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Digestive Physiology

INTERACTIONS BETWEEN GUT MICROFLORA AND DIGESTIVE MUCOSAL IMMUNITY, AND STRATEGIES TO IMPROVE DIGESTIVE HEALTH IN YOUNG RABBITS. FORTUN-LAMOTHE L.^{*}, BOULLIER S.[†] **Station de Rech. Cunicoles, INRA, Castanet Tolosan. lamothe@toulouse.inra.fr. †UMR 1225 INRA-ENVT, Toulouse Cedex 3, France.*

Enteric diseases frequently occur in rabbit around weaning leading to extensive use of antibiotics in rabbit breedings. In this context, breeders as well as consumers ask for alternative strategies that improve the health of animals. But the maintenance of gut health is complex and relies on a delicate balance between the mucosa (including the absorptive epithelium and the digestive immune system), the commensal microflora and environmental factors including diet. Firstly, immune and non-immune mechanisms of protection against pathogens in the gut were presented followed by installation and composition of the gut microflora in the rabbits and its role on health. Finally, several strategies to stimulate digestive immune system or favour beneficial flora to exclude enteric pathogens were discussed. Several nutrients were implicated in the development of immune response and could be used to improve immune ability of animals. Among which, dietary fatty acids ($\omega 3/\omega 6$ ratio) could be of interest in the rabbit. The role of dietary fibres on digestive health have been demonstrated in weaned

rabbits, and strong relations between fibres supply and caecal microflora were evidenced. Some works also reported an influence of fibre level in the diet given to the young before weaning on health status of rabbits after weaning. Therefore, nutritional needs of suckling rabbits, more especially fibre requirements, to enhance subsequent gut health need to be deeply studied, in relation with needs of their mothers. Exogenous flora could also be added to the diet to stimulate the digestive immune system and prevent the development of enteric pathogens. Finally, vaccines permit protection of the host against specific pathogens.

CECAL CONTENT COMPOSITION AND DRY MATTER EXCRETION IN RABBITS CONSUMING SUGAR CANE MEALS. DIHIGO L.E., SAVÓN L., SIERRA F. *Inst. de Ciencia Animal. La Habana, Cuba.*

Twenty-Four white Semigiant x New Zealand commercial hybrid male rabbits of 4.5 months of age and 2.4 kg average weight were used in a completely randomized design. The objective was to study the effect of sugarcane meal (SM) on the cecal contents composition and dry matter (DM) excretion of rabbits. The animals were distributed in four treatments with 0, 15, 30 and 45% SM inclusion in the diets. Six animals per treatment were used. They were allocated in individual metabolism cages and offered 120 g of feed/day. The animals were slaughtered at 14 days age and the contents of their digestive

organs, were weighted and DM, crude protein (CP) and acid detergent fiber (ADF) were determined and expressed as percentages of the live weight (LW). Significant ($P<0.01$ and $P<0.05$) differences were observed in the contents in g/kg DM and the percent the live-weight for the DM respectively in the diets with 30 and 45% SM. With the increase of the SM decrease DM contents in faeces ($P<0.05$) and ($P<0.05$) for the 30 and 45 % SM level with values of (22.17 and 17.57g/kg DM and 0.96 and 0.63 % LW). It is concluded that the inclusion of more than 15% of sugar cane meal in rabbit diets had negative effect on the dry matter cecal contents and the excretion of dry matter in the faeces due to the characteristics of the sugar cane fiber.

EFFECTS OF EXOGENOUSLY ADDED SHORT-CHAIN FATTY ACIDS ON PANCREATIC EXOCRINE SECRETION IN DOMESTIC RABBIT.

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A number of 26 New Zealand White rabbits were anesthetized and surgically prepared by acute fistula of Santorini duct to collect pure pancreatic juice. Acetate, propionate or butyrate and/or secretin were intravenously injected to search their effect on pancreatic juice flow and composition. It was found that intravenous administration of propionate or butyrate significantly potentiated the stimulatory effect of secretin on pancreatic juice flow. Maximal increasing of juice flow was obtained when it was administered an intravenous dose of 640 μ Mols of acetate, propionate or butyrate +2U of secretin/Kg body weight. The highest stimulatory effects on pancreatic juice flow, protein output and amylase output showed butyrate+secretin, following propionate+secretin.

WEANING AGE AND DEVELOPMENT OF THE SMALL INTESTINAL MUCOSA IN THE YOUNG RABBIT. GALLOIS M.^{*}, GIDENNE T.^{*}, FORTUN-LAMOTHE L.^{*}, LE HUEROU-LURONO I.[†], LALLES J.

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The respective roles and interactions of intrinsic and extrinsic factors such as age and feed on digestive maturation of young rabbits are not yet completely identified. However, their knowledge is essential to determine the nutritional requirements of young rabbits around weaning, when they are more sensitive to digestive disorders. Twenty four litters of nine young rabbits were fed *ad libitum* from day 14 till day 49. They were weaned at either 21 (group W21, n=12) or 35 (W35 group, n=12) days of age, in order to modulate the solid feed intake. From day 14 till day 49, five young rabbits per treatment group were slaughtered weekly and pieces of duodenal, jejunal and ileal tissues were sampled and studied for villus-crypt architecture: villus height and width, as well as crypt depth were measured using a microdissection technique and a viewer analysis software system. Many changes in the intestinal mucosa occurred with increasing age irrespective of the weaning age. From day 28 to day 49, the intestinal villi heightened ($P<0.05$) at all sites (duodenum 746 μ m on day 28 vs. 940 μ m on day 49, jejunum 549 μ m vs. 759 μ m, ileum 357 μ m vs. 570 μ m (W21+ W35 together). A proximo-distal decreasing gradient in villus height was also apparent starting from day 28 ($P<0.05$). The crypts deepened from day 14 till day 49 ($P<0.05$). Villus shape, estimated by the height to width ratio, also changed with the beginning of significant solid feed intake. They became wider between day 21 and day 28 ($P<0.05$) at the duodenum (villus height to width ratio 3.7 vs. 2.2), jejunum (4.0 vs. 2.2) and ileum (4.0 vs. 2.4). From 21 till 35 days of age, the rabbits weaned at 21 days ate 57% more solid feed than those weaned at 35 days. However, the effect of weaning age on mucosal morphology was not significant. In conclusion, these results suggest that the maturation of the small intestinal mucosa is independent from solid feed intake level at least until day 35, but may be sensitive to the beginning of solid feed intake.

EFFECT OF A VEGETABLE EXTRACT (TRADE NAME: IMMUNOVET-HBM®) UPON ACTIVITY OF DIGESTIVE ENZYMES IN RABBITS. KÓSA E.* , KOVÁCS M.†, RIGÓ Z.* *Szent István Univ., Fac. of Veterinary Sci., Budapest, István.ekosa@univet.hu; †Univ. of Kaposvár, Fac. of Animal Sci., Hungary.

The authors have compared activity of α -amylase, lipase and trypsin in the pancreatic tissue and small intestinal content of rabbits weaned early (on day 21). Previously in the same animals the effect of a non-medicated diet and of a feed additive consisting of natural ingredients on the growth and on certain anatomical and physiological parameters of the digestive tract was examined. The aim of the study was to get more information on the developmental process of the digestive tract from birth to 42 days of age in order to decrease use of antibiotics and losses due to digestive disorders. It could be established that the early weaning of rabbits can be accomplished by the use of a non-medicated diet without any decrease in production. In the present study the measurement of pancreatic hydrolase's activity in the pancreas tissue homogenates and in the small intestinal content was examined in originated 8 animals from each group. The newborn rabbits were controlled weekly from 1 to 6 weeks of age. The data of the present trial suggest that in the early weaned significantly differs the digestive enzyme activity. The objective of present study was also to investigate the effect of IMMUNOVET-HBM® on hydrolase's activity in the 21 day-old rabbits. The results were summarized in Table 2 and 3.

DEVELOPMENT OF THE CAECAL MICROFLORA OF NEWBORN RABBITS DURING THE FIRST TEN DAYS AFTER BIRTH. KOVÁCS M.* , SZENDRO ZS.* , CSUTORÁS I.†, BÓTA B.‡, BENCSNÉ K. Z.* , OROVA Z.* , RADNAI I.* , BIRONÉ N.E.* , HORN P.* *Univ. of Kaposvár, Fac. of Anim. Sci. †Szent István Univ., Fac. of Vet. Sci., Budapest. ‡MTA-KE Animal Breed. and Hygiene Res. Group, Kaposvár, Hungary.

The caecal microflora and the fermentation processes taking place in the caecum play a key role in the digestion of rabbits. Imbalance of the intestinal microflora (dysbiosis) plays a direct

or indirect role in the development of digestive disturbances or diseases. The composition of the intestinal microflora is rather simple in rabbits, with the predominance of *Bacteroides*. According to Hudson *et al.* (1996), the colonisation is triggered by ingestion of the maternal faecal pellets that gets into the nest during nursing. The objective of the experiment was to study the rate of development of intestinal microflora in newborn rabbits after birth and the effect of nursing method and ingestion of maternal faeces on the colonisation of the caecum by bacteria. Pannon White does and their progeny were used in the experiments. The one-day-old pups of average birth weight were distributed into litters of eight, and these litters were randomly divided into the following three groups: Group 'A' (free nursing): freely nursed pups having access to maternal faeces. Group 'B' (controlled nursing): pups nursed once a day and having access to maternal faeces. Group 'C' (controlled nursing): pups nursed once a day and having no access to maternal faeces. Six young rabbits were examined by group on days 2, 4, 6, 8 and 10 after birth. After kindling, swab samples were taken from the vagina of the doe, from the surface of the vulva, from the skin of the nipples and the surrounding hairs. These samples and also samples from the caecal chyme of the pups were subjected to microbiological analysis. The supply of young rabbits with doe's milk (controlled or free nursing) and their access to the doe's faeces have been shown to affect the development of the caecal microflora. In rabbit pups nursed freely and thus having unlimited access to the doe's faecal pellets, colonisation of the caecum by *Bacteroides* microorganisms took place at a faster rate. Once-a-day nursing in the morning (controlled nursing) only slightly decreased the rate of colonisation by *Bacteroides*. Prevention of the ingestion of the doe's faeces only delayed, but did not prevent, the development of the normal intestinal microflora. This indicates that the faeces left behind by the doe has only limited role in the colonisation of the caecum by *Bacteroides* microorganisms.

