

**THESES OF DOCTORAL (Ph.D.)
DISSERTATION**

UNIVERSITY OF KAPOSVÁR
FACULTY OF ANIMAL SCIENCE
Department of Swine and Small Animal Production

Head of the Doctoral School:
DR. PÉTER HORN
Ordinary Member of the Hungarian Academy of Sciences

Supervisor:
DR. ZSOLT SZENDRŐ
Doctor of the Hungarian Academy of Sciences

**EFFECT OF HOUSING CONDITION ON THE
BEHAVIOUR AND PRODUCTIVE PERFORMANCE OF
GROWING RABBITS**

ZOLTÁN PRINCZ

KAPOSVÁR
2008

1. ANTECEDENTS OF THE RESEARCH, OBJECTIVES

During the last decade with the continuous increase of performances animal breeding changed towards “industrial production”. This process occurred also in rabbit breeding (rabbit meat production) and affected herd size technology and the kept genotypes (pure-bred, hybrids). Simultaneously with these changes, there is an increased demand for alternative technologies (keeping, feeding and rearing) mainly induced by animal welfare movements. Besides an increasing consumer group is being formed (both in the national and international market) who’s main interest is the improvement of the animals’ keeping technology and welfare. As the intensive production is closely connected to animal welfare (VERGA, 2000), several experiments were carried out analyzing different environmental (keeping) conditions (cage size, group size, stocking density, cage height, floor type, environmental enrichment etc). Effects of the above mentioned conditions on the growing rabbits’ production, health, behaviour and meat quality were examined. Several results are already available directly helping the practice of rabbit production but several issues are still remained to be solved.

Contrary to other domesticated species in rabbit breeding there are no EU directives. From the viewpoint of animal welfare providing adequate environment and sufficient space for the rabbits in order to guarantee their welfare and execution of locomotory behaviours are essential (VERGA, 2000). However connected to animal welfare there are several widespread misbelieve therefore publishing results based on objective trials is highly important for the development of EU animal welfare recommendations.

In my study the main objectives were the following:

- to evaluate the growing rabbits' growth, slaughter and meat quality traits and occurrence of ear lesions in cages or pens of different size (applying different group size and stocking density)
- analyze the effects of floor type and environmental enrichment (gnawing stick) on the cage preference (in case of free choice), growth, slaughter and meat quality traits and behaviour of growing rabbits.
- the gnawing sticks' preference of rabbits (ingested *vs.* rejected species) was monitored and the effect of gnawing sticks (from a soft and hard tree) on the production, ear lesions and gnawing stick consumption of growing rabbits were analysed and compared to a control group (where no gnawing stick was applied).
- assess the preference of the rabbits for various cage heights and to monitor the growing rabbits' production and occurrence of ear lesions housing them in pens of different height. Thus the adequacy of the conventional fattening cages was examined.

2. MATERIALS AND METHODS

General characteristics of the experiments

Animals

The analyses were conducted at the University of Kaposvár using Pannon White rabbits.

Diets

Between the ages 5 to 9 and 9 to 11 weeks the rabbits were fed *ad libitum* a commercial pellet (14.5% crude protein, 17.5% crude fibre, 2.0% ether extract, 10.3 MJ DE/kg, 50 ppm Tiamulin, 500 ppm Oxitetracycline, 1 ppm Diclazuril; and 16.0% crude protein, 16.0% crude fibre, 3.0% ether extract, and 10.6 MJ DE/kg, respectively). Water was available *ad libitum* from nipple drinkers.

Environmental conditions

The rabbits were housed in a closed climatized rabbitry at the Kaposvár University. The lighting period was 16L/8D. The temperature of the rabbitry was constantly 18°C.

Preference-test

The rabbits in the preference-tests were housed in cage blocks having a basic area of 2 m² with a stocking density of 16 or 12 rabbits/m². The size of each cage within a block was 0.5 m² and animals could move freely among the 4 cages through swing doors. The floor type, height and complement of the four parts were identical but could be modified if required.

A 24 hour video recording was performed once a week using infrared cameras. Using the recordings, the number of rabbits in each cage (within

the cage blocks) was counted using a scan sampling method with a frequency of 30 minutes (48 times a day). On the days of recording nobody was allowed to enter the rabbitry.

