
Abstracts of the “11^{èmes} JOURNÉES DE LA RECHERCHE CUNICOLE 2005”Paris 29 and 30 November 2005.

The 11th Rabbit Research Days (JRC), organized by the INRA and the ITAVI with the assistance of the ASFC, was held in Paris, 29-30 November 2005. A total of 58 communications (including 3 reviews) were presented in 9 working sessions. **Reproduction.** In this session 12 scientific communications were presented, including a literature revision about the knowledge of the factors of success of insemination and the methods suitable for oestrus induction in order to improve rabbit doe fecundity. **Meat Quality.** This session included 5 scientific communications and a revision where the properties of rabbit meat were compared with those of species most common in human consumption. **Nutrition.** Feeding and Nutrition session included 6 communications and 1 revision about the feeding behaviour of the rabbit, which its good knowledge is necessary to develop balanced diets for each physiological stage. Other sessions were about **Economy and Genetics** (7 comm.), **Behaviour and Husbandry** (8 comm.), **General Pathology** (7 comm.) and **Enteropathy** (7 comm.). Finally, an additional session was assigned to an **Actually Topic** promoted by ASFC about the effect of the *post-weaning management* on the *performance and health of young rabbits* (4 comm.). Expanded abstracts of some of these works are available at <http://cuniculture.info>

Behaviour and housing

ODOUR LEARNING OF RABBIT PUPS UNDER THE MOTHER. COUREAUD G., MONTIGNY D., MONCOMBLE A.S., PATRIS B., PERRIER G., SCHAAL B. coureaud@cesg.cnrs.fr

Odours play a key role in the adaptation of neonatal rabbits by their involvement in the success of sucking behaviour. Predisposed and learning olfactory mechanisms underlie the orientation of pups toward the mother and the nipples. These mechanisms interact, but are experimentally dissociable. Specifically, nipple signalling relies on a pheromonal signal which behavioural activity is independent of learning. But this mammary pheromone is not only a releaser of the nipple-search behaviour. It is also a potent reinforcing agent for olfactory learning. By this latter function, the mammary pheromone contributes to the rapid improvement of sucking and of conspecific recognition performance and it prepares young rabbits to adaptive transitions in individual and social development.

EARLY OLFACTORY LEARNING IN THE NEWBORN RABBIT. NOWAK R., SERRA J. nowak@tours.inra.fr

From the results demonstrating early discrimination of their own nest by rabbit pups, we hypothesised postnatal learning of olfactory cues of this particular ecological niche. Odourisation of the nest with thyme on the second day after birth shows that pups are attracted towards the artificial odour on the following day. So, newborn rabbits are able to memorise quickly new olfactory information in their nest. Several comparisons with odourised nests show a preference for new elements when these are compared to those which were present at birth.

DEVELOPMENT OF A PREFERENCE FOR THE POSTNATAL ENVIRONMENT IN THE NEWBORN RABBIT. SERRA J., NOWAK R. serra@tours.inra.fr

The aim of this study was to evaluate olfactory-based orientation responses of rabbit pups to their postnatal environment. The animals were

submitted to a two choice test on the first (D1) and seventh day (J7) after birth. Newborn pups were attracted to their mother or another doe in the same physiological state, and also to their siblings or others pups of the same age. They oriented to their own nest or an alien nest when these were compared to an empty compartment. When two stimuli were presented, the pups preferred their familiar nest to an alien nest on D1 and D7. On the other hand, there was no preference for their mother compared to an alien doe in the same physiological state, nor for their siblings compared to alien young rabbits of the same age.

FEEDING BEHAVIOUR AND CAECOTROPHY IN THE YOUNG RABBIT BEFORE WEANING.

ORENGO J., GIDENNE T. *gidenne@toulouse.inra.fr*

The aim of this work was to study the intake behaviour of the young before weaning. The study involved 21 litters from primiparous females (NZWx Cal), equalised at 9 kits at birth. Litters were housed with their mother in specific cages allowing a separate feeding. The milk and solid feed intake, and the stomacal content were measured according to age (17-22-28-35 d) and to time delay post-milking (3-8-23 h). The young rabbit consumed almost only milk until 17d of age, and 23 h hours after milking the stomach still contained high milk quantity (score=2.3 and 0.9 resp. at 17 and 22 d). Solid feed was found in low quantity (score=1.0) in the stomach at 17 d, but increased sharply from 22 d of age. The coagulated milk was mainly located close to the stomach wall in the fundus, whereas the feed was more homogeneously spread (unless soft faeces were found). From 22 d, pellet intake reached 7.2 g/d/rab., and then raised to 31 and 48 g/d respectively at 28 and 35d, but it remained highly variable among litters (CV=30% at 35 d). From 28 to 35 d, the feed intake increased with post-milking time delay, and 73 to 76% of the solid intake was from 18:00 to 9:00 h. Thus, the usual nocturnal intake behaviour of the rabbit was installed as soon as the young ate solid feed. Soft faeces were not found until 28 days of

age, and were located in the fundus, they represented 25 to 30% of stomacal content.

DEVELOPMENT OF A FEEDING SYSTEM TO SEPARATE FEMALE AND LITTER FEED INTAKE BEFORE WEANING. MIRABITO L., BOQUIER C.

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The possible evolution of the rabbits' cages in relation with welfare regulation has lead us to design a new feeding system with the possibility of separating young and mother feed intake before weaning. In this study, we report a description of the development of this system and results obtained in a farm where 30 experimental cages were compared to control. Until 18-19 days after delivery, the experimental system did not seem to have an effect on feed consumption of does or growth of pups. At weaning, average body weight of the pups was in some trials reduced compared to control group. We linked these results to a lower feed intake of the pups and hypothesised that the pups' age at the introduction of the pups' trough is a key factor.

