

Abstracts of the communications presented during the

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PRODUCTION, MANAGEMENT

Thoughts on rabbit meat production: future developments and perspectives

MAERTENS L.

Department of Animal Nutrition and Husbandry, Section Small Stock Husbandry
Burg. Van Gansberghelaan 92, 9820 MERELBEKE (Belgium)

The author described the perspectives of rabbit meat production in a global context. Meat production tends to decrease and scandals have a negative influence on consumer behaviour. However, if rabbit meat is promoted as being produced from exclusively herbivorous origin it can be an alternative for the contested red meats. European rabbit meat production and consumption are mainly based in the Mediterranean region. The pressure on animal production as a polluter of the environment as well as from the lobby to use more animal friendly production methods is much less intense than in the more Northern countries. Based on these aspects, future possibilities for rabbit production seem better in Southern countries.

Based on comparative data with pigs and poultry, the author concludes that although the production systems have changed considerably during the last decade, further concentration and intensification can be expected in rabbit meat production. In large units or in single batch systems, the production costs can be further reduced to become more competitive with poultry and pig production.

Other possibilities to reduce production costs are the use of high performance stock (hybrids) or a more intensive reproduction rhythm. However, the most important factor for successful commercial rabbit breeding is prevention against infectious diseases. An efficient prevention method or treatment for several rabbit diseases is still lacking. The use of healthy reproductive stock is an important factor to achieve a more constant production level and good economical perspectives for the rabbit breeder.

The current situation of rabbit production in Hungary

KLING J.

Rabbit Production Board, BUDAPEST, Akadémia u. 1–3
(Hungary)

In 2000, rabbit production in Hungary was 10,870 t live rabbits (5,118 t carcass). The ratio of whole and cut carcasses for export was 44.9 and 55.1%, respectively. Italy accounts for 56.1% of Hungarian rabbit exports, followed by Switzerland (31.2%), Germany (8.4%), Greece (1.7%), Belgium (1.3%), France (0.8%) and Russia (0.5%). Production is based on two Hungarian breeds (Pannon White, Debrecen White) and some hybrids (Hyplus, Hycole, and Zika).

Some observations on behaviour of nursing does

MATICS Zs., SZENDRŐ Zs., HOY S., RADNAI I., BÍRÓ-NÉMETH E., NAGY I., GYOVAI M.

University of Kaposvár, Faculty of Animal Science 7401
KAPOSVÁR, P.O.Box 16 (Hungary)

The aim of the experiments was to examine the nursing behaviour of does under different nursing conditions. A continuous video recording and time-lapse recorder (24 hours a day) was used. The four experimental treatments ($n=10/\text{group}$) were FF: Free nursing between parturition and day 16; FC: Free nursing between parturition and day 9 and controlled suckling between day 10 and 16 (from 8:00 a.m. to 8:30 a.m.); CF: Controlled suckling between parturition and day 9 and free nursing between day 10 and 16 ($n=10$); S16h: free access to the nestbox for 16 hours/day (from 4 p.m. to 8 a.m.) between parturition and day 16.

Between the days 1 and 9 74.8 % of the FF does nursed once a day and 25.2% nursed more than once a day. The respective values between the tenth and six-

teenth days were 78.4 and 21.6 %. In the CF group, a higher frequency of twice-a-day-nursing was observed (36.2% of all cases). The duration of daily nursing decreased ($P<0.01$) during the study period. If does only nursed once a day, the duration was significantly shorter than the first or the second nursing of does that nursed twice a day.

Between days 1 and 9 and days 10 and 16 in the FF group, 74.5 and 84.6% of nursing events were in the dark period (between 9 p.m. and 5 a.m.). In the CF group, 39.3% of does nursed in the dark period because of the high frequency of double nursing. It seems that the change from controlled suckling to free suckling has a significant effect on the frequency of double nursings. The average duration between two nursing events of twice-a-day nursing does was 8 hours and 42 sec; 44.9% of the events were 8 to 12 hours apart.