SOME DIGESTIVE-PHYSIOLOGICAL PARAMETERS OF EARLY-WEANED RABBITS FED NON-MEDICATED DIETS. KOVACS M.*¹, SZENDRO ZS.*¹, CSUTORÁS I.†¹, BÓTA B.‡¹, FÉBEL H.§¹, KÓSA E.†¹, BENCSNÉ K.Z.*¹, SZAKÁCS Á.†¹, HORN P.*¹ *Univ. of Kaposvár. †Szent István Univ., Budapest; ‡MTA-KE Anim. Breed. and Hyg. Res Group, Kaposvár; §Res. Inst. for Anim. Breed. and Nutr., Herceghalom, Hungary.*

The effect of a non-medicated diet and of a feed additive consisting of natural ingredients on the growth of rabbits weaned early (on day 21) and on certain anatomical and physiological parameters of the digestive tract was examined. The aim of the study was to get more information on the developmental process of the digestive tract from birth to 42 d. of age in order to decrease use of antibiotics and losses due to digestive disorders. New-born rabbits were examined weekly from 7 to 42 d. of age. Body weight, quantity and pH of the gastric, small intestinal and caecal content, as well as the weight and length of the empty stomach, small intestine, caecum and colon were measured. Composition of the caecal microflora and volatile fatty acid production were determined. It could be established that the early weaning of rabbits can be accomplished by the use of a non-medicated diet without any decrease in production. The body weight gain of rabbits fed a non-medicated diet and a feed additive containing natural basic ingredients was higher than that achieved by rabbits fed the conventional medicated diet. Differences between groups in certain parameters (gastric pH, composition of the microflora, VFA production) were temporary and they did not lead to development of enteropathy.

WEIGHTS OF DIGESTIVE ORGANS, CAECAL METABOLITES AND FERMENTATION STOICHIOMETRY IN COYPUS AND RABBITS. MAROUNEK M.*¹, SKRIVAN M.*¹, SKRIVANOVÁ V.*¹, SAVKRA O.†² *Res. Inst. of Anim. Prod. Prague. †Inst. of Anim. Physiology and Gen., Cz. Acad. of Sci., Prague, Cz. Republic. ‡Inst. of Biotech. in Anim. Prod. Gzhyskyi Lviv Nat. Acad. of Vet. Medicine, Ukraine. marounek@iapg.cas.cz*

Six coypus and six rabbits fed the same granulated feed *ad libitum* were slaughtered,

digestive organs weighed and their contents analyzed. The caecum was the largest digestive organ in both animal species. Its weight averaged 170 g in coypus and 157 g in rabbits (4.1 and 5.5% of the total body weight, respectively). In rabbits, the weight of stomach was greater and that of the small intestine smaller than in coypus (135 and 89 g vs. 85 and 111 g). Gastric acidity and caecal and colonic dry matter concentrations were significantly higher in rabbits. Total volatile fatty acids (VFA) and ammonia concentrations in the caecal contents of coypus and rabbits were similar (100.1 and 23.3 $\mu\text{mol/g}$ in coypus and 104.8 and 25.5 $\mu\text{mol/g}$ in rabbits, respectively). Molar percentages of acetate and propionate, however, were significantly higher and percentage of butyrate lower in caecal VFA of coypus than in rabbits. The caecal contents were diluted with buffer and incubated anaerobically in order to determine the caecal fermentation pattern. Caecal microorganisms of coypus produced more propionate and methane, and less butyrate and valerate than caecal microbes of rabbits. Thus, different major hydrogen sinks exist in the coypu and rabbit caecum. In conclusion, there are both differences and similarities in the digestion pattern of coypus and rabbits. Caecal fermentation pattern in these herbivore species differed more than other parameters investigated.

DIGESTIBILITY OF DIETARY PEASHRUB NUTRIENTS. REN K.L.*¹, NIU X.W.†¹, LUOH D.*¹, LI Y.S.*¹, WANG F.*¹ *Anim. Husbandry & Vet. Inst. †Shanxi Academy of Agricultural Sci., Taiyuan, China.*

Peashrub, the common name for all cultivates of *Caragana microphylla* Kom., belongs to a perennial deciduous shrub. It is drought/heat-resistant, wind/sand-hardiness and is psammophilous plant grown in fixed/half-fixed sand. Peashrub is regarded as a fine tree variety to sand shifting control and water/soil conservation. It has been listed as one of the important tree varieties in current Conversion Project in northern China. On the purpose to study peashrub nutritional values, a feeding experiment focusing on the effects to rabbit production performance was conducted from

April to June in 2002. For approaches to new feed resources and to make good utilization of peashrub, the present study was undergone to evaluate nutritional values in peashrub through the measurement of rabbits' digestibility of crude protein, crude fat and crude fiber in rabbits. In the present experiment, 18 Hybrid young rabbits, half to half of the male to the female, and the method of endogenous indicator, 4NHCL undissolved ash method, were applied. The results are the following: The rabbits had a digestibility for dietary crude protein as high as 70.60%-73.75% and even high for peashrub CP from 70.59% to 88.76%; While the digestibility decreased along with the rise of level of peashrub meal in diet. Though rabbit's digestibility for crude fiber is rather limited, it was relatively high for peashrub crude fiber; Rabbits had a good digestibility over 98% for dietary and peashrub crude fat. These results suggest that Rabbits are capable of making a good utilization of peashrub nutrients and Peashrub could be considered as one of the important feed resources for domestic rabbits.

THE EFFECTS OF SUPPLEMENTAL MICROBIAL PHYTASE IN DIETS ON THE GROWTH PERFORMANCE AND MINERAL EXCRETION OF REX-RABBITS. ZHAO GUO-XIAN*, FENG ZHI-HUA†, WANG YU-DING*, LI YUN-QI*, LIU GUAN-ZHONG†
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To investigate the effects of supplemental microbial phytase (Natuphos 5000) in diets on performance and mineral excretion, fifty three-month old healthy rex-rabbits with similar weight was assigned randomly into 5 groups for a 6-week trial. Group I-V rex-rabbits were fed with basal diet supplement with 0(I), 400(II), 600(III), 800 UDKg (IV) phytase and 1.8% CaHPO₄ (V) respectively. The basal diet contained normal levels of Ca (0.9%) and total phosphorus (TP) (0.35%), other nutrients and energy levels were close to the rabbit requirements, without phytase and dicalcium phosphate (CaHPO₄). The results indicated that: (1) In comparison to negative control of Group I, the average daily gain of

Group II, III, IV and V increased by 1.65% ($P<0.05$), 5.77% ($P<0.05$), 11.48% ($P<0.05$) and 5.57% ($P<0.05$) respectively. Among the treatments, the average daily gain in Group IV was the highest, but the difference is not significant when compared with Group III and V ($P>0.05$). However, no significant effect on the average daily feed intake and the feed-gain ratio of rabbits ($P>0.05$) were observed in the dietary phytase experiment. (2) Dietary phytase remarkably reduced the excretion of total phosphorus (TP) and phytate phosphorus (PP), are slightly decreased the excretion of Ca. The excretion of Ca, TP, PP of Group I, II, III, and IV were lower than that in Group V. Compared with Group V, fecal TP decreased by 28.24% ($P<0.01$), 30.59% ($P<0.01$), 42.35% ($P<0.01$), 47.00% ($P<0.01$) respectively and it was shown significant difference between Group and ($P<0.05$) fecal PP decreased by 11.1% ($P>0.05$), 19.4% ($P>0.05$), 25% ($P<0.05$), 33.3% ($P<0.01$), respectively, the fourth group was much lower than other three groups ($P<0.01$) fecal Ca decreased by 14.50% ($P>0.05$), 9.92% ($P>0.05$), 12.21% ($P>0.05$), 19.08% ($P<0.05$), there were no significant difference between Group II, III, IV and Group I ($P>0.05$). As the dietary phytase increased, the excretion of Cu increased and the excretion of Zn and Mn were decreased slightly ($P>0.05$). In addition, it shown no regular varying trend in fecal Fe. In conclusion, the difference of faecal Cu, Fe, Zn, and Mn among treatments were not significant ($P>0.05$).

Management and Economics

COLONY REARING OF FATTENING RABBITS. MAERTENS L. Centre for Agricultural Res., Dpt. of Animal Nutrition and Husbandry, Melle, Belgium. l.maertens@clo.fgov.be

After weaning, rabbits are nearly exclusively housed in small collective cages till slaughter age. Group size ranges from 2 to over 50 fatteners and the space per animal in commercial units between 500 and 700 cm². The different housing systems are discussed in this paper and special attention is focussed if the barren environment and restricted natural locomotion pattern causes

behavioural problems. Stereotypies or injuries due to the wire bottom are seldom observed in fatteners. Nevertheless, one of main behavioural needs of rabbits seems to be the possibility of gnawing. Based on experimental results, there seems to be an antagonism between increased group size and or size of the area assigned to growing animals, and their growth performance and sanitary risks. Moreover, in large groups aggressiveness is a problem especially near puberty age. More research is necessary to determine the minimal space required per rabbit to obtain a sufficient level of welfare and optimal production results. Finally the attention is drawn to the fact that alternative pen housing does not fit with actual management systems used in intensive breeding units.

EFFECT OF NURSING FREQUENCY ON RABBITS' PRODUCTIVE PERFORMANCE. ECHEGARAY-TORRES J.L.* , REBOLLEDO-CH.O.†, RODRÍGUEZ-H.J.C.†, SALCEDO-BACA R.*. *Dpt. de Prepa. Agrícola, †Dpt. de Zootec., Univ. Autónoma Chapingo, Texcoco, México. echegart@correo.chapingo.mx

The objective of this experiment was to study the effect of nursing frequency on the performance of rabbits during both lactation and fattening periods. The trial was carried out at the Unidad de Investigación Aplicada en Producción Cunicola (UIAPC) from the Preparatoria Agrícola Department, Universidad Autónoma Chapingo, Mexico, which is located at 19° 29' N latitude, 98° 53' W longitude, and 2250 m altitude. The average monthly temperature is 15.2°C, the annual precipitation is 571.5 mm, and the rainy season takes during the summer. Intensive management was followed in which the pregnant does were housed in reproduction cages 4 days before the expected kindling. Each cage was provided with nest with a door allowed to have controlled access. In group nursed once the doors were opened at 7 am. for a period of 15 min while in the group nursed twice they were opened twice a day, at 7 am. and at 7 pm. If a doe did not want to go into the nestbox for nursing she was enclosed in it. Animals were managed in 3 bands: red (R), green (G) and yellow (Y). All of the bands were

managed in a 42d reproduction rhythm in three batches. Both the litters and the does were moved to fattening cages on day 35 after kindling, but does returned to reproduction cages on day 40 for the next kindling. Data of 122 does and their litters (983 kits at birth), belonging to green and yellow bands were analysed from February to June 2003. Litter size and litter weight at birth, at 21d, at weaning, and at slaughter were recorded, then the average weight of rabbits was calculated. Mortality of each period was calculated. The following model was used to analyse the experimental data: $Y_{ij} = \mu + T_i + B_j + b(x_{ij} - z) + e_{ij}$; where Y_{ij} = independent variable, μ = population mean, T_i = effect of treatment (nursing), B_j = effect of band, x_{ij} = individual litter size, z = population mean of litter size, b = the regression coefficient, e_{ij} = error. Previously to the analysis arcsin transformation was applied to mortality, then general linear model of SAS (1990) was applied to all of the variables. The independent variables were: kits' weight at 21 d of age, weaning weight, slaughter weight, mortality from birth to 21d, from 21d to weaning, and from weaning to slaughter. Treatment has significant ($P < 0.05$) effect on 21d weight and weaning weight but it did not influence the slaughter weight and mortality. Rabbits from does nursing twice a day were heavier by 14 and 30 g at 21d and at weaning, respectively than rabbits from does nursing once a day.