GROUP HOUSING OF RABBIT DOES: ZOOTECHNICAL TRAITS. MIRABITO L.,

GALLIOT P., SOUCHET C., DUMONT F., THOMERET F. *mirabito@itavi.asso.fr*

This study was carried out to assess group housing of breeding does (pen with 4 females-n=19) and pairs, in two cages fitted with a platform and joined at the back (n=27) under normal farming conditions and compared them with animals housed in individual cages (n=27). Six series of females were monitored throughout their first 4 breeding. While fertility and prolificacy were not affected by housing arrangements, the mortality of nursing kits was significantly higher in the group enclosures containing 4 individuals during two cycles than that recorded in individual cages or pair-housing. These deaths could be explained for the most part by to the large number of multiple births in the same nest (37.5% of births took place in a box where a doe had already given

birth). Lastly, it seems that rearing future breeding rabbits together (in order to form social groups as early as possible) induces a high number of fighting injuries and one-third of rabbits culled for this reason.

GROUP HOUSING OF BREEDING RABBIT DOES: BEHAVIOR. MIRABITO L., DUMONT F., GALLIOT P., SOUCHET C. *mirabito@itavi.asso.fr*

In this study, we assessed behavior during the first breeding cycle in 9 four-rabbit enclosures, 9 pair-cages and 18 single-cages. In the 4 rabbit enclosures, does spend 29.9% of their time together whereas in paired cages, this was only 0.8% of the time. The type of housing had mainly an influence by enabling rabbits to sit up on their hind legs (0.5% of the time). Lastly, in enclosures, does spent 2.7% of their time moving about compared with 1.2% in paired cages and 0.6% in single cages. At last, females housed in groups showed few modifications of their activity.

EFFECT OF SPACE ALLOWANCE AND ENRICHMENT ON THE ZOOTECHNICAL TRAITS AND BEHAVIOUR OF BREEDING RABBIT DOES. MIRABITO L., GALLIOT P., SOUCHET C. *mirabito@itavi.asso.fr*

This study was carried out to test the impact of three cage areas (included the nest box) (3420 cm², 4508 cm², 5880 cm²) in combination with two kinds of enrichment (a platform in types 1 and 2 and a plastic tunnel in type 3). All cages were 60 cm high. The performance of the does during 5 theoretical cycles were recorded and we did not observe any difference between the six treatments in term of fertility, prolificacy, mortality and growth rate of the kits. Time-budgets (posture) showed there were no differences between the six treatments except in cages with platforms, where does spent 4 to 15% of their time stretched out, and 10 to 25% of their time in the other cages. Conversely, in the furnished cages they adopted a posture on the platform in a sternal position with legs partly under the body. We related this choice to the space available on the platform.

Genetics and management

MAIN RESULTS OF RABBIT BREEDING REFERENCE NETWORK CUNIMIEUX FROM 2000 -2001 TO 2003-2004. AZARD A. *azard@itavi.asso.fr*

The rabbit breeding reference network CUNIMIEUX has provided since 1997 detailed information on rabbit breeding farms, farmers practices, technical performances and economical results including production cost. As an additional tool of technical and economical survey, it allows to follow the evolution of rabbit production from a hundred breeding farms sample distributed on the whole territory. Economical results analysis in 2003-2004 shows an improvement in gross margin notably due to rabbit price recovery, yet production costs including labour costs remain higher than selling prices. Interest of artificial insemination and of breeding farm size increase in term of working time and farmer's remuneration is confirmed.

RESULTS OF TWO RABBIT REFERENCE FARMS IN BELGIUM: FATTENING RABBITS IN PENS ON STRAW AND A "BANDE UNIQUE" MANAGEMENT OF 49 DAYS. JACQUET M., TELLER C., VAN SANTFOORT L. *Michel.jacquet@fwa.be*

The fattening of rabbits in pens on straw and the 49 days "bande unique" are two different ways of production. These systems are answers too some needs of the market. One year of observation of a reference farm, approved by the General Direction of the Agriculture of the Walloon area for the fattening in pens on straw, shows that the working time and the food conversion index (4.78) are very important factors for the profitability and for the appreciation of the higher price for the sale rabbits. The observation period of another reference farm, approved for "bande unique" of 49 days was two years. Females produced 274.9 lbs live weight per female and per year and, the farm food conversion index was 4.14. This tended to locate the profit at a level comparable to the one that is obtained by a 42 days rhythm.

EVALUATION OF THE PRODUCTIVITY OF RABBIT DOES OF AN ALGERIAN POPULATION, IN EXPERIMENTAL STATION AND IN FARMS.

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The objective of this study was to determine the productivity of the does of an Algerian local population, in an experimental farm during five years on the one hand, from a survey in small farms in the area of Tizi-Ouzou on the other hand. The performances estimated by the breeders are near to those recorded in the experimental farm. The numerical productivity recorded is about 25 to 30 rabbits weaned/female/year. A program of genetic improvement of this population, which allows to improve its performances while conserving its good adaptation is running.

FORMATION OF A STRAIN DERIVED FROM THE CROSSBREEDING BETWEEN AN ALGERIAN LOCAL POPULATION AND A EUROPEAN STRAIN TO IMPROVE THE RABBIT MEAT PRODUCTION IN ALGERIA. GACEM M., BOLET G.
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There is in Algeria a local population well adapted to the climatic conditions, whose prolificacy and adult weight are too low. In the frame of cooperation between INRA and ITELV, a new synthetic strain has been formed from the insemination of females of this local population by fresh semen of INRA2666. As compared to the average performances of the local population, the prolificacy of F2 females has been increased by 1.8 born and 1.6 weaned young. Female weight is higher by 500 g and weight at weaning is increased by 175 g. These results have to be confirmed by a planned comparison in later generations, but they constitute a promising way to improve rabbit meat production in Algeria.

MANAGEMENT AND SELECTION OF THE INRA 1777 LINE: RESULTS OF THREE GENERATIONS OF SELECTION. GARREAU H., DUZERT R., TUDELA F., BAILLOT C., RUESCHE J., GRAUBY G., LILLE-LARROUCAU C., DE ROCHAMBEAU H.
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The 1777 line has been selected during 3 generations on litter size and on direct and maternal effects of weaning weight by maximising genetic progress while constraining the rate of inbreeding to a predefined value equal to 1%. An algorithm aiming at minimizing the coefficients of relationship between the selected reproducers was used to carry out the mating plans. The genetic progress per generation, estimated by the method of the BLUP animal model, was 0.13 born alive per litter, 7.5 grams and 7.2 grams for the direct and maternal effects of weaning weight, respectively. The evolution of consanguinity was almost null on the 3 generations. The algorithm used for the mating plans allowed reducing the evolution of inbreeding beyond that authorized by the method of optimization of genetic progress.

