

# **THESES OF DOCTORAL (PhD) DISSERTATION**

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## **EXAMINATION OF PRODUCTION AND BEHAVIOUR OF RABBIT DOES AND GROWING RABBITS HOUSED IN DIFFERENT CONDITIONS**

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# 1. ANTECEDENTS OF THE RESEARCH, OBJECTIVES

There is an animal welfare pressure from West-Europe to accept regulations in the European Union based on antropomorphic ideas and emotions. If these regulations will be valid, that could mean the end of the European rabbit breeding (SZENDRŐ, 2017). Consequently the task is clear for the researches to investigate the real demand and animal welfare of the rabbits.

Examination of the group housing systems and the behaviour of rabbit does is current topic because some of the consumers show great interest about the products, which are produced under natural conditions.

Furthermore in the last decades organizations (Bioswiss, Naturland) suggested to keep rabbits in groups, provide them the possibility of the natural propagation meanwhile the restriction of the maternal behaviour is banned (EFSA, 2005).

The aim of this type of group housing systems is to keep the animals in large areas where the moving facilities and the chance of the social contact is provided, such as in the nature in the case of the European wild rabbit (*Oryctolagus cuniculus*) (SZENDRŐ and MCNITT, 2012). According to STAUFFACHER (1985) a housing system is appropriate for the rabbits if it gives the chance to find a hiding place and avoid the injuries.

Despite of the above mentioned the rabbit does are kept individually nowadays (EFSA, 2005), because the group housing of rabbit does increases the doe and suckling mortality, the agressivity and the costs, moreover declines hygenic conditions compared to individual housing according to some researches (SZENDRŐ *et al.*, 2016). To eliminate these negative effects Belgian researchers examined the semi-group housing systems for rabbits (periodically group housed) (MAERTENS *et al.*, 2011; MAERTENS and BUIJS, 2015), where they reached better results compared to continuous group housing system.

Despite of this, numerous questions remained unanswered: what kind of wall type (closed or opened) should be used in semi-group housing systems? The

group housed rabbits really prefer to locate together? Are they in connection with each other, when they are in the same place? Do they chase or fight to each other? When and how many times do they that? Are there consequences of these (injuries, mortality, decline of production)? If we would like to develop a housing system, which is appropriate from the aspect of the animal welfare, we have to recognize the natural behaviour, needs and minimum requirements of the animals (BAUMANS, 2005). In order to broaden of this knoweledge we took experiments with semi-goup housing systems.

The connection between the nest building behaviour of rabbit does and the nest materials is unclear. It is known that the generally used nest material is wood shavings in Hungary. Despite of this the European wild rabbit, which is the ancestor of domesticated rabbit mainly use dry stalks of grass to build their nests (HUDSON *et al.*, 2000), which is very different from the wood shavings. We know that the European wild rabbit often select among the available potential nest materials (HUDSON *et al.*, 1996). Based on this the question is obvious: what kind of nest materials are chosen by the domesticated rabbit? That is why I examined the nest material preference of rabbit does in two experiments.

From the viewpoint of the production, the survival rate of the suckling rabbits and later the health and productive performance during the fattening period can be significantly influenced by the nest quality (ZARROW *et al.*, 1963; VERGA *et al.*, 1987; MATICS *et al.* 2002). That is why I examined the quality of the nests and observed the reproductive performance of rabbit does when different nest materials were used.

In my dissertation I also deal with the housing system of the growing rabbits. Nowadays, one of the most important aims of animal housing is to harmonise production with the animal welfare. This can be difficult because in case of growing rabbits' housing, there can be often conflicts between people's or animal protection organization's expectations (bigger moving facilities, comfortable floor, enriched environment) and the real needs of rabbits.

Because of this, we have to identify the benefits and the backgrounds of these housing systems based on experimental results. We always have to keep in front of our eyes the animal welfare, and at the same time we have to check the effect of this the production and economy because these facts serve the success and competitiveness of the rabbit breeding.

Larger living space and moving possibilities can be provided for rabbits with installation of elevated platforms. The newest expectations and demands suggest to install these platforms in more levels. In order to clarify this question I examined the effect of the installed platforms in two levels made from wire-mesh or plastic on the behaviour and productive performance of growing rabbits.