Statistical analysis

Growth, slaughter and meat quality traits, the frequencies of the behavioural patterns and the rabbits' presence (in the preference-tests) were evaluated by performing an analysis of variance with one or multiple factors. The mortality and the ear lesions were evaluated using chi² test. Statistical analysis was performed by means of the SPSS 10.0 software package.

Specification of the experiments

Experiment 1

Effect of the group size and the stocking density on the productive performance, carcass traits, meat quality and incidence of the ear lesions of the growing rabbits

The five-week-old Pannon White rabbits (n=230) were housed in cages (C) or pens (P) with a stocking density of 16 or 12 rabbits/m². Seven groups were established depending on the group size and stocking density: **SC16**=small cage (0,12m²), 16 rabbits/m² (2 rabbits/cage), height: 30 cm (n=36); **LC16**=large cage (0,50m²), 16 rabbits/m² (8 rabbits/cage), height: 30 cm (n=32); **LC12**= large cage (0,50m²), 12 rabbits/m² (6 rabbits/cage), height: 30 cm (n=24); **SP16**=small pen (0,86m²), 16 rabbits/m² (13 rabbits/pen), open top (n=26); **SP12**=small pen (0,86m²), 12 rabbits/m² (10 rabbits/pen), open top (n=20); **LP16**=large pen (1,72m²), 16 rabbits/m² (26 rabbits/pen), open top (n=52); **LP12**=large pen (1,72m²), 12 rabbits/m² (20 rabbits/pen), open top (n=40).

During the experiment the body weight and feed consumption were measured weekly, the mortality was registered daily. At 9, 10 and 11 weeks of age the ear lesions were counted. Rabbits (n=90) at 11 weeks of age were slaughtered only from SC, LC and LP groups with 16 rabbits/m². The carcasses were dissected according to the norms of the World Rabbit Science Association (WRSA) described by Blasco and Ouhayoun (1996). Meat quality was analyzed using thigh muscle samples of 15-15 randomly chosen rabbits from each group: colour, pH₂₄, drip loss, chemical composition, and NIR reflectance spectra.

Experiment 2

Effect of the group size, the floor type and the gnawing stick on the cage-choice, the production, carcass traits, meat quality and the behaviour of the growing rabbits

Experiment 2.1

Effect of the floor type and the gnawing stick on the cage-choice of the growing rabbits

Five week-old rabbits (n=112) were housed in cage blocks having a basic area of 2 m² with a stocking density of 16 or 12 rabbits/m² (2 repetitions with 32 and 24 animals, respectively). The size of each cage within a block was 0.5 m² and animals could move freely among the 4 cages through swing doors. The cages only differed in the floor type (wire or plastic net) and in the presence or absence of environmental enrichment (gnawing sticks). The 25 cm long gnawing sticks were made from fresh barked White locust (*Robinia pseudoacacia*), which after barking were 3 cm in diameter. A 24 hour video recording was performed once a week using infrared cameras. Using the recordings, the number of rabbits in each cage (within the cage

blocks) was counted using a scan sampling method with a frequency of 30 minutes (48 times a day). The feed consumption of the 4 cages in a block was measured weekly. The duration of the trial was 6 weeks (i.e between the ages of 5 to 11 weeks).

Experiment 2.2

Effect of the group size, the floor type and the gnawing stick on the production, carcass traits, meat quality, the behaviour and incidence of ear lesions of the growing rabbits

At 11 weeks of age the rabbits were slaughtered. Using 8-8 samples per group, colour ($L^*a^*b^*$) of *B. femoris* és az *L. lumborum*, chemical composition of the hind leg, Warner-Bratzler shear force and characteristics of the *femur* and *tibia* (weight, length, diameter and shear force) were determined.

The rabbits were housed in either cages (n=72; 2 rabbits/0.122 m²) or pens (n=104; 13 rabbits/0.86 m²) using the same stocking density (16 rabbits/m²). In every second cage and pen the floor was wire mesh or plastic net. Every second cage and pen (with wire mesh or plastic net floor) was enriched with gnawing sticks made from fresh barked White locust. The length and diameter of the gnawing sticks that were placed to the cages were 10 cm and 3 cm, respectively. Because a larger number of rabbits were housed in the pens (compared to cages) the length of the gnawing sticks in the pens was 33 cm. Using infrared cameras 24 hour video recordings were performed at the ages of 6.5 and 10.5 weeks. Recordings were made during the middle parts of the dark and light periods (11.00 am – 5.00 pm: resting period; 11.00 pm – 05.00 am: active period) and were evaluated by recording the behavioural patterns of the rabbits with a frequency of 5 minutes using scan

sampling methods. During the experiment the body weight and feed consumption were measured weekly, the mortality was registered daily. At the end of the experiment (at 11 weeks of age) the ear lesions were counted. The gnawing stick consumption was evaluated with a scale from 0 to 5 (0 = no consumption; 5 = high consumption).