COAT COLORS IN RABBITS: FROM PATTERN TO GENE. A CRITICAL SYNTHESIS. ARNOLD J., DE ROCHAMBEAU H., MENIGOZ J.J.
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This paper provides a method to describe coat color in rabbits. One have to answer to five questions: (i) is the rabbit albino? (ii) to which coat varieties belongs the rabbit? (iii) is the black eumelanin diluted in blue or transformed in brown? (iv) is the medium band orange or white? (v) which is the width of the medium band? Rabbits bred from a cross between chinchilla and albino rabbits reveal that the simplistic coat color genetic model does not depict the phenotype complexity.

GENETIC MAP OF THE RABBIT: STATE OF THE ART AND PERSPECTIVES. CHANTRY-DARMON C., URIEN C., DE ROCHAMBEAU H., ALLAIN D., PENA B., BOLET G., GARREAU H., HAYES H., BERTAUD M., GROHS C., CHADI-TAOURIT S., DERETZ-PICOLET S., LARZUL C., SAVE J.C., CRIBIU E.P., CHARDON P., ROGEL-GAILLARD C.
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A mapping project of the European rabbit (*Oryctolagus cuniculus*) genome has been launched by the INRA institute in December 2001. The aim was to mark out the genome with

microsatellites having a cytogenetic position, in order to directly build an integrated genetic and cytogenetic map. Among 305 newly isolated microsatellite sequences, 183 are anchored onto the cytogenetic map. Three generation rabbit families were produced and genotyped. Polymorphic markers harboured between 2 and 7 alleles with an average of 3,3. The genetic map spans 2729 cM and covers 21 of the 23 rabbit chromosomes. The map comprises 93 markers distributed in 21 linkage groups mapping to 18 distinct chromosomes and 18 single polymorphic markers with a precise cytogenetic position. The density of the existing map is still limited. However, this map, as it was shown by the localization of the angora and albinos genes segregating in the reference families, will allow developing the research of markers, genes or QTL for zoo technical traits in the rabbit.

Nutrition

THE FEEDING BEHAVIOUR OF THE RABBIT.

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The rabbit feeding behaviour is very particular compared to other mammals, with special features, such the cæcotrophy, associated to a particular digestive physiology, intermediate between the monogastric and the herbivore. Therefore, the rabbit is able to consume a very wide variety of feeds, and is able to adapt to various feeding environment. A good knowledge of the rabbit feeding behaviour is necessary to develop balanced diets for each physiological stage. This review is divided into 4 parts, including recalls of anatomy and digestive physiology, and data especially relating to domestic rabbit, but also to wild rabbit.

EFFECT OF RABBIT AGE, TYPE OF PROTEIN AND FEED ENZYME ADDITION ON THE APPARENT DRY MATTER AND CRUDE PROTEIN DIGESTIBILITY OF RABBIT FEED. GARCÍA A.I., GARCÍA J., CORRENT E., CHAMORRO S., GARCÍA-REBOLLAR P., DE BLAS J.C., CARABAÑO R. ai.garcia@nutreco.com

A total of two hundred and forty New Zealand x Californian rabbits weaned at 25 and 35 days of

age were fed with six experimental diets factorially (2x3) arranged. Ten days after the weaning, effects of rabbit age, protein sources (soybean meal vs. sunflower meal) and use of exogenous enzymes (control, protease, protease + xylanase) on the apparent ileal digestibility (AID) of dry matter (DM) and crude protein (CP) were studied. The AID of DM and CP are higher respectively of 2.7 and 1.9 points for animals slaughtered at 35 days of age ($P<0.05$, vs. 45j), 19.7 and 6.0% higher for the diets supplemented with enzymes ($P<0.0001$) and especially when xylanase is present. The use of AID for protein feed evaluation may have limited application due to the age effect. The supplementation with exogenous enzymes may be of interest to reduce the ileal flow of nitrogen increasing the ileal nitrogen digestibility.

NUTRITIVE VALUE OF ALFALFA DRIED AT LOW TEMPERATURE IN THE GROWING RABBIT.

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The nutritive value of alfalfa dried at low temperature – 35°C maxi - (LF) was compared to that of a standard dehydrated alfalfa (LD) with a similar composition. Each type of alfalfa was incorporated at 98,4% in a pelleted diet distributed *ad libitum* between 42 and 60 days to 2 groups of 15 individually caged rabbits. For LD and LF rabbits, in that order, average daily gain was 44 and 47 g/d ($P=0.081$) and feed intake ratio was 3.31 and 2.80 ($P<0.001$). Diet's energy digestibility was LD 54.6% and LF 49.6% ($P<0.001$); that of nitrogen was LD 64.6% and LF 70.7% ($P<0.001$). These differences in digestibility induced a Digestible Protein / Digestible Energy ratio of 49.9 for LD and of 59.6 g/1000 kcal for LF. The excess of digestible proteins of LF diet above requirements, induced a lower retention of digestible proteins for the diet LF than for diet LD: 56,5% vs. 70,0% respectively ($P<0.001$).

EFFECT OF A DIET RICH IN N-3 FATTY ACIDS ON THE PERFORMANCES AND MILK COMPOSITION OF DOES AND THE VIABILITY OF THEIR PROGENY. MAERTENS L., AERTS J.M., DE BRABANDER D.L. l.maertens@clo.fgov.be

Two diets with comparable energy and protein content were fed during 6 reproduction cycles. The diet enriched in PUFA n-3 (n=43 females) was obtained by incorporation of a concentrate based on extruded linseed at the expense of raw materials rich in PUFA n-6 (control diet, n=41). The performances, milk composition and viability of the progeny before and after weaning were studied. Performances did not differ significantly, but females fed the n-3 diet tended to wean 3.5 pups more than the controls during the whole experimental period ($P=0.21$). Feeding a diet rich in n-3 PUFA's resulted in a higher milk fat content (+1.3%; $P<0.05$) and moreover the dietary fatty acid profile was very well reflected in the milk. After weaning, mortality was significantly lower (-4.4%; $P<0.01$) in the n-3 fed rabbits.