## **Aims**

Throughout my experimental work I wanted to get answers for the following questions:

1. Which nest boxes are chosen by the rabbit does to build their nests if these are bedded with wood shavings, hay, straw or Lignocel®.
2. How frequently and which nest material do the rabbit does carry from the hay racks to build their nests if the hay racks are filled with hay, straw or Lignocel®? Which nest material is preferred within these conditions?
3. Does the rabbit doe choose rather the straw or hay to build her nest if the doe has to carry the materials from hay racks?
4. How is that influence the production (especially the mortality of suckling rabbits) and the nest quality, if wood shavings, hay, straw or Lignocel® are placed to the nest trays?
5. How do change the location, the aggressive and sexual behaviour of the rabbit does and how do their reproductive performances change in pens including

common area and individual cages made by different materials (wire-mesh, plastic, or the combination of them)?

6. How do change the location of the growing rabbits depended on the age and on the parts of the day in pens installed with elevated platforms in two levels with different floor types (wire-mesh, plastic slash)?

7. How do the productive performance, carcass and meat quality traits change in pens with platforms made from different materials compared to pens without platforms?

## **2. MATERIALS AND METHODS**

### **2.1. Choice of rabbit does among nest boxes depending on the nest material (Experiment 1)**

The experiment was conducted at Kaposvár University on rabbit does of Pannon breeding program between the third and fifth parturition. The temperature was 15-18 °C and 16-hour daily lighting was applied in the room. The rabbit does consumed commercial pellet *ad libitum* and water was available from nipple drinkers. In a 1.0 x 1.83 m pen one doe (n=37) and four nest boxes (0.37 x 0.23 m) with different nest materials were placed in random order: meadow hay, wheat straw, wood shavings and Lignocel® (fine fibre material J.Rettenmaier&Söhne GmbH). The observation started on the 27<sup>th</sup> day of pregnancy, so rabbit does had at least three days for building the nest. We observed which nest box bedded with different material was preferred by the does. The choice among different nest materials was evaluated by Chi<sup>2</sup>-test using SPSS 10.0 software package.

### **The choice of rabbit does among hay racks loaded with different nest materials (Experiment 2)**

The experiments were conducted at Kaposvár University on multiparous Pannon white rabbit does between the third and fifth parturition. The temperature was 15-18 °C, and 16-hour daily lighting was applied. The rabbit does consumed commercial pellet *ad libitum* and water was available from nipple drinkers. In each 1.0 x 0.91 m pen one rabbit doe and one empty nest box (0.37 x 0.23 m and 0.31 m height) and three 0.30 x 0.40 x 0.125 m racks were placed with 400 g nest materials: hay, straw or wooden thin long fibre material (Lignocel®, J.Rettenmaier&Söhne GmbH) in random order in the experiment 2/a (n=32

does). In the case of the experiment 2/b (n=25 does) two racks were placed with hay and straw in the same schema. The racks were made of wire mesh (hole size : 2.5 x 5.0 cm and the felled big holes were 5.0 x 25.0 cm.

The experiment started on the 27th day of pregnancy. During the preference test we observed which nest material was preferred by rabbit does for making nest. 24-h video recordings in the pens took place until the day of the parturition. The recording was achieved by using infrared cameras (KPC-S50 NV, B/W CCD) and special software (GeoVision GV-800 System, Multicam Surveillance System 6.1.). The evaluation started on the 27th day of pregnancy at 9:15. The other evaluated days started at 6:00 (light switched on). The last day ended at the moment of parturition (10 does/exp.). Every nest carrying occasion from the rack to the nest box were counted thereby the carrying occasions/hour were registered carrying occasions from the floor were also observed because some amount of nest material (especially Lignocel<sup>®</sup>) piled up on the floor. Carrying occasions from the nest box were also observed because rabbit does carried out and into the nest material.

We observed which nest material was found in the completed nest in the nest box. The nests were visually assessed immediately on the day of parturition, at the same time we took photo documentation from every nest. The nests which contained other nest material in more than 10% quantity were assessed as mixed nest. The number of carrying occasions/hour of nest material from racks was evaluated by one-factor ANOVA and the presence of different nest materials in the nest boxes were evaluated by Chi<sup>2</sup>-test using SPSS 10.0 software package. The different groups were paired compared to each other.