Experiment 3

Application of gnawing stick

Experiment 3.1

Gnawing stick's preference of growing rabbits

Rabbits were placed into pens (15 rabbits/pen; 17.5 rabbits/m²) with wire mesh floor. Experiments lasted between the ages of 5-11 weeks. After stripping the bark off, the gnawing sticks were mounted horizontally 15 cm high on the wall of the adjacent pen.

Choice among nine gnawing sticks

In the first experiment (n=180) every cage was provided with three gnawing sticks randomly chosen from White locust, Black elder, White willow, Little-leaf linden, European larch, Black poplar, European white birch, White buckeye and White mulberry species (with a diameter of 3cm and length of 20 cm). During the trial the preference of the rabbits (consumed vs. rejected species) was monitored.

Choice among five preferred gnawing sticks

In the second part of the experiment (n=150) only those gnawing sticks (tree species) were used that were consumed by the rabbits in the first experiment (White locust, White willow, Little-leaf linden, Black poplar and White

buckeye). Every pen was applied with 3 gnawing sticks of different species (using all possible combinations). Size of the stick was the same as in the preceding part of the trial.

Prior to their placement into the cages the volumes of the gnawing sticks were determined by inserting them into a glass cylinder filled with water. Gnawing sticks fully consumed during the experiment were replaced. Gnawing stick consumption was determined (in cm³) from the volume differences measured at the beginning and at the end of the experiment.

Experiment 3.2

The effect of the application and type (hard vs. soft) of gnawing sticks on the production, gnawing stick consumption and occurrence of ear lesions connected to aggressive behaviours of growing rabbits.

Rabbits (n=156) weaned at the age of 5 weeks were placed in pens having a basic area of 0.86 m² (13 rabbits/pen) using a stocking density of 16 rabbits per m². The rabbits were housed in the pens until the age of 11 weeks. Three groups were formed according to the gnawing sticks: H = hard stick (White locust); S = soft stick (Little-leaf linden); C = control (no gnawing sticks were applied). Diameter and length of the gnawing sticks were 3 cm and 20 cm, respectively. The body weight, feed consumption and gnawing stick consumption of the rabbits were measured at every second week. Number of ear lesions was counted at every rabbit at the age of 11 weeks.

Experiment 4

Effect of the cage height on the cage-choice, production and incidence of ear lesions of growing rabbits

Experiment 4.1

Free choice of the growing rabbits depending on the height of the cage

In experiment 1 and 2 (preference test) growing rabbits (n=112) - weaned at 5 weeks of age - were housed in cage blocks (16 or 12 rabbits/m²) having a basic area of 2 m². The cage block consisted of four equal size (0.5 m²) cages and the rabbits could move freely among the cages through swing doors. The cages only differed in their height: in trial 1 the height of the cages was 20, 30, 40 cm or open top, in trial 2 the height of two cages was 30 cm and 40 cm, respectively. During the preference test (experiment 1 and 2) a 24 hour video recording was performed once a week using infrared cameras between the ages 6-11 weeks. Number of rabbits in each cage (of different heights) was counted in every half an hour (scan sampling). The feed consumption was also measured weekly.

Experiment 4.2

Effect of the cage height on the production performance and incidence of ear lesions of growing rabbits

The rabbits (n=156) were housed between the ages 5-11 weeks in wire mesh floor pens having a basic area of 0.86 m² (13 rabbits/pen). The height of the pens was 20, 30 and 40 cm or open top.

The body weight and feed consumption were measured weekly. Number of rabbits with ear lesion (regardless of their number and severity) originating from aggressive behaviour was counted at the ages of 9-10-11 weeks.

3. RESULTS

Experiment 1

Effect of the group size and the stocking density on the production, carcass traits, meat quality and incidence of the ear lesions of the growing rabbits

Stocking density had no effect on the weight gain, body weight, feed intake and feed conversion. In the rabbit groups housed in larger pens the weight gain, body weight, dressing out percentage and fat content of meat slightly decreased but the differences were not significant. Significant differences were found for weight of perirenal fat (SC= 21,3 and LP= 13,7g, $p<0,001$) and for the ratio of the fore part to the reference carcass (LC= 28,2 and LP= 29,0%, $p<0,05$). The group size affected the colour and the dry matter content of the hind leg muscle. With the increasing group size the ratio of ear lesions increased (SC= 0,0%, LC= 7,1%, SP= 8,7%, LP= 17,4%, $p<0,05$).