INFLUENCE OF THE INCORPORATION OF 2% OF FLAXSEED OIL IN DIET OF FATTENING RABBITS ON GROWTH PERFORMANCES AND HEALTH. VERDELHAN S., BOURDILLON A., RENOUF B., AUDOIN E. *sandrine.verdelhan@cybelia.fr*

The aim of this trial was to study the effect of flaxseed oil on growth performances and health of fattening rabbits. This field trial was conducted on 924 rabbits aged of 38 days, they were divided into 2 groups: the treatment group received a diet with 2% of flaxseed oil and the control group received a diet with 2% of rapeseeds. At slaughter, no difference was observed on mortality. However there was a significant decrease of weight (-70g) for rabbits receiving flaxseed oil.

INFLUENCE OF THE DISTRIBUTION OF A BOOSTER OF HSP PROTEINS ISOLATED FROM THE PRICKLY PEAR ON THE GROWTH AND THE MORTALITY OF WEANED RABBITS. COLIN M., GUTTIEREZ G., PINAUT M., PRIGENT A.Y., SALIBA C. *copri@wanadoo.fr*

The effects of the distribution of a booster of HSP proteins isolated from the prickly pear, the Copritex on the growth and the mortality of 2858 rabbits were studied during 4 field tests. A distribution of 0,1 ml/rabbit of Copritex at weaning either individually or collectively in

the drinking water or in the feed was followed up by a rabbit weight improvement (from +3 to +5%) at the end of the growing-fattening period (from $P<0,05$ to $P<0,01$). No difference of mortality was observed.

EFFECT OF PLANT EXTRACTS ON ANTIOXIDANT STATUS OF FATTENING RABBITS. BRIENS C., ARTURO-SCHAAN M., GRENET L., ROBERT F. *cbriens@ccpa.fr*

A plant extract, PLMA, has been distributed for 14 days after weaning (2.65 ml/l drinking water), in addition to a medicated feed with antibiotics, during 3 successive trials, including 344 rabbit each divided in 2 lots (PLMA and control). In trial 3, oxydative stress (TBARS) increased from 35 to 49 days and was lower in PLMA group at 49 days (4.77 vs. 9.03 mM/l $P=0.004$) and serum antioxidant status was improved with PLMA (1.00 vs. 0.83 μ M/l $P=0.056$ tendency). It is a possible explanation of PLMA mortality, significantly lower than control mortality in trial 1 (18.5 vs. 30.1% $P=0.012$) and in trial 3 (17.0 vs. 41.7% $P<0.001$). Mortality was exclusively due to diarrhoea of parasitic aetiology (coccidiosis) for the 3 trials and *E. coli* (trial 1 only). PLMA has not improved the growth.

Pathology

STUDY OF HEPATIC VIRUS RHVD-CARRYING RABBITS, IN 35 AND 57 DAY OLD ANIMALS ORIGINATING FROM MOTHERS DEAD FROM VHD (VIRAL HEMORRHAGIC DISEASE) BEFORE WEANING. BOUCHER S., BOUCRAUT BARALON C., BOUVIER A.C., PINGRET J.L., JACQUINET C. *s.boucher@labovet.fr*

In a rabbitry of Vendée (France), does which were not vaccinated developed RHD, as confirmed by ELISA. The young rabbits where 32 days old when the mother died. The analysis of young rabbits livers with a real time RT-PCR technique showed a contaminated but healthy rabbit at 35 days. The young rabbits were vaccinated with 0,5 ml of Lapinject VHD® when they were 35 days old and their livers were analysed with the same technique when the rabbits were 57 days old. None of these rabbits had died from RHD at

the age of 10 weeks, however three rabbits were contaminated but healthy when they were 57 days old. Thus the authors advise to vaccinate several consecutive batches in case of rabbits reared in infected rabbit farms.

STUDY OF THE PERSISTENCE OF RHVD VIRUS WITH A RT-PCT TECHNIQUE IN THE ENVIRONMENT OF RABBITRIES TO EXPLAIN RELAPSE OF VIRAL HEMORRHAGIC DISEASE (RHD). BOUCHER S., BOUCRAUT BARALON C., DILÉ B., JACQUINET C. *s.boucher@labovet.fr*

Ten rabbitries that had been infected by RHD a first time in 2003 were infected a second time several months later. Swabs were sampled on material and buildings with the objective of investigating RHVD viruses with a RT-PCR technique. None of the rabbitries that had been decontaminated with one of the three commercial products against virus was positive. On the opposite, in rabbitries that had not been decontaminated, the authors found the viruses on dust sampled on the woody framework, on the top of the cages, on the walls, dejections, hair, in the pits, on the food and on blood spots. The authors also raise the question of the duration of immunity induced by the vaccination. The occurrence of the virus more than four months after RHD infection and the diminution of the immunity in some cases could also be at the origin of some recurrences.

IDENTIFICATION AND TYPING OF *PASTEURELLA MULTOCIDA* STRAINS ISOLATED FROM ITALIAN RABBITRIES ANALYSED BY BIOCHEMICAL AND MOLECULAR TECHNIQUES. CERROTE A., BADIOLA-SÁIZ J.I., PEREZ DE ROZAS A.M., GONZALEZ J., PERUGINI A.G., FENZIA D., CAPUANO F., BARTOLA M. *annacerr@tin.it*

This first part of the study regards the phenotypic analysis (diameter and growth speed of the colonies, biochemical kinetics) and the genotypic one (REP-PCR) of 141 *P. multocida* strains isolated in 47 rabbitries in Campania region (Italy). On the basis of the different brake points selected to separate the different genotypes we have obtained the following division: 14 clusters for Biochemical kinetics with

a SR (Relative Similarity) of 90%, 16 clusters for REP-PCR (Intensity of the Band) with a SR of 65% and 22 for REP-PCR with a DD (Dice Distance) of 45.