EXAMINATION OF FACTORS INFLUENCING RABBIT SURVIVAL (PRELIMINARY RESULTS). GYOVAI M*, MAERTENS L†, NAGY I*, BIRÓ-NÉMETH E*, RADNAI I*, PRINCZ Z*, GERENCSÉR ZS*, SZENDRO ZS*. *Univ. of Kaposvár, Fac. of Animal Sci., Hungary. szendro@mail.atk.u-kaposvar.hu. †Centre for Agricultural Res.-Ghent, Merelbeke, Belgium

Sevenhundred-eightyfour female new-born rabbits were used to study the effect of birth weight (BW), number of does (ND), feeding regime during the rearing period (FI) and age at first insemination (AI) on their survival rate. They were divided into 3 groups according to their birth weight (BW): low /L/: 35-45g, medium /M/: 53-58g, high /H/: 65-70g. After the initial

weighing, new litters of 8 kits were constituted with only L, M or H kits. Kits of each group were nursed by one /1/ or two /2/ does (ND) in equal proportion. After weaning at 21 days of age all the groups were halved and then were fed either *ad libitum* (AL) or restricted (R). In the R group, the rabbits' food consumption was limited to 10, 9, 8, 7 and 6 hours/day between the ages of 4-6, 6-9, 9-12, 12-15 and 15-18 weeks, respectively. All 12 groups were halved again and the does were first inseminated at either 15.5 or 18.5 weeks of age. Preliminary results showed that the most important factor of cumulative survival of suckling rabbits is the BW. It was 88.8, 86.8 and 72.4% for H, M and L kits, respectively. The effect of ND was significant only at the level of 0.10 (1=80.4 and 2=85.1%; $P=0.07$). The combined effect of BW and ND on kit survival was significant. The lowest values were in treatments L1 and L2 (70.3 and 73.9%) and they were followed by M1 and H1 (83.5 and 84.9%) and then by M2 and H2 (90.5 and 92.9%). The cumulative survival of rabbits between days 21 and 108 was significantly affected by BW (M=87.2, H=87.0 and L=78.5%; $P<0.05$). The effect of ND and FI was not significant. None of the factors (BW, ND, FI and AI) had a significant influence on the survival of does between the first AI and day 915 but slightly better results were received in group 2A and AI at 18.5 weeks of age.

RESULTS OF THE TECHNICAL MANAGEMENT OF FOUR RABBIT FARMS IN BENIN. KPODEKON MR.* , DJAGO Y.† , FAROUGOU S.* , COUDERT P.‡ , LEBAS F.§
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A study was carried out in 2000 to evaluate the level of the technical management of the rabbit farms of South-Benin. Four farms were included into the investigation. Data collected by the farmers made it possible to note the mean level of the zootechnical performances. The average litter size was 6. An average of 5.6 kits were born alive of which 4.8 were weaned. The interval

between littering was evaluated to 73 days, thus, an average of 6 litters per year can be counted. Considerable variations were observed among the farms in some zootechnical parameters such as the number of born alive per litter. Results of this study show that there is an exploitable genetic characteristic on the level of the rabbit breeding in Benin.

STUDY OF A TWO-PHASE REARING METHOD FOR GROWING RABBITS. MATICS ZS., SZENDRO ZS., RADNAI I., BIRÓ-NÉMETH E., GYOVAI M., OROVA Z. *Univ. of Kaposvár, Fac. of Animal Sci., Kaposvár, Hungary.* szendro@mail.atk.u-kaposvar.hu

Early weaned young (21 days) were reared either at the usual stocking density (20 rabbits/m²) or at a double density till 6 weeks and then divided over 2 cages. This so-called two -phase rearing method was justified by the fact that early weaned young like to huddle together in larger groups. In the control group, 2 rabbits were reared in a cage of 250 x 400 mm basic area between 3 and 10 weeks of age (n=116). In the experimental groups, 4 rabbits were placed in these cages till 6 weeks of age and then 2 of them were transferred into another cage (n=116), while the other two rabbits were reared further in their original cage (n=116). Between 3 and 10 weeks of age, very similar performances were recorded: feed consumption (102, 102 and 101 g/day), body weight gain (38.1, 38.5 and 38.6 g/day), feed conversion rate (2.61, 2.66 and 2.62 g/g), body weight at 10 weeks of age (2235, 2269 and 2239 g) and mortality rates (2.6, 4.3 and 6.9%, respectively). On the basis of these results, the two -phase rearing of early weaned rabbits is recommended. The utilisation rate of fattening cages and buildings is more economical while it seems to fit more with animal welfare considerations.

CHARACTERIZATION OF RABBIT MEAT MIDDLEMEN IN THE METROPOLITAN AREA OF MEXICO CITY. OLIVARES R* , SORIANO R† , LÓPEZ M‡ , RIVERA J§ , LOSADA H¶ . *CIESTAAM Chapingo, Edo. de México. rolivares77@hotmail.com. †Dpt. de Biología de la Repr. Iztapalapa. México D.F. ramon@xanum.uam.mx

Structured interviews composed by 21 questions were applied to seven rabbit middlemen in order to study their procedures in the purchase and sales process. Middlemen bought rabbits up from four farms. A percentage of 57.1% of middlemen purchased more than 100 animals per week, 14.3% of them purchased 50 to 100 animals and 28.6% of them only 20 to 50 rabbits. Purchasing and then selling rabbits showed a different pattern. Two middlemen sold 20-50 animals per week; five of them sold more than 100 animals a week. Two thousand one hundred and eighty animals were purchased by middlemen, while sales reached 2280 rabbits per month. Although middlemen preferred rabbit rose in farm, the consumption of rabbit raised in backyard production system was important in absolute terms. Only 28.6% of the middlemen obtained in the desired volume of the product through the whole year while the remaining 71.4% of them found low consistency in the supply of product.

CONSUMPTION PATTERNS OF RABBIT MEAT IN THE METROPOLITAN AREA OF MEXICO CITY.

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Meat rabbit is a nourishing alternative for people; however, its consumption in Mexico City and in the municipalities of its conurbation is limited. The purpose of this research was to determine the consumption of rabbit meat and its limiting factors, as well as getting elements to encourage a better rabbit meat commercialization. A market research was carried out in Mexico City and some municipalities of its conurbation. Eight hundred consumers were randomly chosen and surveyed in 12 districts of Mexico City and 4 Municipalities. From this sample, 26.25% of the surveyed people consumed regularly rabbit meat. The people that regularly consumed rabbit meat in Mexico City showed a mean value of 21%. On the other hand, the average regular consumption of the product in the four municipalities was 46%. The consumption of rabbit meat in the two locations

showed a difference, being higher in the municipalities of the State of Mexico.

SELLING POINTS AND FORMS OF CONSUMPTION OF RABBIT MEAT IN THE METROPOLITAN AREA OF MEXICO CITY.

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The purpose of this research was to identify the selling points of rabbit meat as well as its forms of consumption. A market research was carried out in 12 random selected districts of Mexico City and in 4 of its conurbation. Eight hundred consumers chosen randomly were surveyed. It was found that the main selling centres in Mexico City were department stores (51.6%) and restaurants (40.4%). In the municipalities, consumers buy rabbit meat directly from the producer (38.5%), in the tianguis-local traditional Mexican markets- (24.0%), and in restaurants (22.1%). The main restraint for the consumption was the lack of promotion (according to 59.0% of consumers). Forms of consumption were linked to traditional ways of preparing other types of meat such as the mixiote, barbecued, grilled, marinated, fried and other.

EFFECT OF NURSING METHOD AND STOCKING DENSITY ON THE PERFORMANCE OF EARLY WEANED RABBITS.

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A 2x2 factorial experiment was performed to study the effect of the rearing method (one or two-phase method) and their milk supply until weaning (one or 2 mothers). Two hundred fifty eight early weaned young (21 days of age), previously nursed by 1 or 2 does were caged per 3 between 21 and 70 days of age (Group 3/3) or caged per 6 between 21 and 42 days of age and later 3/cage till 70 days of age (Group 6/3). The effect of number of nursing does was significant on the feed intake (85 or 81 g/days; $P < 0.05$) and on the weight at 70 days of age (2093

or 2005 g; $P < 0.05$) for rabbits nursed by 2 or 1 does, respectively. The difference in favour of the higher density caging is ascribed to the fact that these young could reach easier the nipple drinkers. Moreover, when previously nursed by 2 does their weight was higher at weaning and by consequence they could also more easily reach the drinkers. But the rearing method had no effect on the overall weight gain between the age of 21 and 70 days, on the body weight, feed intake and feed conversion. The effect of stocking density was significant on kit mortality between days 21 and 70, its value was 36 and 18% for the group 3/3 and group 3/6, respectively. Rearing the rabbits in two phases, 6 rabbits/cage between 21-42 days and 3 kits/cage between 42-70 days of age was found to be economically advantageous since more rabbits were housed in a cage or in a building matched with lower mortality and without any negative influence on the other traits.

THE EFFECT OF DAILY LIGHTING PROGRAM ON THE PERFORMANCE OF GROWING RABBITS. SZENDRO ZS., BIRÓ-NÉMETH E., RADNAI I., METZGER SZ., PRINCZ Z., GERENCSÉR ZS. *Fac. of Animal Sci., Kaposvár, Hungary. szendro@mail.atk.u-kaposvar.hu*

The aim of the present experiment was to compare the performance of growing rabbits between 5 and 10 weeks of age under 16L:8D or 8L:4D:8L:4D lighting program (light:dark) conditions. Pannon White rabbits weaned at the age of 5 weeks were housed in two identical rooms, the only difference was the photoperiod. A commercial pelleted diet was fed *ad libitum*. Except a one-week period, the performance of the two groups was identical. The daily body weight gain was 41.5 and 41.9 g, the body weight at the age of 10 weeks was 2353 and 2353 g, the daily feed intake was 111 and 112 g, while the mortality was 0.5 and 2.9% in the 16L:8D and in the 8L:4D:8L:4D groups, respectively.