Experiment 2

Effect of the group size, the floor type and the gnawing stick on the cage-choice, production, carcass traits, meat quality and behaviour of the growing rabbits

Between ages 5 and 11 weeks the rabbits showed a preference towards the plastic net floor (16 rabbits/m²: 62.5%; 12 rabbits/m²: 76.5%; $P<0.001$). Gnawing stick application significantly affected cage preference: 54.1% (16 rabbits/m²) or 53.1% (12 rabbits/m²) of the rabbits choose the enriched cages ($P < 0.001$).

Compared to cages, the rabbits housed in pens spent less time with resting (58 vs 67%) and more time with locomotion (6.7 vs 3.8%) but the frequency

of aggressive behaviour (measured by the number of ear lesions) was also higher (0.14 vs 0.01%). In pens the application of gnawing sticks significantly decreased the frequency of ear injuries (0.05 vs 0.22 %). The housing system significantly influenced the body weight at 11 weeks of age (2630 vs 2557 g; in cage or pen, respectively) the feed conversion (3.12 vs 3.38 g/g; in cage or pen, respectively) and the slaughter weight (2590 vs 2531 g in cage or pen, respectively; $P < 0.01$) the reference carcass (RC) weight (1266 vs 1234 g; in cage or pen, respectively; $P < 0.05$) and the hind leg meat to bone ratio (6.11 vs 5.62 in cage or pen, respectively, $P < 0.001$). The animals reared in pens showed lower meat pH_u and less coloured meat than those reared in cages by pairs. The dry matter and protein contents of hind leg meat were also influenced by the housing system (26.3 vs 25.9%, 21.9 vs 21.6%; in cage or pen, respectively; $P < 0.05$). Pen-reared rabbits had significantly heavier femur and tibia bones with higher shear force than cage-reared rabbits.

The floor type did not affect the traits tested (any behavioural pattern, productive performance, slaughter traits and the meat quality) significantly.

The gnawing stick consumption affected the body weight at 11 weeks of age (2553 vs 2622 g; without or with gnawing stick, respectively), the percentage of ear lesions (18.5 vs 1.20%; without or with gnawing stick, respectively), especially in pens, reduced the aggressive behaviour and improved the welfare. Gnawing stick presence improved the slaughter yield (59.0 vs 58.3%; $P < 0.05$), the weight of RC (1266 vs 1236 g; $P < 0.05$) and the fore part proportion (29.6 vs 29.2% RC; $P < 0.05$) and significantly reduced the b^* value of meat colour, but shear force increased in m. *Longissimus dorsi* (0.60 vs 0.50 kg/cm²; $P < 0.01$).

Experiment 3

Application of gnawing stick

Based on the results of the first experiment rabbits showed preference towards White locust, White willow, Little-leaf linden, Black poplar and White buckeye as they consumed the gnawing sticks of these species in various amount. Black elder, European larch, European white birch and White mulberry species were rejected as no consumption of these species could be observed (regardless of the different combinations). According to the second experiment the rabbits showed the highest preference towards Little-leaf linden gnawing sticks (1667 cm³), while similar amount of White willow and White buckeye consumption (790cm³ and 765cm³) was experienced. The mechanical and chemical characteristics of the tree species (hardness, smell and taste) may determine which of the investigated species is suitable for gnawing stick. The minimal consumption of White locust and Black poplar (20 and 40cm³) may also be caused by the rabbits' general interest towards "novel objects".

In the third experiment the production of three groups (weight gain, body weight, feed consumption, feed conversion) was not different. The rabbits in the S group consumed significantly ($p < 0.001$) more gnawing stick than in the H group (H: 0.11 vs. S: 1.24 cm³/day/rabbit). Compared to the C group (17,3%) occurrence of ear lesions was significantly ($p < 0.05$) lower both in the H (7.7%) and S (1.9%) groups. Based on the results under group housing conditions application of gnawing sticks (especially made from soft tree: Little-leaf linden) can decrease the frequency of aggressive behaviours of rabbits without influencing their production.