CLONALITY OF HIGH-VIRULENCE RABBIT *S. AUREUS* STRAINS AS DEMONSTRATED BY PULSED FIELD GEL ELECTROPHORESIS. VAN CRAEYNEST D., HERMANS K., DEPLANO A., DENIS O., MEULEMANS L., HAESBROUCK F. *dieter.vancraeynest@UGent.be*

High-virulence *S. aureus* strains from rabbits typically belong to the biotype-phagetype combination “mixed CV-C” - 3A/3C/55/71. In recent years however, some strains, isolated from rabbitries with chronic problems of staphylococcosis, showed a slightly different phagetype. This suggested an evolution of the classic high virulence strains. Yet, recent pulsed field gel electrophoresis (PFGE) showed that the “new” and the classic high virulence strains are clonal. This reassuring news indicates that PFGE is a more reliable typing tool for rabbit *S. aureus* strains than phagetyping. It is however a difficult and expensive tool and therefore, a new and cheaper diagnostic test for use in practice is in development.

DESCRIPTION OF TYZZER'S DISEASE IN A RATIONAL RABBIT FARM. LE NORMAND B., LICOIS D., NIEPCERON A., CHATELLIER S. *blenormand@wanadoo.fr*

In an industrial rabbit farm with good sanitary conditions an intestinal disease occurred on does and 4-week-old rabbits. Mortality was high with profuse and sometimes haemorrhagic diarrhea. A first treatment with aminoglycoside antibiotic was ineffective. Necropsies shown marked oedema of caecal mucosa with digestive necrotic lesions, and necrotic foci on the liver. Tyzzer's disease was suspected but histology didn't confirm this hypothesis. After clinical examination, a second treatment based on cyclines which are known to be effective on *Clostridium piliforme* was used. Diarrhea and mortality stopped. Laboratory diagnosis of Tyzzer's disease is rather difficult but in this

case, it was nevertheless established using a nested-PCR.

CHARACTERIZATION OF RESISTANCE PATTERNS AND DETECTION OF RESISTANCE GENES IN ENTEROPATHOGENIC *E. COLI* (EPEC) ISOLATES FROM RABBITS IN ITALY. PERUGINI A.G., CERRONE A., AGNOLETTI F., MAZZOLINI E., FENZIA D., BARTOLI M., CATTOLI G., BANO L., CAPUANO F. *f.capuano@izsmportici.it*

The dissemination of antibiotic resistance genes among bacterial strains is an increasing problem in infectious diseases. The use of antimicrobials in any venue, including growth promotion in veterinary medicine, can potentially lead to widespread dissemination of antimicrobial-resistant bacteria. In this research, after the analysis of 198 REPEC (Rabbit enteropathogenic *Escherichia coli*) strains for specific virulence factors, such as intimin and fimbriae, which participate in the pathogenesis of the bacterium, the antimicrobial susceptibilities and the carriage of some resistance genes by these isolates have been examined.

WEANING AGE AND SENSITIVITY TO AN EXPERIMENTAL INFECTION BY AN *E. COLI* O103 STRAIN. GALLOIS M., BOULLIER S., MILON A., GIDENNE T. *gallois@toulouse.inra.fr*

10 litters of 9 young rabbits, weaned at 21 (W21, n=5) or 35 days (W35, n=5), were inoculated at 28 days with 10^4 *E. coli* O103 (E22 enteropathogenic strain). Does were seronegative towards this serotype. The disease (anorexia, weight loss, diarrhoea and death) quickly developed in W21 litters: at 36 days, 50% of W21 rabbits were dead, whereas the first deaths were only observed in the W35 group. The evolution of the disease was then similar in W35 litters: 50% of W35 dead rabbits at 45 days, and a similar mortality rate to W21 group at 63 days. Milk seems to confer a transitory protection against O103 colibacillosis, which could be partly related to a temporary lower growth of *E. coli* O103 in the digestive tract (faecal excretion of *E. coli* lower in W35 than in W21 litters from 31 to 36 days).

RECENT STUDY ON MINIMUM INHIBITORY CONCENTRATION (MIC) DETERMINATION OF TIAMULIN FOR CLOSTRIDIA ISOLATES FROM RABBITS AFFECTED BY RABBIT EPIZOOTIC ENTEROPATHY (REE). BOUVIER A.C., JACQUINET C., MANCO B. *claire.jacquinet@ceva.com*

This study was intended to assess the MIC of Tiamulin for Clostridia isolates sampled in 2004 from rabbits affected by REE. All Clostridia isolates collected from rabbit caecal samples affected by REE clinical signs were sensitive to Tiamulin and 0.8 µg/ml inhibits 90 % of the strains. This study confirms that efficacy of Tiamulin is high, despite of large use during years.

METHODOLOGY OF REPRODUCTION OF EPIZOOTIC RABBIT ENTEROPATHY SYNDROME (ERE): DIRECT OR INDIRECT CONTACT CONTAMINATION WITH ONE OR SEVERAL RABBITS INOCULATED WITH TEC2 INOCULUM. BOISOT P., DUPERRAY J., GUYONVARCH A., LICOIS D., COUDERT P. *pboisot@evialis.evls.net*

The purpose of this trial was to study rabbit contamination by direct or indirect contact with one or several rabbits inoculated with TEC2 inoculum. Direct or indirect contact of rabbits with one rabbit inoculated with TEC inoculum reproduces ERE syndrome with a delay in death expression of only 2 to 5 days compared to oral inoculation of TEC inoculum. The use of two contaminating rabbit per cage instead of one did not modify the intensity of the disease for the other rabbits of the cage. Mortality and morbidity of rabbits contaminated by direct or indirect contact were higher compared to that of inoculated rabbits. Sick rabbits would represent a stronger contamination load than the inoculum TEC orally inoculated.