Wool and Fur

EFFECT OF PROTEIN LEVEL ON LACTATING PERFORMANCE, DAILY GAIN AND FUR DENSITY IN REX RABBIT. GU Z.L.* , BAI Y.F.† , CHEN B.J.* , HUO G.C.† , ZHAO C.* *Mt Area Res. Inst. of Hebei Agr. Univ. Baoding. †Food Sci. College of Northeast Agr. Univ. Haerbin. China. hebaugzl@sohu.com*

Forty-five synchronous lactating rabbits and sixty 30-days old weaned Rex rabbits were distributed into three groups at random. Three diets with three different protein levels (17.5%, 16% and 14.5%) were fed respectively. The weight gain, lactating performance and fur density were tested. The weaning weight, litter weight and survival rate at weaning of young rabbit fed with high, middle, low protein was 450.4g, 429.0 g, 389.2 g; 3213 g, 2946 g, 2517 g; 95.5%, 92.0%, 86.6%, respectively. The weaning survival rate of middle protein group was not higher than in the low one while weaning weight and litter weight were improved greatly ($P < 0.05$). Thus the protein level in lactating rabbits should be above 17.5%. The growing Rex rabbit gained rapidly with increasing protein levels. Gain of low group was significantly reduced than the high ($P < 0.01$) and the middle ($P < 0.05$) at 3, 4 and 5 month period. The skin area at five months old fed with the high and middle protein diet reaches the standard of first class. Fur density showed the same regularity as body development. The peak of weight gain and fur density occurred during 2 and 3 month of age for Rex rabbits. The rabbits fed with a high protein diet have the highest weight and the largest fur density. In Rex rabbit, there was a superposition in hair follicle differentiation and gain of growing animal.

STUDY ON FUR DENSITY IN REX RABBIT. GU Z.L., CHEN B.J., DONG B., ZHAO C., REN W.S., HUANG R.L. *Mountain Area Res. Inst. of Agricultural Univ. of Hebei. Baoding. China.hebaugzl@sohu.com*

Thirty American Rex rabbits (1 to 6 months-old) were selected in winter (December to February) and summer (June to August) respectively and the wool thickness (1cm² width) were measured at scapula, middle of back, middle of one side of

body, buttocks and middle of belly respectively by five point sample-taking method. The thickness was measured again at the same points after the rabbits were slaughtered and the density was counted. The observations indicated. The fur density was different at different age, season and body position and increased with age before 5-months old and especially before 3-months old. The fur density reached a maximum at 5-months old and decreased slightly at 6-months old. This indicated that the hair follicle differentiation of rabbit was over at 5-months old. The fur density was different according to season and the winter's was thicker than the summer's but the difference was not significant ($P>0.05$). The fur density was significantly different according to body position. The middle of the belly was the thinnest while the buttocks' was the thickest. It was typical at the middle of one side of body or the middle of back. Under the same feeding and management, the fur density was significantly different among the individual. The top average density was 19000/cm² and at back it reached 30000/cm². It is caused by heredity difference. In the study, the fur coefficient was calculated according to the correlation between fur density and thickness. This made fur density-measuring quantitative, simple and practical. It is important for Rex rabbit breeding and fur grading.

EFFECTS OF DIFFERENT STRAINS AND COMBINATIONS ON THE PRODUCT PERFORMANCE OF REX RABBIT. GU Z.L., ZHAO C., CHEN B.J., REN W.S., HUANG Y.T., DONG B. *Mt. Area Res. Inst. of Hebei Agric. Univ. Baoding, China.* hebaugz1@sohu.com

The productive performances of American (A), German (G) and French (F) rex rabbit were compared under same raising conditions. The A is the best for litter size at birth and at weaning, birth and weaning weights (30-days old), and survival rate of weaned rabbit. For the same traits, F is better than G, while F was the second for the individual weight at weaning and 3-month old. At 5-months of age, G had the highest body weight followed by F and A. The fur density, length and skin area at 3-months and 5-

months old of the G are the highest. The fur length at 3-months old is similar to that at 5-months old, the fur length of G is longer than that of F and A is the shortest. These data showed: G and F rex rabbit had strong capacity of growth development and fur follicle differentiation. Crossing rex rabbits of A type as dam with G and F types as sire, respectively G×A and F×A were made. The results showed that cross rabbit had better reproductive performances than F and G, but were similar to A. The rabbit reproductive performances were mainly determined by the dam. The experiment was conducted to compare birth weight and weaning survival rate between the two crossbreds. No significant differences were observed. The litter size at birth and at weaning, daily gain and fur thickness of crossbreds rabbit were better than for F, A and G. Thus the crossbreed had the highest commercial value. A second crossbreeding experiment with the two above crossbreds as dam and G and F rex rabbit as sire, G×FA and F×GA, respectively, was conducted. The result showed G×FA crossbred reproductive performances were the best among the four crossbred types. Except for litter size weight at birth, significant differences were observed between G×A, F×A and F×GA for other traits. To conclude, when crossbreeding was carried on, A type was the ideal dam and F and G are the ideal sires. Performances of A×F and A×G were similar. When using A×F and A×G as dams and F and G as sires, the reproductive performances, body condition and fur quality of crossbreds were better than in the parents and G×FA was the best. Thus G×FA was the best combination in practice.

PRIMARY MEASUREMENT FOR PRODUCTION PERFORMANCE OF THE ORIGINAL AMERICA BREED REX RABBITS AND THEIR OFFSPRING. YANG J., LI L., WU L., LIU J. *Quanzhou Rabbit Development Company, Lmt. Lingshi Shanxi, China*

In year of 2002, 304 Rex rabbits of three colours were introduced in two groups from the United States of American among them 224 were of white color type, 64 of California and 16 of Chinchilla ones. A breeding plan was made

based on pedigree registration supplied by the exporter and Shanxi local conditions. True bred progeny second generation is consisted of 40 litters of white color, 30 litters of California and 10 litters of chinchilla color type. The results showed that the new introduced American Rex rabbit had a fairly good production performance and adaptability in China. The weaning survival rates for the white, California and Chinchilla were 92.5%, 89.3% and 88.5% and the individual weaning weight for the above mentioned three color types were 748.5 g, 637.1 g and 580.5 g respectively. It demonstrated that the offspring of the pure bred grew quite well as the weaning weight, body weight at 150 d. and the daily gain for the white, California and Chinchilla were 762.8 g, 613.0 g 560.0 g; 2963.4 g, 2939.3 g, 2544.9 g; and 20.19 g, 1.35 g, 18.21 g respectively. As far as the hair coat is mentioned, the hair length for the original breed of the three color type white, California and Chinchilla are 2.10 cm, 2.07 cm and 2.08 cm, which are in the range as recorded in literature. While the minimum length of 1.6cm shows a tendency of increase.

BREDDING SELECTION OF WAN STRAIN COARSE WOOL ANGORA RABBIT. ZHAO H.L., ZHU X.B., LI L.B., CHEN S. *Inst. of Animal Sci. Anhui Hefei. China. zh11988@sina.com*

Adopting hybridization method of breeding, Wan strain coarse wool Angora rabbit, which is of high yield, high quality, and high efficiency, are incubated successfully by means of Germanic Angora rabbit crossing with White New Zealand rabbit after systematic breeding for 10 years. This rabbit is of medium body type. The body weight, body length, and chest girth of 11 months of age are 4258.3 g, 51.9 cm, and 33.5 cm respectively. It grows relatively quick prophase. The body weight of 5 months of age is equivalent to 84.2% of adult. Wool yield and rate of coarse wool are all high relatively. Shearing hair capacity and rate of coarse wool of 11 months of age are 294.3 g (equivalent to 1177.1 g per year) and 15.9% respectively. The hair quality is fine. The length, fineness, intensity, and stretched length are 11.6 cm, 47.0 μ m 28.4 g, and 47.3% for coarse wool fibre, 7.4

cm, 15.6 μ m, 4.8 g, and 45.4% for fine wool fibre of 11 months of age, respectively. Harvesting manner is not restricted, either shearing or plucking wool. The reproductive performance is moderate. The number is 7.21 for primiparous litter size, and 6.82 for live litter size. The birth weight, body weight of 21days of age, and weaning litter weight are 363 g, 2244 g, and 5027 g, respectively. Survival rate at weaning is 91.7%.

Meat quality and Processing

RABBIT MEAT PROCESSING AND TRACEABILITY. CAVANI C., PETRACCI M. *Dpt. of Food Sci. Univ. of Bologna Italy. ccavani@disa.unibo.it*

Rabbit meat is a highly digestible, tasty, low-calorie food, often recommended by nutritionists over other meats, yet it is still considered a niche product, especially because of its time consuming preparation which requires culinary skills and because of cultural differences among European consumers. For this reason, the processing industry in Europe is gradually improving the availability of rabbit meat in a large variety of processed ready-meals which make it easier to prepare thus meeting the demands of modern consumers. This shift towards further processed products in Europe will soon underscore the necessity for higher standards in rabbit meat in order to improve sensory characteristics and functional properties. Rabbit production and processing involve a series of interrelated steps and the quality of rabbit muscle as food depends upon chemical, physical, and structural changes that occur in the conversion of muscle to meat. During the production and management of rabbits, (preslaughter) factors not only exert important effects on muscle growth, composition, and development, but also determine the state of the animal at slaughter. Moreover, large rabbit industry integration is becoming more important and the development of rabbit meat production is forcing processing plants to improve slaughter capacities by using high-speed and more automated slaughter lines. From the point of view of food safety, these changes can lead to higher microbial risks due

to the possible cross-contamination during preslaughter (crating, transportation, and holding conditions) and processing (skinning and evisceration) operations. Furthermore, European rabbit production has been influenced by the introduction of more restrictive regulations and higher consumer attention to food safety aspects. All this has come about as a consequence of the many meat safety crises of previous years which have convinced the European Union to enact several regulations aimed at guaranteeing meat safety and systems to prevent or at least manage similar future crises. From January 1st 2005 (Regulation 178/2002/EC), it will be compulsory for all feed and food operators to adopt a traceability system. The major objective is to enforce the provision of clear and reliable information to consumers at sales points, based on a system of being able to track meat back to the source animal, the slaughterhouse and the cutting unit of origin. This paper is divided in two sections, the first provides an overview of the steps of rabbit processing and its influence on product quality, while the second focuses on the application of traceability to rabbit production.