### **Effect of different nest materials on nest quality and reproduction performance of rabbit does (Experiment 3)**

The experiment was conducted at the Kaposvár University. Pannon Ka and Pannon White rabbit does (n=200) were randomly divided into four groups according to the nest materials used for bedding the nest tray: hay (n=50), straw (n=50), wood shavings (n=50), Lignocel® (wooden, thin, long, fibre material made by J.Rettenmaier&Söhne GmbH; n=50). The temperature was 15-18 °C, and 16-hour lighting was used in the room. The rabbit does consumed commercial *ad libitum*, and water was available from nipple drinkers. Rabbit does were placed in 60x54x30 cm flat-deck cages equipped with 54x27 cm nest boxes including the 37x20x15.5 cm deep nest tray. The nest tray was made from plastic perforated underneath.

The experiment started on the 27th day of pregnancy, so the rabbit does had at least three days for preparing the nest. The rabbit does were inseminated on the 18<sup>th</sup> day after the parturition, using a 49-day reproduction rhythm. After equalization 8 and 9-10 kits were in a litter for nulliparous and multiparous does, respectively. The does could freely nurse their kits except for the three days before insemination when controlled nursing was used as a biostimulation method. Photos of the nests were taken on 4-5 days after parturition, which were assessed by skilled experts on scores 1-5. The qualities of the nests were evaluated according to SAWIN and CRARY (1953), and DENENBERG *et al.* (1963):

- 1: hair completely missing, no nest shape, kits were uncovered;
- 2: small amount of hair, shapeless nest, kits were hardly covered;
- 3: average amount of hair, meanly shaped nest, kits were are partly covered;
- 4: sufficient amount of hair, well-shaped nest, which covered the kits well;
- 5: large amount of hair, perfectly shaped nest, which covered the kits completely.

The quality and contamination of the nest material were checked daily. The contaminated nest materials were exchanged. Litter sizes (total, alive, stillborn, after equalization, at 21 day) and daily kits mortality were recorded. The 21-day litter weights were measured, and the individual weights were calculated.

The productive performance and the quality of the nest were evaluated by one-way ANOVA, the suckling mortality by  $\chi^2$ -test. All statistical analyses were conducted using the SPSS 10.0 software package.

#### **Location preference, behaviour and performance of rabbit does in a pen system of combination of group and individual housing (Experiment 4)**

The experiment was conducted at Kaposvár University with pregnant and lactating Pannon White rabbit does (n=48). The 1.83 x 2.00 m open top pen consisted of four individual cages (0.5 x 0.91 m) which were connected to the 1.83 x 1.00 m common area throughout a 0.25 m long and 0.20 m wide lockable corridor. The rabbit does were randomly divided into three groups. The groups differed only in that the material of walls of the individual cages. Pen with solid wall cages (Solid, n=16); pen with wire-mesh wall cages (Wire, n=16) and pen with partly solid and partly wire-mesh wall cages (Mix, n=16). Four rabbit does were placed to the closed individual cages 3 days before the expected parturition for 21 days. 18 days after kindling the entrances of the individual cages were opened, and the 21-day group-housing started. All 4 does and their kits could use all individual cages and the common area freely. The kits were weaned at 35 days of age. The injuries on ears, and body were checked on days 2, 4, 8, 14 and 22 after grouping the does. 24-h video recordings were made on days 1, 2, 3, 7 and 13 after opening the doors, and location of rabbits was registered at every 15 min.

Location preference, the rate of aggressive and sexual behaviour and mortality and ratio of injured rabbits were evaluated by Likelihood Ratio-test, productive traits were evaluated by one-factor ANOVA using SPSS 10.0 software package.