INTERACTION BETWEEN THE HISTORICAL SANITARY STATUS OF DOES OR OF YOUNG RABBITS BEFORE WEANING WITH REGARDS TO EPIZOOTIC RABBIT ENTEROPATHY (ERE) SYNDROME AND AN EXPERIMENTAL CONTAMINATION OF THESE RABBITS DURING THE FATTENING PERIOD. BOISOT P., DUPERRAY J., GUYONVARCH A., LICOIS D., COUDERT P. *pboisot@evialis.evls.net*

The interaction between the historical sanitary status of does or of young rabbits before weaning with regards to ERE and an experimental contamination of these rabbits during the fattening period was studied. Does contaminated with ERE during their growth did not transmit, 6 month later, the disease to their young. Furthermore, these young rabbits showed partial resistance to an experimental contamination with ERE during the fattening period with a major death rate reduction compared to young rabbits from healthy does (4% vs. 27%). But, a similar and significant growth decrease has been observed for both of these groups in comparison with the corresponding non inoculated groups. Young rabbits contaminated at 12 days of age contracted the disease before weaning (death rate of 33%), survivors being resistant to a second contamination after weaning.

INFECTIOUSNESS OF INOCULUM TEC4: DOSE EFFECT AND PERSISTENCE OF VIRULENCE ACCORDING TO TIME. LICOIS D., COUDERT P.
Dominique.licois@tours.inra.fr

A new inoculum (TEC4) was recently made up, starting from intestinal contents obtained from SPF rabbits experimentally infected with TEC3. Its capacity to reproduce the ERE syndrome was tested with various doses and after conservation, in dry environment at room temperature. Whatever the inoculated dose and this until that of 1/1000th, the response of animals (SPF or conventional) was similar: reproduction of a pathology which develops over the first week, associated with clinical signs of ERE and mortality varying from 10 to more than 40%. At the dose of 1/10000th, the disease appeared about one week later. On the opposite, the virulence of TEC4 was not affected, after nearly one year of conservation at room temperature, on dry medium.

EPIZOOTIC RABBIT ENTEROPATHY: STUDY OF EARLY PHENOMENA WITH STANDARD INOCULUM TEC3. COUDERT P., LICOIS D.
Pierre.coudert@tours.inra.fr

Using 180 35-day-old SPF rabbits, this study used the effectiveness of the bacitracin as tool for a better knowledge of the various phases of the ERE, in particular in early hours which follow the inoculation. Six groups of animals were used including 3 treatments with Bacivet S (bacitracin) at different time around the inoculation, with our standard inoculum TEC3. Three parameters were studied: growth, mortality and rumbling noises (borborygmi). A significant fall of growth was observed during the first 18 hours following the inoculation in all the inoculated groups medicated or not. The treatment with bacitracin allowed to suppress mortality and borborygmi but not this initial fall of growth. Treatment starting 18 hours after inoculation is less effective during the acute phase than the preventive treatment. Even with a preventive treatment stopped as soon as 18 hours after inoculation a delay of several days is observed before the apparition of the disease (fall of growth, appearance of the borborygmi) and the total mortality is reduced. Very few pathogens can explain this early fall of the growth. Bacitracin is an antibiotic which makes it possible to control the disease very well and thus probably the pathogen but not the physio-pathological disturbances of the first hours. The intervention of an exogenic toxin as soon as the moment of the contamination seems likely.

DETECTION OF POTENTIALLY PATHOGENIC AGENTS IN RABBITS AFFECTED BY EPIZOOTIC RABBIT ENTEROPATHY (ERE). SEARCH FOR A CORRELATION BETWEEN THE PRESENCE OF THESE AGENTS AND THE PATHOLOGY BY COMPARISON WITH NON AFFECTED RABBITS. PERSILLON C., FRANCHET C., LICOIS D., RAVOT G.
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DNA or RNA sequences specific for several potentially pathogenic agents (bacteria, viruses, phages) have been searched in an inoculum reproducing ERE (inoculum TEC3). The ones that have been detected in this sample have been searched in different kinds of samples: other inoculums (TEC), negative (control) inoculums, intestinal samples collected from rabbits of rabbit farms affected or not by ERE, air samples collected during experimental

reproduction of ERE. These results allow proposing hypotheses about the pathogenic agent(s) responsible for ERE. The validity of these hypotheses will have to be confirmed by complementary experiments.

GENETIC VARIABILITY OF THE RESISTANCE FOR EPIZOOTIC RABBIT ENTEROPATHY (ERE): NEW RESULTS. GARREAU H., LICOIS D., RUPP R., DE ROCHAMBEAU H. garreau@toulouse.inra.fr

To measure the genetic variability or resistance to epizootic rabbit enteropathy, two batches of 330 rabbits from 22 sires have been inoculated after weaning using the inoculum INRA TEC3. Four indexes were defined -mortality, diarrhoea, normal growth, resilience- to characterize the response of the rabbits from day D5 to day D33 day. The application of a logistic regression highlighted a significant effect of the sire on the indexes diarrhoea, normal growth and resilient but not on mortality. The genetic parameters of three of these indexes were estimated by the method of REML. The heritabilities estimated for mortality, the index of normal growth and resilient were respectively 0.05, 0.07 and 0.28. The genetic correlations between the index of mortality, on the one hand, and the indexes of growth and resilient, on the other hand, were favourable (-0.45, -0.29). Resilience is genetically more related to the index of growth than to the index of mortality.

Post-weaning management

EFFECTS OF LEVEL AND ORIGIN OF DIETARY ENERGY ON REPRODUCTION PERFORMANCE OF THE DOES AND HEALTH STATUS OF THE YOUNG. FORTUN-LAMOTHE L., LACANAL L., BOISOT P., JEHL N., ARVEUX P., HURTAUD J., PERRIN G. lamothe@toulouse.inra.fr

This study concern 9137 rabbits from 927 litters of 555 does reared in 6 experimental units. Animals were assigned in three experimental groups according to feed (T: energetic and rich in starch, F: rich in fibres or MG: energetic and rich in lipids and fibres diets) given before weaning (18-35 days) to the does or around weaning (18-49 days) to the young. Fertility of

does was similar in the three groups for the two first reproductive cycle but was lower in F groups for the 3rd cycle (70% vs. 87.8%; $P < 0,05$). Litter size and weight were not affected by experimental diets. Young were lighter at weaning in F group than in other groups (-4%; $P < 0,001$) but this difference does not exist anymore at 63 days. 4639 rabbits were controlled from 35 to 63 days of age. The mortality was lower in F and MG groups (15.9% et 14.6% respectively) than in T group (21.6%; $P < 0,01$). This study showed that a feed fibre- and energy-rich diet improves health status of the young without decrease the reproductive performance the does.