EFFECTS OF NUTRITION AND SELECTION ON MEAT QUALITY. PLA M. *Dpt. Ciencia Animal. Univ. Politécnic de Valencia, Spain. mpla@dca.upv.es*

Nutrition and selection are both factors which mainly affect rabbit carcass and meat quality. Effects of feeding level and of dietary fibre, dietary fat and fat quality and protein quality are summarised. Four ways of studying the effects of selection for growth rate on rabbit carcass and meat quality are also reviewed.

EFFECT OF GENOTYPE AND SEX ON pH OF BICEPS FEMORIS AND LONGISSIMUS DORSI MUSCLES IN RABBIT CARCASSES. BARRÓN G., ROSAS G., SANDOVAL CH., BONILLA O., REYES G., RICO P., CARDONA L., ZAMORA F. *FMVZ, UNAM, Itzcalli, México. marybarron68@hotmail.com*

The effect of genotype and sex on pH variation of the muscles *Biceps femoris* (BF) and *Longissimus dorsi* (LD) in rabbits carcasses was

determined. Two hundred eight rabbits 70 days old were slaughtered, having 52 animals for every single genotype (New Zealand, California, Chinchilla and a Synthetic line). Significant differences ($P < 0.01$) were observed between genotypes, New Zealand showed the highest value of pH_{24h} in LD muscle and Chinchilla and New Zealand showed the highest values of pH_{20min} and pH_{24h} in BF muscle. In the muscle LD, males exhibited the highest pH_{20min} values ($P < 0.01$).

CARCASS AND MEAT QUALITY OF STRAIGHTBRED AND CROSSBRED RABBITS.

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The objective was to evaluate the effects of the genetic group (straightbred vs. crossbred) and age on carcass quality of rabbits. A total of 128 straightbred Botucatu and Botucatu x White German Giant crossbred rabbits, males and females, were involved in the study. Young rabbits were weaned at 35 days and sequentially slaughtered, four per genetic group x sex combination, at: 42, 49, 56, 63, 70, 77, 84 and 91 days of age. A 2X2 factorial arrangement in a split-plot design was employed. Commercial carcasses were heavier and reference carcasses tended to be heavier in crossbred rabbits throughout the experiment (1284 vs 1229 g and 1036 vs. 1000 g, respectively, $P < 0.05$), but when the data were corrected for slaughter weight, differences became non significant. No genetic group effect was detected on dissectible fat weight, both not adjusted and adjusted for slaughter weight. Loin and fore part were heavier in crossbreds (309 vs. 296 g, $P = 0.0511$ and 298 vs. 283 g, $P < 0.05$, respectively); these differences also became non significant with the adjustment for slaughter weight. No genetic group effect was detected for hind part weight. Non adjusted weights of kidneys, liver and thoracic viscera were larger in the crossbred genetic group (12.5 vs. 11.8 g, 73.2 vs. 68.3 g, and 30.8 vs. 26.2 g, respectively; $P < 0.05$). After the adjustment for slaughter weight, only the weight of thoracic

viscera remained significantly heavier in crossbreds (30.4 vs. 28.6 g). No effect of genetic group was detected on meat to bone ratio and muscle ultimate pH (pHu). With the exception of hind part weight adjusted for slaughter weight, all other traits showed age effects. Muscle pHu oscillated between 5.49 and 5.70, whereas commercial and reference carcass weights ranged from 544.1 to 1492 g and 696.4 to 1798 g, and meat to bone ratio from 5.10 to 8.47, between 42 and 91 days of age. Dissectible fat represented 2.11% of the reference carcass at 42 days and 3.38% at 91 days of age. Crossbreeding may be recommended for the production of prime retail cuts. For a minimum reference carcass weight of 1 kg, slaughter should take place between 63 and 70 days of age.

GROWTH TRAITS AND DRESSING PERCENTAGE OF STRAIGHTBRED AND CROSSBRED RABBITS. BIANOSPINO E., WECHSLER F.S., MOURA A.S.A. M.T., FERNANDES S. *Dpt. de Produção e Exploração Animal, UNSEP, Botucatu. anamoura@fca.unesp.br*

The objective was to evaluate the effects of genetic group (straightbred vs. crossbred) and age on growth and dressing percentage of rabbits. A total of 128 straightbred Botucatu and Botucatu x White German Giant crossbred rabbits, males and females, were involved in the study. Young rabbits were weaned at 35 days and sequentially slaughtered, four per genetic group x sex combination, at: 42, 49, 56, 63, 70, 77, 84 and 91d of age. Body weight, average daily feed consumption, pre-slaughter weight, hot carcass weight, weights of skin, distal parts of fore and hind legs, and of empty gastrointestinal tract were recorded. A 2X2 factorial arrangement was employed in a completely randomized design with repeated measures. Crossbred rabbits were heavier and consumed more feed than straightbred ones throughout the experiment (2032 vs. 1962 g and 143.5 vs. 131.0 g/d, respectively). No difference between genetic groups was detected for average daily gain corrected for feed consumption, suggesting that feed efficiency was similar between groups. There was a genetic group x age interaction for dressing percentage; crossbreds showed higher

yield at 70d of age, but the difference was not maintained after 84d of age. A genetic group x sex x age interaction was detected for weight of distal parts of legs. Crossbreds showed heavier skins (314 vs. 293 g), distal parts of legs (76.6 vs. 70.4 g) and empty gastrointestinal tracts (178 vs. 171 g). When these weights were corrected for live weight at slaughter, only the weight of distal parts of legs remained higher for crossbreds (176 vs. 173 g). Age, as expected, affected all traits. With the exception of the empty gastrointestinal tract being heavier in females (178 vs. 171 g), no other gender differences were found. Crossbreeding may be recommended for the production of light carcasses. Weights of retail cuts, fatness and meat quality should be evaluated for the production of heavier carcasses.

A SURVEY ON CARCASS AND MEAT CHARACTERISTICS OF ISCHIA RABBITS RAISED IN PITS. BOVERA F*, DI MEO C.*, BARONE C.†, GAZANEO M.P.*, TARANTO S.‡, NIZZA A.* **Dpt. di Sci. Zoo. e Ispezione degli Alimenti; bovera@unina.it. †Dpt. di Sci. Zootec. e Ispezione degli Alimenti, Univ. di Napoli "Federico II", Italy. ‡Veterinary consultant.*

The aim of the paper was to investigate the carcass and meat characteristics of Ischia rabbits raised in pits, according to the traditional island technique. Fourteen animals, fed grass and field beans as protein source, were slaughtered at 4.5 months of age, on average. After slaughter, skin, distal legs and tail, urinary bladder and gastrointestinal tract were removed and weighed to obtain the "commercial carcass", chilled at 4°C for 24h. The head, lungs, thymus gland, trachea, heart, liver and kidneys were removed to obtain the "reference carcass" from which the muscles of hind legs and the *Longissimus dorsi* (LD) muscle were removed. One hour and 24h after slaughter the pH was measured on LD and *Biceps femoris* muscles. The right hind leg and the LD muscle were used to measure colour while on the left LD muscle the water holding capacity (WHC) was determined. After calculating the meat to bone ratio, the meat obtained from dissection of the left hind leg was used for chemical composition. Our results show

that rabbits raised in pits, both due to their genetic type breed and the particular breeding technique adopted, is small (average weight at slaughter 1286 g±169) and has a low hot dressing percentage (52.9%±3.5) due to the high percentage of the gastrointestinal tract (26.4%±3.5). Nevertheless, it is possible to note a good pH decrease and WHC, as well as a similar meat chemical composition to those of other genetic types raised for meat production.

DOES SELECTION FOR GROWTH RATE IMPAIR BONE RESISTANCE IN THE RABBIT? COMBES S.^{*}, LARZUL C.[†], GONDRET F.[‡], ROCHAMBEAU H.[†]. **St. de Rech. Cunicoles, INRA, Castanet-Tolosan. combes@toulouse.inra.fr; †St.d'Amélioration Génétique des Animaux, INRA, Castanet-Tolosan. ‡UMR sur le Veau et le Porc INRA, France.*

Two lines of rabbits divergently selected for 5 generations for live body weight at 63 days (High: rapid-growing line, n=61; Low: slow-growing line, n=74) and a cryopreserved control line (Control, n=60) were slaughtered at the same body weight (2297 + 10 g). Average daily gain from weaning (28d) to slaughter was 47.6, 56.0, and 65.8 g/d for Low, Control and High lines, respectively. The effects of growth rate at a fixed slaughter weight on carcass traits, morphometry and mechanical properties of bone were assessed. Selection for high body weight at fixed age had no effect on carcass traits, bone shape and bending resistance, compared to the control group when rabbits were slaughtered at the same weight. On the other hand, selection for low body weight at 63 d improved carcass weight, dressing out percentage (+2.8% for both traits) and hind part percentage (+3.6%), while adiposity remained unaffected. Femurs from Low line rabbits were lighter and thinner (lower moment of inertia) than in the other 2 groups resulting in a reduced bending resistance (-13.5% and -5.8% for yield and ultimate force respectively). Although tibia shape from the Low line was similar to the other two groups, its bending resistance was higher (+13.7 and +9.3% for yield and ultimate force, respectively). For both bones, elastic modulus (intrinsic stiffness) was higher in the Low line rabbits than in the

other two groups. Length and whole stiffness increased with age in both bones, suggesting that these traits are good indicators of physiological maturity of the animal, independently of body weight. In conclusion, divergent selection for live body weight at 63 days affected carcass traits, morphometric characteristics and mechanical properties of bone in rabbits slaughtered at the same weight. However, an asymmetrical response to growth rate selection was observed. The effects of selection on carcass traits, morphometric characteristics and mechanical properties of bone were significant for decreased growth rate only.