### **Behaviour and location of growing rabbits in pens with multilevel platforms and comparison of production, carcass traits and meat quality of growing rabbits in pen without and with multilevel platforms (Experiment 5)**

The experiment was conducted in the Kaposvár University rabbit farm using the maternal line of the Pannon Breeding Program. A total of 174 rabbits of both sex, weaned at 5 weeks of age were studied for six weeks. In details, they were randomly divided into three groups, and distributed into six same-size wire-mesh pens (1.0 x 1.83 m). The pens were differing by the presence or not and the type of platforms and groups of 29 rabbits per pen (two pens per treatment) were created: two open – top pens without elevated platforms and four, two pens equipped with seven wire-mesh elevated platforms and two pens with the same number of plastic elevated platforms placed in different heights. A 24-h-pool-faeces sampling took place at 7, 9 and 11 weeks of age to evaluate rabbits response to stress. The recording was achieved by using infrared cameras. Rabbits position was evaluated once a week, every half an hour for 24 hours and the number of rabbits on bottom level (under the platforms or free area) and on each of the platforms were registered.

Morbidity, mortality and ratio of injured rabbits were evaluated by chi<sup>2</sup>-test. Location preference and productive traits were evaluated by multi-factor ANOVA. Concentration of corticosterone metabolites in faeces, and the feed intake and feed conversion ratios were evaluated by one-factor ANOVA. All data were evaluated with the SPSS 10.0 software package.

### **3. RESULTS**

#### **3.1. Choice of rabbit does among nest boxes depending on the nest material (Experiment 1)**

The goal of the experiment was to examine which nest materials are preferred by the rabbit does building their nest.

48.6% of does kindled in nest boxes with pure materials (Lignocel<sup>®</sup>: 40.5%, straw: 5.4%, hay: 2.7%); however 51.4% of does mixed the nest materials: does carried Lignocel<sup>®</sup> (21.6%) or Lignocel<sup>®</sup> and hay (5.4%) into nest box bedded with straw, Lignocel<sup>®</sup> (8.1%) into nest box bedded with wood shavings, hay and straw (5.4%) into nest box bedded with Lignocel<sup>®</sup>. It can be concluded that rabbit does preferred kindling into nest box bedded with Lignocel<sup>®</sup>, and most of them refuse the nest box with wood shavings.

#### **3.2. The choice of rabbit does among hay racks load with different nest materials (Experiment 2)**

The aim of the experiments was to examine which nest materials are preferred by the rabbit does for building their nest from the hay racks.

In experiment 2/a the frequency of nest material carrying was the highest on the day of parturition. The preferred nest material was Lignocel<sup>®</sup> (compared to hay and straw) on each experimental day except day 30. At the day of kindling 87.5%, 6.3% and 6.3% of the nests contained pure Lignocel<sup>®</sup>, mixed Lignocel<sup>®</sup>-hay and Lignocel<sup>®</sup>-straw, respectively.

In experiment 2/b the frequency of nest material carrying (mostly straw) was the highest on the day of parturition, and on days 27, 30. More does built nest with only straw (72%) than hay (16%), and in 12% of the cases the straw and hay were mixed. For the purpose of nest building material straw was the most

frequently used (72%) compared to other possibilities (hay: 16%, straw-hay: 12%). It can be concluded that rabbit does showed the following clear preferences for specific nest building materials: a clear preference order: Lignocel<sup>®</sup> > straw > hay.

### **3.3. Effect of different nest materials on nest quality and reproduction performance of rabbit does (Experiment 3)**

The target of this experiment was to examine the effect of four different nest materials on nest quality and the production performance of rabbit does.

The quality of nests made of different materials was significantly different ( $p < 0.001$ ): the hay nest received the best quality scores (4.11), which was followed by straw (3.76), Lignocel<sup>®</sup> (3.56) and wood shavings (3.13).

The nest material did not influence the litter size, the litter- and the individual weight at day 21, and suckling mortality between 0-21 d. However the reproduction performances of the two breeds were different ( $p < 0.05$ ).

It was concluded that the rabbit does built the best nest quality by hay and the worst by wood shavings; the type of the nest material did not influence the productive performance of does; the commonly used wood shavings could be good in the practice.