Experiment 4

Effect of the cage height on the cage-choice, production and incidence of ear lesions of growing rabbits

The rabbits had a low preference for open top cages, the least number of rabbits chose this cage type independently of the stocking density, age and part of the day (11.7-20.4% vs. 22.0-38.7%; $p < 0.001$). In trial 1 among the closed cages most of the rabbits stayed in the 40 cm and 20 cm high cage during the active and resting period, respectively independently of the stocking density ($p < 0.001$). In trial 2 preference for the 30 and 40 cm high cages was the same.

The cage height had no effect on the rabbits' production. The frequency of the ear lesions connected with aggressive behaviours was the smallest in the 30 cm (5,1%) and the greatest in the 20 cm high (20,5%) cages, respectively ($p < 0.05$).

4. CONCLUSIONS

Stocking density

Applying a stocking density less than 16 rabbits/m² had no favourable effect on the production of growing rabbits. This stocking density (less than 16 rabbits/m²) had no favourable effect on the behaviour of growing rabbits either therefore its application was not justified by economical or welfare reasons. However, when applying a stocking density of 12 rabbits/m² higher frequency of ear lesions was observed which makes further experiments necessary. Stocking density or (more precisely) body weight per 1m² basic area affected the floor preference of growing rabbits. Rabbits rather chose a less preferred floor type than experience a high stocking density (kg rabbit/m²).

Group size and cage size

In large pens (larger groups) duration of rearing is longer than in conventional cages (2 rabbits/cage). Due to the higher activity of rabbits lower dressing out percentage can be expected. When applying smaller pens no substantial decrease can be expected in the growth and slaughter performance and at the same time the possibility for locomotory behaviours is increased which is favourable from the animal welfare viewpoint. The cage size affects the growing rabbits' behaviour. The decreased activity in the small cages was in accordance with the scarce available space for the rabbits. The largest risk of rearing rabbits in groups is the increased frequency of aggressive behaviours. The more frequent ear lesions in the increasing group size is caused by the aggressive individual that can injure more group-mates in larger groups which is against the growing rabbits' welfare. Therefore recommendation of too large groups (alternative

systems) is questionable. Aggressive behaviour occurs during the active period and its increased frequency can be observed at the end of the fattening period. Lower meat production in larger groups is not favourable but deposition of smaller abdominal fat depots is useful from the consumers' aspect. On the contrary further decrease of fat content of the otherwise lean meat is not desirable. The too low fat content is not favourable for tastiness. Among the meat quality traits of the pen reared rabbits mainly the smaller or larger increase of meat colour (L^* , a^* , b^*) and pH-value can be expected. Based on the results application of groups rearing can be suggested with a group size of (max.) 6-8/rabbits/cage. Considering animal welfare creation of larger groups is to be avoided (aggression).

Floor type

Plastic net cage floor offers good alternative of wire net.

Rabbits show high preference for this floor type (favourable from animal welfare viewpoint) which does not affect their production and behaviour. Due to its quick soil however increases the risk of sicknesses. Frequent application can also be hindered by the relatively high costs compared to wire net. The cage preference of rabbits is influenced by the part of the day: during the resting period the growing rabbits like to stay on the more comfortable plastic net. Based on the results and on the literature it can be concluded that the wire net floor also provides an adequate surface for the growing rabbits. The rabbits' production and behaviour is not affected negatively by this floor type. Therefore further tests of different types of wire net floors are necessary taking the diameter, hole size and hole shape also into account.

Gnawing stick

The rabbits do not prefer the Black elder, European larch, European white birch tree and White mulberry. Rabbits showed preference towards gnawing sticks of White locust, White willow, White buckeye, Little-leaf linden and Black poplar.

Gnawing stick made from soft tree is an environmental enrichment factor that can reduce the frequency of aggressive behaviours (ear lesions) without decreasing the production of growing rabbits. Application of Little-leaf linden gnawing sticks can be recommended especially by group housing of rabbits.

Adequately chosen gnawing sticks may have favourable effects on the growing rabbits' certain slaughter traits or even on their meat quality. As the rabbits can consume a considerable amount of gnawing sticks this can affect feed consumption and in case of curative properties (of the gnawing tree species) digestion and health of the rabbits can also improve. Because of the above mentioned advantages the gnawing sticks can play important role also in the alternative technologies even producing high quality products.