EFFECT OF MATERNAL FEED RESTRICTION ON MUSCULAR CHARACTERISTICS OF RABBIT OFFSPRING. DALLE ZOTTE A., RÉMIGNON H.^{*}, CHIERICATO G.M. *Dpt. of Animal Sci., Legnaro Italy. antonella.dallezotte@unipd.it. *ENSAT, Castanet-Tolosan Cedex, France.*

Thirty hybrid female rabbits of 15 weeks of age were at random divided into three groups and fed with one of the 3 following diets: "C diet" for young females (DE=11.71 MJ/kg DM) fed *ad libitum*; "R diet" was the C diet fed at 80% of *ad libitum*, "F diet" rich in fiber (24.6% vs. 18.7% for C diet; DE=9.77 MJ/kg DM) fed *ad libitum*. The does were inseminated at the 19th weeks of age. The 3 diets were administered until the first parturition, afterwards all the does received the C diet *ad libitum*. Three pups per litter were slaughtered at birth, at 35d of age (weaning) and at 81d of age, respectively. At the second parturition, another pup per litter was slaughtered at birth. Ten minutes *post mortem* the *Longissimus lumborum* (LL) muscle of each slaughtered rabbit was sampled and then underwent the histochemical treatment: mean cross-sectional area (CSA), compactness index (CI) and sphericity (SPH) of the fibers of the new-born rabbits; percentage of the fiber types (bR, aR or aW) and CSA for rabbits of 35 and 81d of age. At birth all the fibers of LL muscle were typed as aR. The maternal feed restriction, applied as qualitative restriction (diet F) or quantitative restriction (diet R) significantly

increased the CI of LL fibers of newborn rabbits of the first kindling, while maternal feed restriction effect was not evident on young of second kindling. At weaning, the young rabbits belonging to the first kindling exhibited an effect of maternal feed rationing on fiber type distribution. R diet, compared with F and C diets, significantly increased the percentage of β R fibers, while F diet significantly reduced the percentage of α R fibers. The greatest effect of maternal feed restriction on weaning rabbit was observed on the percentage of α W fibers ($P < 0.01$), which was the highest for F diet (85.2%), intermediate for C diet (78.0%) and the lowest for R diet (71.8%). At 81d of age, no effect of maternal dietary treatment was found on offspring.

EFFECT OF FEED RESTRICTION DURING POSTWEANING GROWTH ON FIBER CHARACTERISTICS OF BICEPS FEMORIS MUSCLE IN THE RABBIT. DALLE ZOTTE A., RÉMIGNON H.* , OUHAYOUN J.† *Dpt. of Animal Sci., Legnaro, Italy. antonella.dallezotte@unipd.it.* *ENSAT, Castanet-Tolosan. †Station de Rech. Cunicoles-INRA, Castanet-Tolosan Cedex, France.

At weaning (five weeks of age), 50 hybrid rabbits were at random divided into five groups (labelled blocks). Block 1, which were fed *ad libitum* with a commercial diet during weaning period, were slaughtered. The remaining rabbits were placed in individual cages and fed the same amount of food until slaughter, but differently rationed. From 5 to 8 wk of age, the rabbits coming from blocks 2 and 4 received 70% of *ad libitum*, meanwhile those belonging to blocks 3 and 5 received 90% of *ad libitum*. Animals of blocks 2 and 3 were slaughtered at 8 wk of age, while those of blocks 4 and 5 received the reverse restriction level and were slaughtered at 11 wk of age. All the animals were weighed before slaughter and the *Biceps femoris* muscle was immediately dissected and thereafter its fibers were typed (β R, α R and α W) and mean crosssectional area was determined for each muscle. As expected, at eight-weeks slaughter age, rabbits given for 3 weeks the strictest feed restriction (70% of the *ad libitum*) showed the

lowest body weight but presented significantly higher ($P < 0.01$) body weights after successive 3 weeks of rationing at 90% of the *ad libitum*, if compared with the rabbits that followed the inverse feeding treatment. The 70-90% rationing mode reduced the proportion of oxidative fibers. No relationship was found between the enlargement of muscle fibers and body weight. At the light of actual knowledge further investigations are needed to better understand the relationship between feed restriction and fiber characteristics.

A BAYESIAN APPROACH OF THE EFFECT OF SELECTION FOR GROWTH RATE ON SENSORY MEAT QUALITY OF RABBIT. HERNÁNDEZ P.* , GUERRERO L.† , RAMÍREZ J.† , MEKKAWY W.* , PLA M.* , ARIÑO B.* , IBÁÑEZ N.* , BLASCO A.* **Dpt. de Ciencia Animal. U.P. Valencia. phernan@dca.upv.es. †IRTA, Centre de Tecn. de la Carn, Girona. Spain.*

The effect of selection on for growth rate on sensory characteristics of rabbit meat was assessed by comparing a selected and a control population of rabbit. Embryos belonging to generation 7th were frozen, thawed and implanted in does in order to produce the control group. The control group was formed from the offspring of the embryos belonging to the 7th generation. Selected animals belonging to 21st generation (S) were compared with animals of the control group (C), both were contemporary. Forty animals per group were slaughtered at 9-weeks-old. The sensory analysis was carried out on samples of the *Longissimus dorsi* muscle. The parameters evaluated were: intensity of rabbit flavour (IRF), aniseed odour (AO), aniseed flavour (AF), liver flavour (LF), tenderness (T), juiciness (J), fibrousness (F). A Bayesian analysis was performed. The ratio of the selection and control effects was analyzed. There was a difference between selected and control groups for IRF, AO, AF and LF. Conversely, no differences were found in T, J and F between groups. Selected group had 3% and 23% higher values of IRF and LF respectively, than control group. A relevant effect of selection on AO and AF appeared (probability of relevance = 1), with lower values for selected animals. There was a difference

between males and females groups for IRF, but not relevant. No differences between sexes were found for the rest of the characteristics evaluated. Selection for growth rate has not affected the main sensory characteristics of meat rabbit, like tenderness and juiciness but, it has a negative effect for some flavour characteristics.

GROWTH PERFORMANCES AND SLAUGHTER TRAITS OF A LOCAL KABYLIAN POPULATION OF RABBITS REARED IN ALGERIA: EFFECTS OF SEX AND REARING SEASON. LAKABI D.*[‡], ZERROUKI N.*[‡], LEBAS F.[†], BERCHICHE M.*[‡] *Lab. de Rech., Univ. Mouloud Mammeri, Algeria. [‡]Cuniculture, Corronsac, France; lebas@cuniculture.info

Growth performances of 189 rabbits (102 females and 87 males) from the local Kabyle population were studied from 4 to 11 weeks and for 90 of them until 15 weeks. The average growth rate was 27.7±6.3 g/d between 4 and 8 weeks, and was reduced to 22.2±5.4 g/d during the 3 following weeks, and to only 18.0±6.3 g/d between 11 and 15 weeks. At 15 weeks, the rabbits have reached 2.29 kg which are 81% of the adult weight. Feed intake was maximum at 73 g/kg LW 0.75 during the 7th week and then decreased regularly down to the 56 g/kg 0.75 observed during the 14th week. Growth rate and feed intake were similar for both sexes. Growth rate was reduced by 13% in summer time (weanings of June-July) when compared to spring (weanings of February). Most of the slaughter traits were similar in males and females sacrificed at 15 weeks. Slaughter rate was the highest for rabbits slaughtered in August (compared to June and September) in relation with a significant reduction of the full digestive tract (11.2% vs. 12.4-12.6% of body weight).

FT-NIR SPECTROSCOPY OF TREATED BLOOD PLASMA TO PREDICT CARCASS AND MEAT QUALITY OF YOUNG FEMALE RABBITS. MASOERO G.*[‡], BERGOGLIO G.*[‡], BRUGIAPAGLIA A.[†], DESTEFANIS G.[†], CHICCO R.*[‡] *Ist. Sp. per la Zootec. Torino. giorgio.masoero@isz.it. [†]Dpt. di Sci. Zootec., Grugliasco. Italy.

In two replications, involving a total of 32 young females (slaughter-weight 3648 g), half of the

rabbits were restricted from solid feeding for 36 hours. The applied fasting treatment resulted in minor global effects (multivariate R²=0.35) in comparison to the replication effects (R²=0.81), which caused remarkable differences in some conventional variables of meat quality. The blood samples were centrifuged and the plasma (1 ml) was submitted to a rapid reaction with ethanol (ETA: 0.5 ml) or to a freeze-drying (FD) process before being examined by FT-NIR spectroscopy (1000-2500 nm). The spectra were correlated and cross-validated to fixed experimental effects: fasting and replication, as binary data (1, 2). Some biological and quality traits of the meat and carcass were also fitted by ISI-2 software chemometrics. In short, 1-VR crossvalidated values, which resulted after a double passage for outlier elimination using a liberal t-level of 2, are reported. Replication effects were clearly present in the NIR spectra and appeared to be higher for the FD samples (0.87) than for the ETA ones (0.59). Intramuscular fat in *Obliquus abdominis* and hindleg muscles were more represented in the ETA (0.55; 0.63 respectively) than in the FD spectra (0.26; 0.26), as were the interscapular fat percentage (0.44; 0), the water content of *Longissimus thoracis et lumborum* (0.41; 0) and of *Obliquus abdominis* muscles (0.52; 0.32), and the meat-to-bone ratio (0.39; 0.25), but the liver percentage (0.25; 0.40) was not. The colour and rheological meat quality traits did not generally appear to be correlated to the FTNIR spectra. The first conclusion that was made was that the freeze-drying of plasma samples does not improve the method, which can function rapidly after a very simple alcohol reaction. The confirmation of several significant relationships with the FT-NIR spectra of plasma will encourage this kind of study, starting from live animals.

FT-NIR SPECTROSCOPY OF FRESH AND TREATED MUSCLE TISSUE IN YOUNG FEMALE RABBITS. MASOERO G.*[‡], BERGOGLIO G.*[‡], BRUGIAPAGLIA A.[†], DESTEFANIS G.[†], CHICCO R.*[‡] *Ist. Sp. per la Zootec. Torino. giorgio.masoero@isz.it. [†]Dpt. di Sci. Zootec., Grugliasco. Italy.

A total of 32 young female rabbits (live weight 3.648 g) were made to fast or allowed to eat for 36 h before slaughter. Samples of the *Longissimus lumborum* (LL) muscle and two strips of the *Obliquus abdominis* muscle (OA) were sampled from chilled carcasses. The muscles were divided into three parts: 1) to determine the moisture; 2) placed in a plastic tube, then immersed in 95% ethanol; 3) stored at -18°C, then freeze-dried. A further sample, from the dissected hindleg (HL), was stored at -18°C and freeze-dried. The quality traits were measured in raw LL, cooked or alcohol treated. An interesting close relationship ($r=0.78$) emerged between the two substrates used for shear force measurements: alcohol vs. cooked. The muscles were submitted to FT-NIR spectroscopy as fresh tissue (LL, OA and HL), then as intact freeze-dried (LL_if and HL_if) and also as ground freeze-dried (LL_gf, OA_gf and HL_gf), and were then used to predict the intramuscular lipid content. Two intact alcohol samples (LL_e and OA_e) were examined. The spectra were correlated and cross-validated to fixed experimental effects as binary data and to quantitative traits. 1-VR cross-validated values were reported. The fasting effect shown by the NIR was almost four times lower than the replication effect (av.ge 1-VR=0.12 vs. 0.52). The freeze-drying of substrates amplified the effects in the NIR spectra, while the alcohol treatment generally decreased them. The estimation of the intramuscular lipid content through scanning of the intact muscles was nearly half-efficient vs. scanning of the ground freeze-dried tissue for OA (0.55) and for HL (0.53), but was poor for LL (0.16). An agreement between the spectra of OA and the presence of noising and experimental effects was confirmed. The LL in ethanol, which is easy to transport to a laboratory, seems to be suitable for tenderness measurements, but the NIR scan should be further investigated for meat quality assessment.