### **3.4. Location preference, behaviour and performance of rabbit does in a pen system of combination of group and individual housing (Experiment 4)**

The aim of the experiment was to test a special pen system of combination of group and individual housing, examination of production and preference of rabbit does. On day 1 rabbit does preferred to stay alone than together (Solid: 62.3%; Wire: 64.3%; Mix: 82.8%). Later on, less rabbit does located alone (on day 13: Solid: 30.8%; Wire: 51.0%; Mix: 39.2%). On day 1 in all pens the

majority of the does located in the individual cages (Solid: 77.3%; Wire: 76.8%; Mix: 83.9%), however later the percentage of does in the individual cages decreased until day 13. At almost every day less rabbit does preferred the individual cages in the Solid than in Wire or Mix group. Rabbit does preferred their own cages, more rabbit does stayed in the own cages than the expected probability (25%) on all days (day 1: Solid: 64.6%; Wire: 68.4%; Mix: 74.6%; day 13: Solid: 28.0%; Wire: 38.0%; Mix: 34.5%). In Mix group rabbit does which were housed in solid wall cages before grouping preferred to stay in the solid wall cages in all days (day 13: 59.1%) and that of housed in wire-mesh cages before grouping preferred to stay in wire-mesh cages (day 13: 65.6%). Frequency of all examined behavioural patterns (fighting, chasing) were the highest on day 1 (Solid: 175, 203; Wire: 110, 86; Mix: 91, 61). The most fighting were observed between 5:00-11:00 and the less usually between 23:00-5:00. On the first day more fighting were registered in the individual cages than in the common area. After that the place of fighting fluctuated. Very few amount of “mating attempts” happened in all pens in the total experimental period. But in Solid four times more mating attempts occurred in the common area than in the individual cages, but in Wire it was totally inversely. High frequencies of injured rabbits were observed in the whole experimental period (Solid: 68.7%; Wire: 56.2%; Mix: 56.2%). No significant differences were found between the different types of pens in almost the all production traits. The productive performance fits to the results of Pannon breeding program. On the other hand in Wire and Mix groups the does mortality were 6.3% and 12.5% and the kindling rates were 62.5 and 68.8%. Based on the results it can be concluded that the main problems of group housing of does (aggressiveness, injuries) have not been solved with this system.

### **3.5. Behaviour and location of growing rabbits in pens with multilevel platforms and comparison of production, carcass traits and meat quality of growing rabbits in pen without and with multilevel platforms (Experiment 5)**

In this experiment the productive performance, carcass traits, meat quality, cortisol metabolites in faeces and location (preference) of growing rabbits housed in different type of pens (without or with wire-mesh or plastic-mesh elevated platforms) were examined.

The animal density was higher on the floor compared to platform (in pen with wire-mesh platform: 12.0 vs. 5.2, plastic platform: 10.2 vs. 7.4). Under the platforms and on the free area were a similar number of rabbits in the two case. At the same time choose the plastic platform more frequently (1.4 times higher) than the wire-mesh platform, and the second level (wire-mesh: 2.9 times higher, plastic 1.6 times higher) than the first level. The greatest number of rabbits stayed in the free area than under the platform. It can be explained by the fact that the rabbits on the platform may urinate on the rabbits underneath the platform. The majority of growing rabbits stayed under the platform most often in their resting period between 11:00 a.m. and 05:00 p.m., accordingly the fewest number of rabbits were on the platform in this time, furthermore they relaxed also. Less rabbit stayed in the free area at the resting period than between 05:00 p.m. and 05:00 a.m., moreover more rabbit choose the plastic platform counter to wire-mesh platform in all of time of day.

The percentage of injuries recorded as ear lesions was not affected by the pen type. Body weight and weight gain were not significantly affected among the groups. The type of pen (with or without platforms) did not cause any difference on neither feed intake, nor feed conversion of the rabbits. Morbidity and mortality were not affected by the type of pen. No significant difference in any of carcass and meat quality parameters was noticed among the three groups.

Similarly, the presence of platforms did not affect significantly the rheological traits of meat.

The installed platforms increased the moving possibility and enriched the environment of rabbits, while the productive traits don't changed significantly. We couldn't evidence significantly, tendentious difference in neither of growth performances. So this experiment can be prove the less stocking density and the bigger, richer moving facility don't influence the production of growing rabbits. The stocking density under 16 rabbit/m<sup>2</sup> doesn't give significant effect on the weight gain, body weight, feed intake and feed. So this experiment can be prove the less stocking density and the bigger, richer moving facility don't influence the production of growing rabbits.