Nursing of kits by two does. Foster does are weaned at 21 days and nurse freely from evening till morning

SZENDRÖ Zs., GYARMATI T., RADNAI I.,
BIRÓNÉ NÉMETH E., MATICS Zs.

University of Kaposvár, Faculty of Animal Science 7401
KAPOSVÁR, P.O.Box 16 (Hungary)

Two experimental groups were established. Besides the traditional nursing method and weaning at 35 days ($n=61$ litters, 488 kits), young in the experimental group were nursed by two does to the age of 21 days ($n=74$ litters, 592 kits). The first (original) doe suckled in the morning (between 8 and 9 a.m.). The second doe was weaned at 21 days and afterwards she was used as a foster doe (free nursing between 3 p.m. and 8 a.m.). The double-suckled kits grew faster, their weight at 10 weeks of age was 2534 g compared to 2349 g for the control group. The daily feed intake between 5 and 10 weeks was 123 and 139 g, respectively ($P<0.05$) but no significant difference was found in the feed conversion.

Effect of birth weight, milk supply and feeding scheme on the performance of rabbits between 3 and 13 weeks of age

SZENDRÖ Zs., GYOVAI M., BIRÓ-NÉMETH E.,
RADNAI I., NAGY I., MATICS Zs.

University of Kaposvár, Faculty of Animal Science 7401
KAPOSVÁR, P.O.Box 16 (Hungary)

Using a 3-factorial design, the effect of birth weight, milk supply and feeding regime was studied. New-born rabbits were weighed and divided into three groups according to their birth weight (small=35–45 g, medium=53–58 g and large=65–70 g). Litters of eight young were constituted and half of the litter was nursed by one doe while the others suckled from two does. After weaning at 21 days, each group was subdivided, and the rabbits were fed *ad libitum* or restricted. The daily feeding period was 10 hours between 3 and 10 weeks of age and 9 hours between 10 and 13 weeks of age, which was about 85–90% of the *ad libitum* intake.

All factors significantly influenced weight gain, body weight and feed intake ($P<0.01$). There was no effect on feed conversion. The differences in feed intake and weight gain between the most disadvantageous treatment (small new-born rabbits nursed by one doe and fed restricted) and the most advantageous group (large new-born rabbits nursed by two does and fed *ad libitum*) were 32.8 and 12.9 g/day, respectively between the 3rd and 6th week of age. Corresponding figures were 70 and 12.1 g/day between the sixth and tenth weeks and 60 and 12.6 g/day from 10 to 13 weeks. The differences in body weights at 6, 10 and 13 weeks of age were 430, 768 and 1034 g, respectively.

Effect of weaning age, cage size and stocking density on the performance of fattening rabbits

EIBEN Cs., SZENDRÖ Zs., RADNAI I.,
BIRÓNÉ NÉMETH E.

Institute for Small Animal Research, 2101 GÖDÖLLÖ, P.O.Box 417. (Hungary)

The authors carried out a 2 x 2 x 2 factorial trial to examine the effect of weaning age, cage size and stocking density on production of kits. Altogether 632 Pannon White rabbits were used, half of the litters were weaned at 28 days and the others at 35 days of age. Both groups were divided into two subgroups at weaning and reared in large cages (85x55 cm) or in smaller fattening cages (50x33 cm). In both cases, high or low stocking densities were compared (8–9 or 6–7 animals / large cage (18.2 or 13.9 rabbits/m²), and 3 or 2 animals / small cage (18.2 or 12.1 rabbits/m²). The 35 d weaning resulted in lower stress as indicated by a lower mortality rate in first week after weaning as compared to the 28 d weaning. During the whole fattening period, however, the mortality was similar or higher for the 35 d weaning

age. There was no significant difference in the weight gain or body weight at 11 weeks of rabbits weaned at 28 or 35 days of age. Rearing kits in larger groups of 8–9 or 3 animals per cage was not disadvantageous because their performance corresponded to that of those housed in smaller groups of 6–7 or 2 animals.