BONE PARTICLE DETERMINATION IN MECHANICALLY SEPARATED RABBIT MEAT. PRELIMINARY RESULTS. McNITT J.I.* , NEGATU Z.* , McMILLIN K.† *Small Farm Family Res. Develop., Southern Univ. Agr. james_mcnitt@suagcenter.com. †Dpt. Anim. Sci., Louisiana St.Univ., Baton Rouge, USA

The standard laboratory technique used in the U.S. for bone particle determination takes 13 or more hours and relies on enzymatic digestion using papain followed by separation in carbon tetrachloride, acetone and ether. This study was conducted to modify the existing laboratory method for isolation of bone fragments in mechanically separated meat to increase the accuracy, to shorten the time required, and to avoid use of noxious reagents. Preliminary studies with mechanically separated rabbit meat indicated that bromelain and papain in equal concentrations (0.25%) and ficin at 0.002% provided better separation than papain alone. Furthermore, separation was improved when the samples were autoclaved after incubation with the enzymes rather than before. Two incubations of one hour each were as effective as a five hour followed by an 8 hour incubation. Washing with water was as effective at separating the bone fragments as the use of acetone, carbon tetrachloride, and ether. It was concluded that this shortened, more environmentally friendly method would prove useful once validation studies are completed.

COMPARISON OF CARCASS TRAITS AND MEAT QUALITY OF HYPLUS HYBRID, PUREBRED PANNON WHITE RABBITS AND THEIR CROSSBREDS. METZGER SZ.* , ODERMATT M.† , SZENDRO ZS.* , MOHAUPT M.† , ROMVÁRI R.* , MAKAI A.† , BIRÓ-NÉMETH E.* , RADNAI I.* , SIPOS L.† *Fac. of Animal Sci., Univ. of Kaposvar, Hungary, metzger@mail.atk.u-kaposvar.hu. †OLIVIA Ltd., Lajosmizse, Mizse 94, Hungary.

The aim of the experiment was to study the influence of the adult weight and that of the selection based on CT (computerized tomography) measurement on the carcass traits and meat quality. Four different genotypes [PP: purebred Pannon White (n=84), PH: offspring of Pannon White bucks and Hyplus PS19 does (n = 97); HP: offspring of Hyplus PS59 bucks and Pannon White does (n = 79); HH: offspring of Hyplus terminal cross (n=77)] were compared. Pannon White rabbits are selected primarily on the basis of body weight gain and carcass traits measured by CT values. In the case of the PS19 females and the PS59 males, selection is based

on prolificacy and body weight gain, respectively. The genotype had a significant effect on all performance and carcass traits studied. Rabbits of HP genotype had the highest while those of PP genotype the lowest weight gain (38.9 and 36.6 g/day, respectively; $P<0.05$). The Pannon White breed had an advantageous influence on the dressing out percentage (PP: 58.0%; PH: 58.7%; HP: 57.7%; HH: 57.6%; $P<0.001$) and on the ratio of the *m. Longissimus dorsi* to the reference carcass (PP: 11.2; PH: 10.6; HP: 10.3; HH: 10.2%; $P<0.001$). The fat content of the carcass was lower in the offspring of the PS59 bucks (1.15, 1.16, 0.89 and 0.85% for PP, PH, HP and HH rabbits, respectively; $P<0.001$). Significant differences were found between the meat samples of progenies of purebred Pannon White and the hybrid terminal cross rabbits in the moisture and fat content of hindleg meat (moisture content: PP: 75.5%, HH: 76.1%, $P<0.05$; fat content: PP: 2.38%, HH: 1.46%; $P<0.001$), while the results of the groups HP and PH were not significantly different from the other two genotypes (moisture content: HP and PH: 76.0%; fat content: HP: 1.96%, PH: 1.56%). There were no differences between the experimental groups in the colour and pH of meat. The results of this experiment confirmed that a large body sized male improves the offspring's weight gain and body weight at slaughter. From the point of view of the dressing out percentage and especially the volume of the *m. Longissimus dorsi* the usage of Pannon White genotype is advantageous. Dressing out percentage of the offspring of the early-matured PS19 does and the CT-selected Pannon White bucks is remarkable.

EXAMINATION ON THE CARCASS TRAITS OF DIFFERENT RABBIT GENOTYPES. METZGER SZ.^{*}, ODERMATT M.[†], SZENDRO ZS.^{*}, MOHAUPT M.[†], ROMVÁRI R.^{*}, MAKAI A.[†], BIRÓ-NÉMETH E.^{*}, RADNAI I.^{*}, HORN P.^{*} ^{*}Fac. of Animal Sci., Univ. of Kaposvar, Hungary, metzger@mail.atk.u-kaposvar.hu. [†]OLIVIA Ltd., 6050 Lajosmizse, Mizse 94.

The aim of this experiment was to study the carcass traits of rabbits when the same maternal stocks were mated with bucks of two well-known

hybrids selected for growth traits or with Pannon White bucks selected for carcass traits by CT (computerised tomography). Carcass traits of seven different genotypes were compared (PP: purebred Pannon White, n=60; HP: Hycole bucks x Pannon White does, n=59; PH: Pannon White bucks x Hycole does, n=60; HH: Hycole hybrid terminal cross, n=52; PM: Pannon White bucks x Maternal line does, n=60; ZM: Zika bucks x Maternal line does; n=59; ZH: Zika bucks x Hycole does n=58). The hybrid males generally increased the body weight, since mating the same maternal stock with hybrid or Pannon White bucks, the body weight of the offspring of hybrid males was usually higher than that of the offspring of Pannon White bucks (PP and HP: 2644 and 2758 g, $P<0.05$; PH and HH: 2616 and 2671 g, NS; PH and ZH: 2616 and 2890 g, $P<0.05$; PM and ZM: 2539 and 2684 g, $P<0.05$). The most important carcass traits were advantageous in Pannon White rabbits. Genotype had a significant effect on the dressing out percentage ($P<0.001$), which was the highest in PM (61.1%) and in PP (60.7%) genotypes, and the lowest in HH rabbits (58.9%; $P<0.05$). The ratio of the *m. Longissimus dorsi* to reference carcass was also higher in rabbits derived from P males or females (PP: 11.6%, PM: 11.5%, HP: 11.5%, PH: 11.2%, HH: 10.7%, ZH: 10.6%, ZM: 10.8%; $P<0.001$). Genotype had a significant effect on the fat content of the carcass ($P<0.05$), it was the lowest in group ZM (1.38%), while the highest in the early-matured genotypes as PM (1.77%) and PP (1.78%) rabbits ($P<0.05$). Results of the dressing out percentage and the *m. Longissimus dorsi* proved that the selection of Pannon White rabbits based on CT was successful.

EFFECT OF SELECTION FOR GROWTH RATE ON CARCASS AND MEAT COMPOSITION IN RABBITS. PASCUAL M., ALIAGA S., PLA M. *Dpt. de C. Animal, UPV, Spain. ampasam@dca.upv.es*

Effect of selection for growth rate on carcass and meat chemical composition in rabbit was studied. Animals from a control (C) group (7th generation, n=60) and a selected (S) group (21st, n=60) were bred contemporarily and slaughtered at 63 days of age. Liveweight and carcass weight

was higher for the selected group, but there were no differences in dressing out percentage. Selected animals were better conformed. The hind part percentage was lower in the selected group, although selection did not affect the percentage of the other parts of the carcass and most of the viscera. Meat to bone ratio in the hind leg and therefore in the carcass did not differ between groups. Selected animals showed a higher percentage of dissectible fat and it seems that have a higher fat percentage in the meat of the hind leg, that leads to a lower moisture content.

INTRAPERITONEAL ELECTRONIC IDENTIFICATION OF RABBITS. PINNA W.*¹, SEDDA P.*², MARONGIU M.L.*¹, MONIELLO G.*¹, NIZZA A.†², DIMEO C.†² ¹*Dpt. di Biologia Animale, Univ. di Sassari, prodanim@uniss.it.* ²*Dpt. di Sci. Zootec., Univ. di Napoli, Italy. nizza@unina.it*

The authors propose an innovative technique of intraperitoneal electronic identification in rabbits using an injectable HDX 32.5 × 3.8 mm transponder. A steel shot injector was used to implant 79 Half Duplex passive bio-glass encapsulated injectable transponders in abdomen cavity of 37 males and 42 females rabbits 62 days old. 44 animals (24 males and 20 females) were slaughtered at 83d of age and averaged live weight of 1,975 kg. The transponders were recovered easily in abdominal cavity by the operator in slaughter chain. The readability, the localisation and effects on health of transponders were evaluated *in vivo* during 6 months. The readability of transponders in abdomen was checked with a hand-held reader immediately after transponders application and then at 1d, 7d, 30d and 240d. In 4 rabbits (2 males and 2 females) transponders location in abdomen cavity was monitored by using a X-Ray apparatus at 0d, 1d, 30d, 240d after transponders application. Health status and performances of rabbits were not modified by transponders presence in abdomen during the control period. In restrained animals the transponders showed a 100% readability. Farmers and technicians expressed their interest on the use of the electronic identification system.

The use of the intrabdominal electronic identification can be an interesting innovative method for tagging rabbits, improving the traceability of animals and meat along productive chain.

LINEAR MEASUREMENTS OF CARCASSES AS A TOOL TO IMPROVE THE EVALUATION OF THE RABBIT MEAT PRODUCTION. PINNA W.*¹, MARONGIU M.L.*¹, SEDDA P.*², MONIELLO G.*¹, NIZZA A.†², PICCOLO G.†² ¹*Dpt. di Biologia Animale, Univ. di Sassari, Italy. prodanim@uniss.it.* ²*Dpt. di Sci. Zootec., Univ. di Napoli, Italy. nizza@unina.it*

In order to improve the methodologies for objective evaluation of rabbit meat production a series of linear measurements have been carried out on rabbit carcasses, integrated by the carcass commercial traits usually evaluated at slaughter. Ninety-six crossbred rabbits (New Zealand White x Californian) were weaned at 28d (LW 493±63 g), slaughtered at 77d (LW 2167±157 g) and carcasses prepared by removing blood, skin, distal legs, urinary bladder and gastrointestinal tract. The average dressing out percentage (59.7±8.1%) was calculated. Carcasses were then refrigerated at 2°C for 24h and average cold carcass weight (CCW) 24h after slaughter resulted 1179±96 g. Head, lungs, thymus gland, trachea, heart and liver were removed and the conformation, fatness and colour of carcasses was classified, by visual examination, using a scale of 5±scores. Averages of some linear measurements effectuated on cold carcasses resulted: body length 32.8±1.0 cm, loin width 12.4±0.7 cm, chest width 9.0±0.4 cm, carcass length 26.9±1.0 cm, chest depth 6.5±0.6 cm and leg length 16.5 ± 0.8. Carcasses were then dissected to measure fat content and muscle to bone ratio. The average coefficients of correlation (r) calculated between the linear measurements and the dressing out percentage of carcasses resulted: body length 0.659; loin width -0.063; chest width 0.347; carcass length 0.633; chest depth 0.844; and leg length 0.392. The main linear measurements of carcasses could represent an additional tool for supporting the evaluation of rabbit meat production.

