of cases, rabbit does built nests with mixed materials.

## DISCUSSION

Although the suckling mortalities in this experiments are not comparable, according to Farkas *et al.* (2015) the nest material did not influence the mortality of kits in our present study.

**Table 4:** Number of nest carrying occasions/hour from 27<sup>th</sup> day of pregnancy until the parturition in Experiment 2/b.

Days of gestation	Frequency of nest material carrying, occasions/h				SE	P-value
	From hay rack		From the floor	From nest box		
	Hay	Straw				
27	0.018 <sup>aA</sup>	0.135 <sup>aB</sup>	0.000 <sup>aA</sup>	0.000 <sup>A</sup>	0.013	<0.001
28	0.006 <sup>aB</sup>	0.000 <sup>aA</sup>	0.000 <sup>aA</sup>	0.000 <sup>A</sup>	0.001	<0.001
29	0.000 <sup>a</sup>	0.000 <sup>a</sup>	0.000 <sup>a</sup>	0.000	0.000	-
30	0.020 <sup>aA</sup>	0.197 <sup>aB</sup>	0.045 <sup>aA</sup>	0.001 <sup>A</sup>	0.015	<0.001
Day of parturition	0.381 <sup>bA</sup>	5.597 <sup>bB</sup>	0.414 <sup>bA</sup>	0.000 <sup>A</sup>	0.188	0.008
SE	0.014	0.182	0.021	0.000	-	-
P-value	<0.001	<0.001	<0.001	0.089	-	-

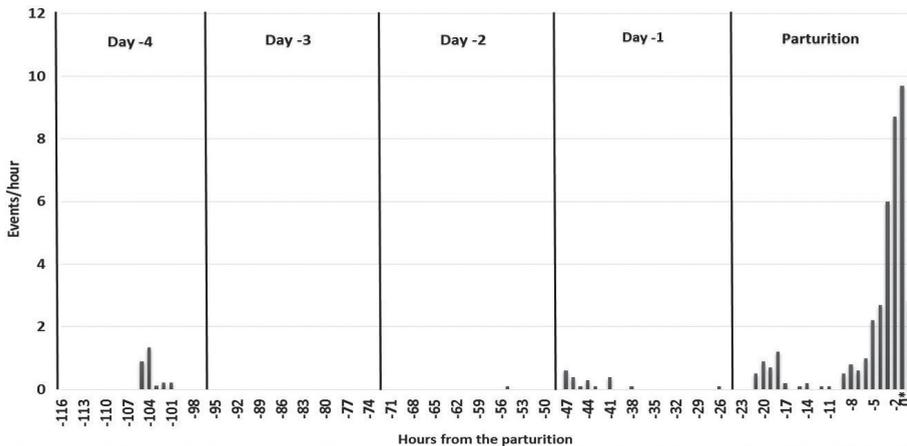
<sup>A,B</sup>: different superscripts within a row show significant differences ( $P < 0.001$ ).

<sup>a,b</sup>: different superscripts within a column show significant differences ( $P < 0.001$ ).

SE: standard error of the mean.

Rabbit does chose L most frequently when it was available. The high preference for L is unexpected because, compared to L, H is more similar to the dry grass which is used by European wild rabbit (Hudson *et al.*, 2000). In line with our findings, Gedeon *et al.* (2010) found counterintuitive results connected to the nesting material preference of European ground squirrels. Contrary to expectation, the squirrels preferred fresh nest material compared to the dry material, which could be explained by its better insulation property. In our study, rabbit does did not choose the nest boxes bedded with W, which is generally used in commercial rabbit farms. A similar observation was made by Blumetto *et al.* (2010), where 88.7% of does chose S, and only 11.3% of them kindled into nest boxes with W. The reason could be that the does are unable to build a suitable nest when they can use only W, as reported by Deutsch (1957) and Hudson *et al.* (1996). The does kindled into nest boxes containing W only if the nest also contained some other materials. These results agree with the observation of Blumetto *et al.* (2010), who found that most does built a nest if they carried and mixed S with W.

The high preference of L might be explained by its fibrous surface, as it was not so smooth as the S and H, so the does got well tangled and easy to carry material, and it was easier to build a nest from it. The rabbits were able to hold it in their mouth and carry large amounts into the nest box. Denenberg *et al.* (1963) also used a long, thin wooden fibre nest material which was similar to L, and was easy to carry. It was more difficult for the does to collect



**Figure 4:** Frequency of nest material carrying in Experiment 2/b back from the parturition, events/h. 0\*: Time of parturition.

**Table 5:** Presence of carried nest materials in the nest boxes after parturition in Experiment 2/b.

Nest materials	Choice of nest material (%)
	Hay, straw
n (doe)	25
Nests from pure materials	
Hay	16 <sup>a</sup>
Straw	72 <sup>b</sup>
Nests from mixed materials	
Hay and at least 10% straw	4 <sup>a</sup>
Straw and at least 10% hay	8 <sup>a</sup>
P-value	< 0.001

<sup>a,b</sup> Means with different letters differ significantly ( $P < 0.001$ ).

In experiment 2/a, most rabbit does used pure L to build the nest, in a trend similar to that of experiment 1. None of the rabbit does used pure H or S to construct nests, although they are similar to the dry grasses used by European wild rabbit (Hudson *et al.*, 2000). According to González-Mariscal *et al.* (1994) for the first 25-26 d of pregnancy the rabbit does only ate from the straw. As parturition approached, pregnant does handled the same straw as nesting material rather than as food. It may be one of the explanations for these results, especially because exp. 2/b shows that the rabbit does could build their nests from these materials.

Nest material carrying activity was the highest in late afternoon and early evening, and on the day of parturition, which is typical of rabbit behaviour (Deutsch, 1957; Verga *et al.*, 1978; González-Mariscal *et al.*, 1994). No explanation can be given for the difference in the material carrying activity between experiments 2a and 2b.

## CONCLUSIONS

Contrary to our expectation, the rabbit does did not frequently use the hay and straw for nest building, although these materials are generally considered to be natural and optimal from the animal welfare viewpoint. Moreover, the commonly used wood shavings were the least preferred nesting material, which suggests a possible change in the generally used nest material in large scale rabbit farms. However, further research is needed related to the costs and kit survival aspects based on different nest materials.

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