Production traits of fattening rabbits kept in small-group cages

VIRÁG GY., MOHAUPT M., KEREPECKI Z., NAGY S.

Institute for Small Animal Research, 2101 GÖDÖLLÖ, P.O.Box 417. (Hungary)

Consumers increasingly demand production systems that are sufficient regarding animal welfare aspects. In the fattening period affordable housing should provide space for movements characteristic of the rabbit and the companionship of littermates. Daily weight gain from 35–84 days of age and slaughter live weight were lower by 12% (36.3 vs. 30.3 g/day and 2609 vs. 2293g, respectively, $P<0.001$) when rabbits were reared in small groups (8 littermates/cage) compared to the traditional cage (2 rabbits/cage). The cold carcass weight and the percentage of the hind limb were 27 grams and 1.8% higher, respectively, for group housed animals. The meat quality was also influenced by the rearing method so that water content increased by 1.2% in this particular group.

Fattening in this special type of cage, which has a slatted plastic floor and provides space and companionship, can be satisfactory for the consumer and advantageous for the slaughterhouse at the same time. For rabbit breeders it could be rewarding if a higher price was provided for this product.

REPRODUCTION

Preliminary studies on the long-term storage of rabbit semen

BARANYAI B., SOMFAI T., VIRÁG GY., LACZKÓ L., RI HAK CHOL, POLGÁR Zs., GÓCZA E.

Agricultural Biotechnolgy Centre, 2100 GÖDÖLLÖ, P.O.Box 411 (Hungary)

Two vitrification protocols were compared and the effect of cryopreservation on rabbit spermatozoa was evaluated. With Kovacs–Foote staining of the spermatozoa, their viability and fertilizing ability can be observed.

Both cryopreservation methods decreased the ratio of living cells significantly (from 90.7% to 70.2 and 18.8%, respectively), however, the apparent difference in their effectiveness was not statistically significant. That can be due to the small number of samples or to the different rate of dilution applied in the two cases (2x vs. 4x). Increase in cell number results in poorer survival. No difference was found in post-thaw live cell number between males. The strong negative effect of cryopreservation may have masked any detectable difference in the sensitivity of males to semen cryopreservation. It may be overcome with the use of higher number of males.

NUTRITION

Influence of feeding intensity on the growth of different body measurements in rabbits II. Hungarian giant rabbit

FODOR K., FEKETE S., ESZES F., GÁSPÁRDY A., ZÖLDÁG L., BERSÉNYI A.

SzIE Faculty of Veterinary Science, 1400 BUDAPEST, P.O. Box 2. (Hungary)

An experiment with young female Hungarian Giant rabbits was carried out to establish the values of live body measurements as a function of feeding intensity. Group AL animals ($n=11$) were fed *ad libitum*, while their sisters' feeding was restricted ($n=11$) at 70% of *ad libitum* (Group RS). The starting live weights were practically the same: 1.72 ± 0.34 vs. 1.75 ± 0.35 kg in groups AL and RS, respectively. The feeding trial lasted from 7 to 24 weeks of age. The average body weight at 24 weeks of age was higher in AL (5.42 ± 0.69 kg vs. 4.86 ± 0.32 kg, respectively). The average body weights of AL does at 17 weeks and RL does at 21 weeks of age were similar (4.47 and 4.42 kg, respectively). Significant differences ($P<0.05$) were found in trunk length, head height and fore cannon lengths. between the two groups of animals at the same body weight.

Feeding–genotype interaction during rearing of growing breeding female rabbits: Its relation to total body composition

II. Hungarian giant rabbit

FEKETE S., ZÖLDÁG L., FODOR K., BERSÉNYI A.,
GÁSPÁRDY A., ANDRÁSOF SZKY E.