FAO Rabbit Science and Production

RABBIT PRODUCTION IN HOT CLIMATES. EL-RAFFA, A.M. *Poultry Production Dpt., Fac. of Agric., Alexandria Univ., Egypt.*

In hot climates, rabbit production is faced with many problems. At environmental temperatures of 32° C and higher heat stress occurs, leading to production losses. When temperatures of 35° C and higher persist, the greatest losses from heat stress may result. In this article, the effect of heat stress on rabbits performance, all requirements of successful intensive rabbit production in hot climate are discussed.

RABBIT BREEDING IN LA PAMPA: A COOPERATION MODEL FOR THE RABBIT BREEDING IN LA PAMPA: A COOPERATION MODEL FOR THE PRODUCTION OF QUALITY RABBIT MEAT. FACCHIN E.*¹, COSSU M.E.†²., GARCÍA S.M.‡³, GAUNA C.‡³ *Scambiarti-Onlus; Verona, Italia. a.associazionescambiarti@tin.it.* †*Fac. Agronomia. Univ. Buenos Aires, mcosu@agro.uba.ar;* ‡*Fundación Nuestros Pibes, Santa Rosa La Pampa; Argentina fnpibes@cpenet.com.ar*

La Pampa's rabbit basin is situated in the centre of the Argentine Republic (at 35° and 39°S), and since the year 2000 has been receiving support from International Cooperation Programs with the purpose of implementing an "integrated farmed rabbit breeding model." The aim of the project is to help impoverished population sectors that have been deeply affected by the country serious social crisis. Among the most vulnerable sectors considered, young people at risk or in legal trouble with the criminal law are included. The main objective was to develop a production chain – production and distribution of rabbit meat - characterized by high levels of environmental and ethological compatibility, sustainability, and social utility. The model is based on the principle of permanent professional training and information updating for chain operators, a "rural" and "multifunctional" production and the re-investment of part of the profits on other sustainable and socially useful projects. The Productive Model receives support from municipal and provincial governments and has set up a Professional Development and

Training Centre, which offers permanent advice to rural operators by a technical team. From the productive point of view, a Pilot Centre for the production of rabbit (New Zealand x California) meat was developed, including an Artificial Insemination Centre and a Professional-Technical Assistance Centre. There is a slaughter house complying with all the national regulations for the home market and, in the near future, for export. The producers of the basin organized themselves into: an Association (30 members) and 33 producers "in training" (5 young ex-convicts, 10 young in legal trouble, 14 young persons coming from Minority Programs for youth at risk without relapsing into crime, 4 women "family chief").

STUDIES ON THE PRODUCTIVE AND REPRODUCTIVE PERFORMANCES OF SOVIET CHINCHILLA AND NEW ZEALAND WHITE BREEDS OF RABBIT UNDER THE SUBTROPICAL CONDITION OF TRIPURA. GHOSH S.K.*¹, DAS A.†², BUJARBARUAH K.M.‡³, DAS ASIT§⁴, DHIMAN K.R.¶⁵, SINGH N.P.#⁶ *Dpt. of Animal Reprod., Tripura.* †*Dpt. of Anim Prod, ICAR.* ‡*Director, ICAR.* §*Dpt. of Anim Nutr, IVRI, Bareilly.* ¶*Dpt. of Plant Breeding, ICAR, Meghalaya.* #*Joint Director, ICAR, Tripura-India. subrata_kghosh@yahoo.co.in*

Productive and reproductive performances of New Zealand White and Soviet Chinchilla breeds of rabbit were studied under the sub-tropical climate of Tripura in India. Data from 261 litters were collected and studied. Both the breeds under study performed equally well. Only the number of service per conception and inter kindling interval were significantly ($P < 0.01$) higher in New Zealand White than Soviet Chinchilla. Both the breed and sex of the rabbit had no significant effect on individual body weight at weaning (42d) as well as at day of slaughter (90d). Season of kindling exerted highly significant ($P < 0.01$) effect on service period, kindling interval, and individual weight at weaning (42d) and at slaughtering age (90d). Winter season (November-March) was the most favourable season for kindling in terms of both their productive as well as reproductive efficiency where as summer season (April-June) turned to be the most unfavourable season. Age

at first fertile service, age at first kindling, gestation period, litter size at birth did not influence by the season of kindling.

EVALUATION OF SOME PRODUCTION PARAMETERS IN RABBIT. COMPARATIVE STUDY OF LOCAL MOROCCAN RABBIT AND CALIFORNIAN BREED IN PURE AND CROSS BREEDING. JAOUZI T.^{*}, BARKOK A.[†], BOUZEKRAOUI A.[‡] ET BOUYMAJJANE Z.^{*} **Dpt. de Pathologie Aviaire I.A.V. Rabat-Instituts, t.jaouzi@iav.ac.ma. †St. Avicole de Skikima, Témara. ‡Inst. Tech. Agricole de Ben Khliil Khénifra, Maroc.*

The present study was intended to evaluate production performances of local population of rabbit and Californian breed, both in pure and cross-breeding in Moroccan conditions. The breeding experiments studied were: *Local male x local does (group 1). *Californian male x local does (group 2). *Californian male x Californian does (group 3). *Local male x Californian does (group 4). Data reported here showed a positive improvement of performances of local rabbit population such as litter size at birth (6.2), number born alive (5.7), litter size at weaning (5.2), daily weight gain (33.6 g/day), live weight at slaughter (2117.5 g), feed efficiency index (2.16) and a decrease in mortality rate from birth through slaughter (-13.56%), when bred with Californian male rabbit. These findings support the benefit use of exotic breed with local rabbit female to better improve performances.

INCLUSION OF CRUDE OLIVE CAKE IN GROWING RABBITS DIET: EFFECT ON GROWTH AND SLAUGHTER YIELD. KADI S.A., BELAIDI-GATER N., CHEBAT F. *C. de Formation Prof. et de l'Apprentissage Mechtras, Tizi-ouzou. Algeria. kadisiammar@yahoo.fr*

Two pelleted diets were distributed, during 08 weeks, to two groups of fattening rabbit. The first (control diet) is the only one rabbit feed available on the market and used by breeders. The second (experimental diet) is formulated to contain the minimum of ingredients and the maximum of low-cost by-products available locally in order to come back cheap; it contains 61% of hard wheat bran and 20% of crude olive

cake. There was not significant difference on the main parameters of growth and slaughtering. The obtained performances are 24.68 g/d of growth, 77.5 g/d of feed consumption and 24.11 g/d of growth, 87 g/d of feed consumption respectively for the control group and the experimental one. The slaughter yield seems better with rabbits consuming the experimental diet (68.23 % vs. 66.64). Crude olive cake can be included in diets of fattening rabbits in total replacement of the alfalfa hay as source of fiber.

RABBIT PRODUCTION IN SMALL RABBITRIES IN TEXCOCO MEXICO. MARTÍNEZ F.^{*}, BECERRIL P.C.M.^{*}, PRO M.A.^{*}, GARCÍA D.G.[†], GARCÍA M.R.[†], CUCA G.M.^{*} **Progr. de Ganadería y Economía. Colegio de Postgr. Texcoco, México. color@colpos.mx*

Data and information collected on a weekly basis through an entire year from four small rabbitries located in Texcoco county, Mexico, were used to characterize productivity and economics of rabbit production. Based on previous studies rabbitries were selected according to doe number. The number of fattening rabbits produced by doe and year increased as the number of does did, resulted figures were 12.2, 24.2, 15.7 and 53.9, when does numbers were 5, 26, 37 and 58, respectively. Also, only the smallest production unit showed no profit. There exists a big potential to improve productivity in the Mexican rabbit units, although good quality data and information are needed for prospective studies and development programs.

RABBIT PRODUCTION, EDUCATION AND RESEARCH IN HUNGARY. SZENDRO ZS. *Univ. of Kaposvár, Fac. of Animal Sci., Kaposvár, Hungary. szendro@mail.atk.u-kaposvar.hu*

At the present time, the rabbit production of Hungary is less than half of the quantity achieved in the peak years, 1982 and 1991. In 2003, the total quantity of the Hungarian rabbit production was 10,932 tons in live and 5,471 tons of home carcass production and 459 tons of carcass import. Very special for Hungary is that the 97-98% of total production is exported, while the proportion of the Hungarian market is very

low (2-3%). In 2003, Italy had 44%, Switzerland 28% and Germany a 18% share from the Hungarian export. The shipments included 61% whole carcass and 39% cut products. The majority of the abattoirs are in foreign (Italian or Swiss) ownership. Earlier, 95-98% of the rabbits was produced at small farms, now about 75% of the total production originates from large farms of some hundred or thousand does. The angora wool production peaked in 1986, with a yearly output of 187 tons. At this time, Hungary was the biggest exporter country in Europe. The dramatic drop of wool price pressed the production down and now its quantity is near to zero. At most of the agriculture faculties of the universities and colleges, students can study rabbit breeding as a compulsory or a facultative course. Most of the Ph.D. students finished their study at the University of Kaposvár and some of them on one of the faculties of the „Szent István” University and Eötvös University. One of the main research

centres in Hungary is at Kaposvár. There are 500 does at the experimental farm, which is, as well, the selection centre of the Pannon White breed. High-tech equipment available at the University of Kaposvár are the CT and the MRI. The main research activity is in the field of selection, management, reproduction, digestive physiology, meat quality, ethology and animal welfare. The historical centre of rabbit research with traditional breeding of NZW and Californian stocks is the Institute for Small Animal Research at Gödöllő. Their research focuses on management, reproduction and nutrition. The Faculties of Agricultural and Environmental Science and Veterinary Science of the „Szent István” University (at Gödöllő and Budapest) are the centres of nutritional and physiological research. The Agricultural Biotechnology Center at Gödöllő is speicalized for the proteins of transgenic rabbit milk. The Eötvös University (ELTE) at Budapest is specialized for the ethology of rabbits.