## 4. CONCLUSIONS AND RECOMMENDATIONS

The conclusions are shown in the same order as the results are presented in the Results and discussion section.

### **Experiment 1**

The Lignocel<sup>®</sup> is usable as a nest material for rabbit does.

In the case when wood shavings, straw, hay and Lignocel<sup>®</sup> nest materials were offered for rabbit does to make their nests, they preferred Lignocel<sup>®</sup> expressly.

Among nest materials mentioned above rabbit does mainly carried Lignocel<sup>®</sup> and mixed it with other nest materials.

Wood shavings are commonly used at rabbit farms as nest material but it is less preferred by does compared to hay, straw and Lignocel<sup>®</sup>. Straw and hay as nest materials are preferred only moderately by rabbit does.

However the exchange of the commonly used wood shavings to Lignocel<sup>®</sup> is not suggested from economical viewpoint because its price is much more higher.

### **Experiment 2 (2/a and 2/b)**

The rabbit does mainly preferred the Lignocel<sup>®</sup> nest material compared to straw and hay in the case when they had to carry it from the hay racks. Lignocel<sup>®</sup> as nest material is easily carriable. Rabbit does clearly preferred the straw against hay if these two materials were available.

The following preference order was observed: Lignocel<sup>®</sup> > straw > hay. The frequency of nest material carrying activity and the nest building were the most intensive on the day of parturition, which was more pronounced if only straw and hay were available from the hay pockets.

### **Experiment 3**

The rabbit does made the best quality of nests from hay and the worst from wood shavings in the case when nest materials were given them in nest trays.

The material of the nest did not influence the reproduction performances so from the viewpoint of the production the generally used wood shavings is appropriate nest material. If it is necessary, the substitution of wood shavings with other nest material can be a good solution without decline of production.

### **Experiment 4**

Based on locational and behavioural results the differentiated area can provide possibility for the rabbit does for hiding, running away from each other or staying together. In the beginning of the group housing period rabbit does locate alone more, but later they search for the presence of each other and spend more time together.

The majority of the does located in the smaller individual cages than in the larger common area if the walls of the individual cages were made of wire-mesh we suppose that this type of walls provide the opportunity of visual contact.

We suppose that the rabbit does recognise their own individual cages because they choiced them more frequently.

In this semi-group housing system the agressivity, the fightings and the sexual behaviour were very common.

The disadvantages of group housing (stress, injuries, pseudopregnancy) were present in this system. In spite of high rate of aggressive behaviour the reproductive performance was satisfying. On the other hand, the agressivity could be responsible for the doe mortality and the lower kindling rate. The semi-group housing system is suitable for suckling rabbits, they can avoid the aggression of does and the negative effects of this. The investigation of location and behaviour of rabbit does in all experimental days are recommended to draw

up deeper conclusions. From the viewpoint of the economy and animal welfare the change from individual housing to semi-group housing is not suggested.

### **Experiment 5**

The installed platforms increased the moving possibility and enriched the environment of rabbits, which is beneficial from the viewpoint of animal welfare. From animal welfare aspect the usage of plastic platforms was considered better because the rabbits located on them more frequently (higher density).

In pen housing system with platforms installed in more levels, the lower stocking density and the bigger, richer moving facility did not influence the production of growing rabbits.

It can be good solution to satisfy the expectations of the consumers (e.g. lower stocking density, bigger moving possibilities and the enriched environment with housing in big groups) with the usage of elevated platforms in more levels.

## 5. NEW SCIENTIFIC RESULTS

Based on the experiments the following new results were obtained:

1. It was established that, 40.5% of the rabbit does chose the nest boxes bedded with fine fibre wooden material (Lignocel<sup>®</sup>), 5.4% chose straw bedding and 2.7% chose nest boxes bedded with hay for parturition. 51.4% of the rabbit does used more different nest materials (Lignocel<sup>®</sup>, straw, hay) to make their nests from the materials placed in nest boxes. In 87.5% of cases rabbit does purely used fine fibre wooden material (Lignocel<sup>®</sup>) to make their nests and in 6.3-6.3% of the cases purely used straw and hay among the nest materials placed in hay racks.