SZIE Faculty of Veterinary Science, 1400 BUDAPEST, P.O. Box
2. (Hungary)

Female Hungarian Giant rabbits ($n=22$) were divided into two groups: *ad libitum* (AL) and 70% restricted (RS) feeding. As a baseline, another 7 analogous rabbits were analysed for major chemical components. The trial lasted from 7 to 24 weeks of age. The starting live weights were similar: 1.72 ± 0.34 vs. 1.75 ± 0.35 kg in groups AL and RS, respectively. Using time-shifted pair feeding, individuals of group RS received the 70% of the previous day's feed intake of the appropriate counter-partner. After euthanasia at the end of the experiment the total body chemical composition was determined. The final live weight on week 24 for RS females was 84.4% (4.86 ± 0.32 kg) of the AL (5.42 ± 0.69 kg). The effect of feed restriction resulted in lower fat, as well higher ash and protein contents both on a whole body and a dry matter basis. Seven week rabbits hadn't reached chemical maturity but the rabbits had done so by the end of the trial. Restricted feeding delayed sexual maturity, i.e. ovarian activity and responsiveness developed later, and the ovaries contained fewer tertiary follicles.

MEAT, BODY COMPOSITION

Experience of rabbit meat quality evaluation aimed at keeping consumer confidence

CAVANI, C., PETRACCI, M.

Department of Food Science. Alma Mater Studiorum.
University of Bologna. Via S. Giacomo 9, BOLOGNA (Italy)

Rabbit researchers are attempting to give concrete answers to the increasing demand of consumers for guarantees of safety and eating quality of meat, and animal welfare and environmental issues. From this point of view, a change can be foreseen from current housing systems to systems that are closer to the natural behaviour of rabbits.

bits. Similarly, animal feeding is being adapted to fit this new need by modifying present standards and selecting raw ingredients in a way that the feeding plans are as close as possible to what would be a natural and typical diet for rabbits. The current status of research with rabbits indicates that breeding systems and feeding can be modified without compromising technological and sensory properties of meat. For this reason, it is important to improve the evaluation of meat by means of the design and development of new analytical techniques. Low resolution nuclear magnetic resonance allows fast and accurate evaluation of water holding capacity of meat, but in the future also could be used to improve the characterisation of meat as a function of various breeding systems. This paper aimed to review some recent studies carried out by our research group in line with the new expectations of the consumers for meat quality.

Use of the TOBEC method in the selection on body fat content of rabbits

LÉVAI A., MILISITS G., MAROSFFY V.

University of Kaposvár, Faculty of Animal Science 7401
KAPOSVÁR, P.O.Box 16 (Hungary)

The aim of this study was to clarify the usefulness of the TOBEC method in the selection for body fat content of rabbits and to compare the production of rabbit populations selected for high and low body fat content. Rabbits of mean ± 1 S.D. live weight at 10 weeks of age and of mean ± 1 S.D. daily weight gain between 6 and 10 weeks of age were chosen from the experimental stocks of the university. Fat content was determined with an EM-SCAN SA-152 type for small animal body composition analysis (by means of the TOBEC method). Based on the fat content determined, the highest and lowest 16% of the females and the highest and lowest 8% of the males were chosen and mated with each other (fatty does with fatty bucks and lean does with lean bucks).

Conception rate was significantly higher (75.0 vs. 54.8%, $P<0.1$) and the number of inseminations needed for one kindling was significantly lower (1.26 vs. 1.53) for the fatty rabbits. No significant differences were observed in the total and live litter sizes, but non-fatty does produced larger litters in both cases (8.3 vs. 9.0 and 7.9 vs. 8.2). Because of the significant difference in the ratio of dead-born pups (4.5 vs. 10.2%, $P<0.01$), the 0.7 pup difference in total litter size decreased to 0.3 for live-