Cage height

The rabbits had a low preference for open top cages therefore their recommendation is questionable. Rabbits like to rest in low (20 cm high) cages but these cages are not adequate for executing locomotory behaviours and the frequency of aggressive behaviours increases. Examining the welfare indicators (preference test, ear lesions connected to aggressive behaviours, production of the growing rabbits) it can be concluded that the generally wide-spread 30-35 cm high cages are adequate for the growing rabbits.

5. NEW EXPERIMENTAL RESULTS

1. In cages applying a stocking density less than 16 rabbits/m² had no advantages because production of growing rabbits did not improve and behaviour was also not altered.
2. In larger groups production and slaughter performance of growing rabbits decrease. In larger groups the frequency of the aggressive behaviour is higher. Rearing rabbits in small groups (6-8 rabbits) offers a good compromise as production and slaughter parameters hardly change, the rabbits can execute locomotory and social behaviours without increasing the occurrence of ear lesions (aggression).
3. The growing rabbits prefer the plastic net but the wire floors do also provide appropriate environment for the rabbits. Their production and their behaviour it was the same on the plastic net or wire mesh floor.
4. The growing rabbits do not prefer the Black elder, European larch, European white birch tree and White mulberry. Rabbits showed preference towards gnawing sticks of White locust, White willow, White buckeye, Little-leaf linden and Black poplar. Gnawing stick made from soft tree is an environmental enrichment factor that can reduce the frequency of aggressive behaviours (ear lesions) without decreasing the production of growing rabbits. Application of Little-leaf linden gnawing sticks can be recommended especially by group housing of rabbits.

5. The rabbits had a low preference for open top cages (pens). Examining the preference test and production of the growing rabbits it can be concluded that the generally wide-spread 30-35 cm high cages are adequate for the growing rabbits.

6. PUBLICATIONS ON THE SUBJECT OF THE DISSERTATION

Papers published in foreign-language peer-reviewed journals:

1. *Princz Z., Orova Z., Nagy I., Jordan D., Štuhec I., Luzi F., Verga M., Szendrő Zs.* (2007) Application of gnawing sticks in rabbit housing. *World Rabbit Science*, 15, 29-36.
2. *Princz Z., Dalle Zotte, A., Radnai I., Biró-Németh E., Matics Zs., Gerencsér Zs., Nagy I., Szendrő Zs.* (2007) Behaviour of growing rabbits under various housing conditions, *Appl. Anim. Behav. Sci.* (in press).
3. *Princz Z., Dalle Zotte A., Metzger Sz., Radnai I., Biró-Németh E., Orova Z., Szendrő Zs.* (2008) Response of fattening rabbits reared under different housing conditions. 1. Live performance and health status. *Livest. Sci.* (in press).
4. *Dalle Zotte A., Princz Z., Metzger Sz., Szabó A., Radnai I., Biró-Németh E., Orova Z., Szendrő Zs.* (2008) Response of fattening rabbits reared under different housing conditions. 2. Carcass and Meat quality. *Livest. Sci.* (in press).
5. *Princz Z., Radnai I., Biró-Németh E., Matics Zs., Gerencsér Zs., Nagy I., Szendrő Zs.* (2008) Effect of cage height on the welfare of growing rabbits. *Appl. Anim. Behav. Sci.* (in press).

Full conference papers in foreign-language in proceedings:

1. *Princz Z., Szendrő Zs., Radnai I., Bironé Németh E., Orova Z.* (2005) Freie Platzwahl der Jungkaninchen zwischen Boxen unterschiedlicher Höhe; 14. Arbeitstagung über Haltung und Krankheiten der Kaninchen, Pelztiere und Heimtiere, Celle, 38-46. p.
2. *Szendrő Zs., Matics Zs., Princz Z., Orova Z.* (2006) free choice method to investigate the welfare of growing rabbits. 3rd Rabbit Congress of the Americas, Maringa, Brasil, CD.
3. *Princz Z., Dalle Zotte A., Radnai I., Biró-Németh E., Matics Zs., Gerencsér Zs., Nagy I., Szendrő Zs.* (2007) Behaviour of growing rabbits under various housing conditions. 15. Arbeitstagung über Haltung und Krankheiten der Kaninchen, Pelztiere und Heimtiere, Celle, 28-34.
4. *Princz, Z., Nagy, I., Biró-Németh, E., Matics, Zs., Szendrő, Zs.* (2008). Effect of gnawing sticks on the welfare of growing rabbits. In *Proc.: 9th World Rabbit Congress, Verona, Italy.* (accepted)

Full conference papers in Hungarian-language in proceedings:

1. *Princz Z., Szendrő Zs., Radnai I., Bironé Németh E., Orova Z.* (2005) Free choice of rabbits among cages with different height. 17th Hung. Conf. Rabbit Prod., Kaposvár, 87-94.