2. It was established that, the nest material carrying frequency showed fluctuation during the 3 days prior to parturition, and this behaviour was the most intensive in the intervallum 4-5 hours before parturition.

3. It was established that, in the pens included individual cages made of wire-mesh walls the rabbit does located more often alone than together and more often in the individual cages than in the common area on the 13<sup>th</sup> observation day compared to pens plastic slat covered walls cages.

4. It was established that, the rabbit does chose their own cages more frequently than the expected probability (25%) opposite to the other three individual cages in pens included common area and four individual cages. It was true only on the first three experimental days in the case of pens include only solid walls individual cages, later on that there was not significant difference from the expected probability (25%).

5. It was established that, the rabbit does which were accustomed to solid wall cages preferred to stay more frequently in the solid wall cages in all observed days and does accustomed to wire-mesh cages stood more frequently in wire-mesh cages in the pens included two individual cages half made of plastic slat and two cages made of wire-mesh.

6. It was established that, growing rabbits used the plastic platforms more often than the wire-mesh platforms were installed in two levels. The growing rabbits used the second level of platforms more frequently than on the first level.

7. It was established that, there are no significant differences in any of production traits and carcass parameters among rabbits housed in pens without or with two levels of wire-mesh or plastic-mesh elevated platforms. Furthermore no difference was noticed in cortisol metabolites concentration measured in faeces.

## 6. PUBLICATIONS ON THE SUBJECT OF THE DISSERTATION

### 6.1. Papers published in foreign language peer-reviewed journals

**Farkas T. P.**, Szendrő Zs., Matics Zs., Radnai I., Nagy I., Gerencsér Zs., (2018) Preference of rabbit does among different nest materials. *World Rabbit Sci.* 26:(1) pp. 81-90.

Matics Zs., **Farkas T. P.**, Dal Bosco A., Szendrő Zs., Filiou E., Nagy I., Odermatt M., Paci G., Gerencsér Zs. (2018) Comparison of pens without and with multilevel platforms for growing rabbits. *Ital. J. Anim. Sci.*, 17:(2) pp. 469-476.

Martino M., Mattioli S., **Farkas P.**, Szendrő Zs, Dal Bosco A, Ruggeri S., Matics Zs, Castellini C., Gerencsér Zs. (2016) Carcass traits and meat quality of growing rabbit sin pens with and without different multilevel platforms. *World Rabbit Sci.* 24:(2) pp. 129-138.

### 6.2. Papers published in Hungarian language peer-reviewed journals

**Farkas T. P.**, Szendrő Zs., Matics Zs., Mayer A., Radnai I., Odermatt M., Gerencsér Zs. (2016) A fészekanyag hatása a fészek minőségére, valamint a szaporasági és nevelési tulajdonságokra különböző fajtájú anyanyulak esetén. *Állattenyésztés és Takarmányozás*, 65:(2) pp. 35-41.

### 6.3. Full conference papers in proceedings

#### 6.3.1. In foreign language

Matics Zs., Szendrő Zs., Radnai I., **Farkas T. P.**, Kasza R., Kacsala L., Nagy I., Szabó R. T., Terhes K., Gerencsér Zs. (2017) ANIHWA - Experimental

results at Kaposvár University. In Proc.: 20<sup>th</sup> International Symposium on housing and diseases of rabbits, furproviding animals and pet animals, Celle, pp. 27-36.

**Farkas T. P.**, Szendrő Zs., Matics Zs., Radnai I., Mayer A., Gerencsér Zs. (2016) Effect of different nest materials on performance of rabbit does. In Proc.: 11<sup>th</sup> World Rabbit Congress.: Qingdao, pp. 197-200.

**Farkas T. P.**, Dal Bosco A., Szendrő Zs., Filiou E., Matics Zs., Odermatt M., Radnai I., Paci G., Gerencsér Zs. (2016) Production of growing rabbit sin large pens with and without multilevel platforms. In Proc.: 11<sup>th</sup> World Rabbit Congress, Qingdao, pp. 663-666.

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#### **6.4. Abstracts in proceedings**

##### **6.4.1. In foreign language**

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