born pups. The mortality rate and the total litter loss was lower in the non-fatty does (26.0 vs. 21.6 and 8.1 vs. 5.6%, respectively) during the whole suckling period. As a result of these important, but not significant differences, the litter sizes at 21 days also differed (5.8 vs. 6.6). Highly significant differences were observed in the body fat content of rabbits in the first selected generation. The estimated fat content of the offspring of fatty parents surpassed the body fat content of the offspring of non-fatty parents (5.4 vs. 3.8%, respectively; $P<0.001$). The differences in the scapular and abdominal fat ratios to the live weight were also significant. If these trends can be observed in more generations and differences in the production level of does can be proven statistically, the TOBEC method will show its potential as a practical tool for selection of rabbits.

Investigation of the effect of saturated and unsaturated fatty acid complementation on the muscle fatty acid profile of rabbits

SZABÓ A., FÉBEL H., SZENDRŐ ZS., ROMVÁRI R.

University of Kaposvár, Faculty of Animal Science 7401
KAPOSVÁR, P.O.Box 16 (Hungary)

Pannon White rabbits ($n=36$ males) at 4 weeks of age were treated with different fatty acid supplementation diets for a trial period of 25 days. Fat powder (40%) and full-fat soybean (10 and 24.5%, respectively) were used to modify the saturated and unsaturated fatty acid composition. Two muscle types (m. L.D. and m.Q.F.) were investigated to follow the changes – by means of gas chromatography – induced by different dietary fatty acid supplementation. Statistically significant differences existed within the feeding groups between the muscles in contents of C14:0 (miristic acid), C16:1 (palmitoleic acid), C18:1 (oleic acid), C18:2 (linoleic acid) and C18:3 (linolenic acid). Important differences ($P<.05$) were found between the two feeding groups for m.L.D. and m.Q.F. in the contents of C14:0, C16:1, C18:0, C18:1, C18:2 and C18:3. Within feeding groups, m.L.D. showed a lower concentration of arachidonic acid (C20:4). No differences were observed for C15:0 and C17:0. The very different muscle fiber types and functional properties may explain the existing differences within the feeding groups.

PHYSIOLOGY

Effect of alloxan treatment on glutathione-peroxidase activity in rabbit

VIRÁG GY., ERDÉLYI M., MÉZES M., OPPEL K., TEMESVÁRI K.

Institute for Small Animal Research, 2101 GÖDÖLLŐ, P.O.Box 417. (Hungary)

Alloxan is a well-known inducer of insulin dependent diabetes but also acts as a strong pro-oxidative agent. The purpose of the present study was to determine the short- (48 hours) and long-term (8 weeks) effects of alloxan treatment beside continuous blood plasma glucose control and insulin treatment if necessary (>12 mmol/l). It was found that malondialdehyde content of tissues (liver, kidney) increased only during long-term treatment but not as a short-term effect of alloxan. The substrate of glutathione-peroxidase enzyme – reduced glutathione – moderately decreased in liver, but enzyme activity did not change during the short-term study and only changed as a long-term effect of alloxan. The rate of decrease of glutathione-peroxidase is extreme, which is caused by the extreme increase of protein content of the tissue homogenates. Results of the present study showed that alloxan can be a useful pro-oxidant model for investigation of environ-

Clinical laboratory diagnostics of rabbits treated with heavy metals (Cd, Pb, and Hg)

BERSÉNYI A., FEKETE S., GLÁVITS R., GAÁL T., HUDÁK A.