2. *Princz Z., Szendrő Zs., Dalle Zotte A., Radnai I., Bironé Németh E., Metzger Sz., Gyovai M., Orova Z.* (2005) Effect of different housing on productive traits and some behaviour patterns of growing rabbits. (Preliminary results). *17th Hung. Conf. Rabbit Prod., Kaposvár, 95-102.*
3. *Princz Z., Romvári R., Szabó A., Metzger Sz., Radnai I., Biróné Németh E., Orova Z., Nagy I., Szendrő Zs.* (2006) Effect of the group size and stocking density on the productive performance, carcass traits, meat quality and welfare of growing rabbits. *18th Hung. Conf. Rabbit Prod., Kaposvár, 159-164.*
4. *Princz Z., Radnai I., Biróné Németh E., Matics Zs., Orova Z., Szendrő Zs.* (2006) Free choice of rabbits among cages of different heights. *18th Hung. Conf. Rabbit Prod., Kaposvár, 165-170.*
5. *Princz Z., Radnai I., Biróné Németh E., Gerencsér Zs., Nagy I., Szendrő Zs.* (2006) Effect of cage height on productive performance and incidence of ear lesions of growing rabbits. *18th Hung. Conf. Rabbit Prod., Kaposvár, 171-176.*
6. *Princz Z., Dalle Zotte A., Radnai I., Biróné Németh E., Matics Zs., Orova Z., Nagy I., Szendrő Zs.* (2006) Effect of floor type and gnawing stick on the cage-choice of the growing rabbits. *18th Hung. Conf. Rabbit Prod., Kaposvár, 183-188.*
7. *Princz Z., Radnai I., Biróné Németh E., Matics Zs., Nagy I., Szendrő Zs.* (2006) Application of gnawing sticks in rabbit housing. *18th Hung. Conf. Rabbit Prod., Kaposvár, 177-182.*
8. *Princz Z., Radnai I., Biróné Németh E., Matics Zs., Orova Z., Gerencsér Zs., Szendrő Zs.* (2006) Examination of cages height from aspect of production and welfare of growing rabbits. *3th Scientific Day in Óvár, 55.*
9. *Princz Z., Nagy I., Radnai I., Biróné Németh E., Matics Zs., Gerencsér Zs., Szendrő Zs.* (2007) The effect of the type of gnawing stick on the productive performance and incidence of ear lesions of growing rabbits. *19th Hung. Conf. Rabbit Prod., Kaposvár, 89-94.*
10. *Princz Z., Dalle Zotte A., Radnai I., Biró-Németh E., Matics Zs., Gerencsér Zs., Nagy, I., Szendrő, Zs.* (2007) Effect of housing conditions on the behaviour of growing rabbits. *19th Hung. Conf. Rabbit Prod., Kaposvár, 95-100.*

Abstract in proceedings:

1. *Szendrő Zs., Princz Z., Radnai I., Biró-Németh E., Orova Z.* (2005) Free choice of rabbits among cages with different height. *COST Action 848, Joint Scientific Meeting, Palermo. 2005. June 23-25.*
2. *Szendrő Zs., Princz Z., Dalle-Zotte A., Radnai I., Biró-Németh E., Metzger Sz., Gyovai M., Orova Z.* (2005) Effect of different housing on productive traits and on some behaviour patterns of growing rabbits. *COST Action 848, Joint Scientific Meeting, Palermo. 2005. June 23-25. 18.*

3. Szendrő Zs., Matics Zs., Orova Z., Princz Z. (2005) Do the rabbits know something about their welfare? In: 29. *International Ethological Conference. Budapest, 2005.*
4. Dalle-Zotte A., Princz Z., Szendrő Zs., Radnai I., Biró-Németh E., Metzger Sz., Gyovai M., Orova Z. (2005) Effecto di diversi sistemi di stabulazione sulle prestazioni produttive e sul comportamento dei conigli in accrescimento – Risultati preliminari. *Atti „Giornate di Coniglicoltura” ASIC 2005. Forli, 2005. sept. 30-okt. 1.*