INTEREST OF HYDRIC RESTRICTION COMPARED TO FEED RESTRICTION IN GOOD SANITARY CONDITIONS AND DURING AN EXPERIMENTAL REPRODUCTION OF EPIZOOTIC ENTEROPATHY SYNDROME (ERE) IN GROWING RABBITS. BOISOT P., DUPERRAY J., GUYONVARCH A. pboisot@evalis.evls.net

The interest of a hydric restriction (access to drinking water 1h/day) was compared to a severe feed restriction (-35% of *ad libitum* feeding) in good sanitary conditions and during an experimental reproduction of ERE. Two groups of rabbits (good sanitary conditions (189 rabbits) and inoculated with TEC 2 inoculum (128 rabbits)) were divided at weaning into 3 groups and controlled up to 67 days of age: A (control group), B (hydric restriction from 32 until 53 days of age) and C (feed restriction from 32 until 53 days of age). In good sanitary conditions, hydric restriction was distinguishable from feed restriction by a lower water/feed consumption ratios (1.2 vs. 3.5) and a limited compensatory growth when rabbits were back to *ad libitum* feeding (-19% compared to feed restriction). In ERE conditions, a preventive hydric restriction (1h/day) was as efficient as feed restriction to reduce mortality and morbidity compared to the control group (death rate lowered by 22 points).

INTERACTION BETWEEN STARTER DIETS AND WEANING AGE IN THE YOUNG RABBIT. FEUGIER A., SMIT M.N., FORTUN-LAMOTHE L., GIDENNE T. feugier@toulouse.inra.fr

This study aimed to evaluate the interaction between weaning age (23 vs. 35 days old) and starter diets (FEM vs. LAP, respectively formulated to meet the nutritional requirements of the doe and of the young) given *ad libitum* from 18 to 35 d, on digestive health and growth performance in young rabbits. At 18 days of age, 39 litters of 9 pups per litter were allotted in four groups according to a 2x2 factorial design: FEM23 (n=84 rabbits), LAP23 (n=86), FEM35 (n=85) and LAP35 (n=74). At 35 days pups were caged in collective fattening cages (5 rabbits per cage). Feed intake and final live weight were not influenced by starter diet. Between 23 and 35 days of age no difference in solid feed intake occurred. After 35 days of age, feed intake was 10.7% higher for conventionally weaned than early weaned rabbits ($P<0.05$). Live weight was higher for conventionally weaned than early weaned rabbits at both 35 and 53 days of age (+26.7%, +11.3% respectively; $P<0.05$). Mortality rate was 21.2 points higher from 23 to 35 days of age ($P<0.001$) and 42.9 points higher ($P<0.001$) from 35 to 53 days of age for early weaned (at 23 days of age) than for conventionally weaned pups. These data suggest that an early weaning had a detrimental effect on digestive health and growth of the young. These negative effects were not compensated by a diet with a starch/protein ratio more adapted to the young digestive capacity.

DIGESTIVE EFFICIENCY OF THE EARLY-WEANED YOUNG RABBIT: METHOD OF MEASUREMENT AND EFFECT OF THE RATIO PROTEIN/ENERGY IN THE DIET. GIDENNE T., FEUGIER A., LACROIX S. *gidenne@toulouse.inra.fr*

Three groups of 22 young rabbits, weaned at 23 d of age, were placed in metabolism cages (3x11 cages of 2 rab.). Animals were fed *ad libitum* with one of the three experimental diets (MAD1, 2 or 3), differing essentially by their crude protein content (resp. 14,7 - 17,8 - 20,5%), but having similar energetic value. Using the "European" referenced method in 4 wks old rabbits, overestimated of the energetic value of the diet (+150 kcal). Digestibility data more consistent with the physiology of the young were obtained

by correcting the intake and excretion measured before 35 d. of age. The protein digestion did not vary between 4 and 6 wks of age, contrary to the energy digestion that increased by 2.7 units. Digestibility of organic matter decreased from MAD1 to 3 (-2.5 units, $P<0.01$), while the protein digestion improved by 2 units ($P<0.01$).

Reproduction

PREPARATION OF THE RABBIT DOE TO THE INSEMINATION: BIBLIOGRAPHIC ANALYSIS.

THEAU-CLÉMENT M. *theau@germinal.toulouse.inra.fr*

This bibliographical review gives a description of knowledge of the factors of success of insemination and the methods suitable for oestrus induction in order to improve rabbit doe fecundity. The parity, the lactation status, pseudopregnancy as well as the sexual receptivity at the time of insemination highly influence reproductive performances. Pseudopregnancy strongly depresses fertility; however the cause of these ovulations is unknown today. The routine use of PMSG on lactating does, makes it possible to increase in a durable way, the proportion of receptive does at the time of the IA and in consequence their productivity, without important immune risks. Applied just before the insemination different alternative methods have been studied: an animal manipulation (change of cage, does gathering), a "buck" effect, a short dam-litter separation, feeding programmes and light stimulations. Some of these methods improve the fecundity, but they sometimes also decrease young growth (dam-litter separation, lighting programmes...). Consequently, for an optimal application in farms, it is important to consider long term effects such as global productivity and durability of the effects. However, a better knowledge of the underlying physiological mechanisms would allow a better control of the reproduction in rabbit farms.

IN UTERO CHARACTERISATION OF FOETAL GROWTH BY ULTRASOUND SCANNING IN THE RABBIT.