SzIE Faculty of Veterinary Science, 1400 BUDAPEST, P.O. Box 2. (Hungary)

New Zealand White female rabbits were treated orally with inorganic salts of cadmium, lead and mercury ($n=4/treatment$) in concentrations of 2.3, 4.1, and 30 mg/kg DM, respectively, for 28 days. The Pb exposure significantly decreased the red blood cells (RBC), blood hemoglobin (HGB), and hematocrit (HCT) compared to the control ($5.04\pm2.74\times10^{12}/l$, 96.75 ± 49.30 g/l, and $29.55\pm16.00\%$ vs. $6.56\pm0.82\times10^{12}/l$, 120.95 ± 11.39 g/l, and $37.41\pm4.51\%$, respectively; $P<0.05$). As mean cell volume (MCV) and the mean cell hemoglobin (MCH) were also significantly increased (59.10 ± 1.12 fl and 20.03 ± 2.17 pg vs

57.08±1.63 fl and 18.53±0.91 pg, respectively; P<0.05), hyperchromic macrocytic anemia was obtained. The zinc protoporphyrin (ZP) test was applied to diagnose the exposure to lead. The ZP concentration was practically unchanged (106.00±19.78 mmol/mol hem vs. 114.57±37.80 mmol/mol hem, respectively). The result indicates that ZP concentration was not a good indicator of lead contamination because protoporphyrin increases provisionally in lead-poisoned rabbits. Both the significantly increased AST activity by Pb and Hg loading (41.25±15.27 and 43.23±12.75 U/l vs 20.23±6.92 U/l, resp.; P<0.01), and ALT activity by Hg exposure (64.15±17.48 U/l vs 49.53±8.08 U/l; P<0.01) indicated damage of the liver parenchyma such as focal fatty infiltration. Cadmium loading also increased the ALT activity (61.13±12.93 U/l). This can be explained by toxicity to the kidneys, although the slight tubulonephrosis did not affect the renal functions.

GENETICS

Distribution of κ and β -casein alleles and their effect on the reproductive performance in two INRA rabbit strains

TÓTH SZ., MÉSZÁR Z., VIRÁG GY., BOLET G., BÖSZE ZS.

Agricultural Biotechnolgy Centre, 2100 GÖDÖLLŐ, P.O.Box 411 (Hungary)

The aim of the experiment was to characterize the allele distribution of the milk components: β and κ caseins in two INRA rabbit strains. The two strains (A1077 and A 2066) were selected for litter size at birth and at weaning, respectively, through 28 generations. In strain A2066 we found only the A allele of κ -casein. In strain A1077, allelic frequencies of A(0.46) and B(0.54) were rather similar. We produced crossbred females by inseminating κ -casein AB females of strain A1077 with AA males of strain A2066 to analyse the relation between genotype and reproduction by comparison of daughters of different genotypes. Collection of data from the crossbred females is still under way, however reproductive data from G29 and G30 females of A1077 strain indicates that there is a significant effect of the κ casein genotype on individual weight at weaning even if it is corrected for litter size at weaning.

Analysis of pluripotent rabbit embryonic stem cells during in vitro development of rabbit embryos

GÓCZA E., KOBOLÁK J., HIRIPI L., MAKOVICS F., BÖSZE ZS.

Agricultural Biotechnolgy Centre, 2100 GÖDÖLLŐ, P.O.Box 411 (Hungary)

We aimed to establish a rabbit embryonic stem (ES) cell line that may contribute to the germ line as well. Pluripotent ES cells are undifferentiated cells derived from early embryos and are capable of unlimited undifferentiated proliferation in vitro. A strategy originally used for creating ES cell lines from non-permissive mouse strains was adapted for rabbits.

In our experiments, the OctNeo vector was co-injected with the Green Fluorescent Protein encoding EGFP vector. Since a joint insertion of the two vectors is expected, the presence of the EGFP also marks the insertion of the OctNeo vector. More than 1200 microinjected rabbit embryos have been transferred to recipient mothers and about 770 microinjected rabbit embryos were analyzed in vitro. Following PCR analysis of DNA of the 134 progeny born so far, three OctNeo/EGFP transgenic rabbits were found.

Non-injected control (n=161) and injected (n=773) embryos were cultured in vitro after injection. In the presence of G418, non-transgenic cells, and differentiated cells were selectively removed. This allowed the pluripotent, OctNeo transgenic cells to expand. Five control ES like cell lines from the control, and two from the injected rabbit embryos have been established so far.