CHAVATTE-PALMER P., LAIGRE P., SIMONOFF E., CHALLAH M., CHESNÉ P., RENARD J.P. *pascale.chavatte@jouy.inra.fr*

In the objective of developing research on pregnancy development in rabbits, it has become important to be able to measure foetal growth *in utero* using medical imaging. In this study, 42 New Zealand does bred naturally (N=12) or transferred with *in vivo* produced embryos (2, 4 or 6 embryos/doe) have been scanned with a 7.5 Mhz transabdominal probe from Day 7 post-coitum to measure foetal and placental growth. Vesicle, placental, embryo and head size have thus been determined according to number of foetuses and time. In late gestation, foetuses that were transferred in limited numbers to the uterus of does were significantly larger than their natural breeding counterparts.

CRYOPRESERVATION OF RABBIT DOE OVARIAN CORTEX: TOXICITY OF TRANSPORT MEDIA. NETO V., JOLY T., LORNAME J., CORRAO N., BUFF S., GUÉRIN P. *v.neto@vet-lyon.fr*

Freezing of ovarian cortex allows preservation of animal's genetic resources through the female pathway. The aim of this study was to define the optimal conditions for the transport of ovaries of the rabbit doe from the *post mortem* collection to the cryopreservation step. Morphological evaluation of follicles was made after 1 h of transport in 3 media (TCM 199, Brahma or D-PBS) at 10°C or at room temperature. Our results show that at 10°C, the proportion of follicles without any morphological defect is similar, whatever the medium is. But this rate decreases significantly during the transport at room temperature, except for TCM 199. Optimal conditions for the transport of the ovaries of the doe are TCM 199 used at 10°C.

FREEZING OF RABBIT SEMEN: A CALORIMETRIC APPROACH. SALVETTI P., BAUDOT A., JOLY T. *p.salvetti@isara.fr*

The cryoconservation of the semen is an effective and safe tool to preserve animal genetic resources and to diffuse the genetic progress; however, this technique is not controlled yet for the rabbit. The aim of this study is to characterize the thermodynamic behavior of the three main mediums of rabbit semen freezing using differential scanning calorimetry (DSC, Perkin-

Elmer). The real freezing and thawing rates are presented for each freezing method. The crystallization phenomenon in the cryoprotective solutions are characterized by temperatures measurements of the first ice crystals appearance and estimations of the total quantity of ice formed. Our first calorimetric approach establishes the bases necessary to define the optimal rates for the rabbit semen freezing.

EVALUATION OF THE RABBIT SEMEN CONCENTRATION ACCORDING TO TWO METHODS: HAEMOCYTOMETER AND NUCLEO COUNTER SP 100. THEAU-CLÉMENT M., FALIÈRES J. *theau@germinal.toulouse.inra.fr*

The aim of that study was to compare and to test the repeatability and the accuracy of concentration measurements of rabbit semen using two methods: haemocytometer (standard method) and the NucleoCounter^â (tested method). The concentration was evaluated from 106 ejaculates by both of the methods. At the NucleoCounter, the correlation between the concentration of two different drops coming from a same sample is +0,97 ($P<0,0001$). At the haemocytometer, the correlation is +0,99 ($P<0,0001$). Moreover, whatever the drop, the correlation between the measurements done by the two systems is +0,96 ($P<0,0001$). These results evidenced a positive and linear relation between two successive measurements of a same sample as well as between the two methods. It is demonstrated, whatever the concentration, that the NucleoCounter is an as repeatable and accurate tool for rabbit semen evaluation as the standard method. Moreover, simple and rapid, that method could allow, by a generalisation of concentration evaluation in AI Centers, a better control of quantitative aspects of the rabbit insemination dose.

VARIABILITY AND PHENOTYPIC CORRELATIONS OF SOME PRODUCTION AND QUALITY TRAITS OF RABBIT SEMEN. GARCÍA-TOMÁS M., SÁNCHEZ J., RABEL O., RAMON J., PILES M. *monica.garcia@irta.es*

A total of 2140 ejaculates from 156 adult males pertaining to 4 groups of bucks were analysed. Principal component analysis and phenotypic correlations were performed in order to examine the relationships between qualitative and quantitative traits of rabbit semen. The first four principal components (PC) explained 62% of total variation. Percentage of sperm viability (Vi), percentage of sperm with acrosome integrity (NAR), percentage of sperm normalcy (Nr), percentage of sperm morphological abnormalities of neck-midpiece (Nm) and tail (T) were the predominant variables in the first PC. Mass and individual motility (Mm, Mi), pH, concentration (Cn) and total number of spermatozoa per ejaculate (TSE) were located in the second. Percentage of sperm with the presence of proximal and distal cytoplasmic droplet (Dp, Dd), NAR, Vi and Nr were the predominant traits in the third and volume (V) defined the fourth.

EFFECT OF AN INTRAUTERINE INFECTION WITH BACTERIAL LYPOPOLYSACCHARIDS ON SOME ASPECTS OF RABBIT DOES REPRODUCTION. DAL BOSCO A., BRECCHIA G., CARDINALI R., CASTELLINI C., BOITI C. *dalbosco@unipg.it*

The aim of the trial was to define a protocol for obtaining sub-clinical inflammation in the genital tract of rabbit does and to assess the role of seminal plasma on spermatozoa transport. The does were inoculated 500 µg of bacterial lipopolysaccharids (LPS) of *E. Coli* close to the cervix region, 60 h before artificial insemination carried out by inoculating 0.2 ml of pooled semen (experiment 1) and 0.5 ml of sperm diluted in TALP or in seminal plasma (experiment 2); after 12 h, the does were sacrificed. The number of spermatozoa in the different genital tracts was counted and uterine tissue was examined by histological technique. The spermatozoa recovery was significantly lower in the uterine horn of LPS-treated does, and absent in the oviducts; the addition of seminal plasma helped the transport of spermatozoa, but their number was, in any case, lower than in non treated does. Histological examinations of LPS-does showed

an endometritis-like inflammation. The immunoprotective action of seminal plasma is not strong enough to protect spermatozoa.

REDUCTION OF REPRODUCTIVE RHYTHM AND LACTATION LENGTH IMPROVE BODY CONDITION AND FERTILITY OF RABBIT DOES.

FEUGIER A., FORTUN-LAMOTHE L., LAMOTHE E., JUIN H. *feugier@toulouse.inra.fr*

This research aimed to evaluate the respective influence of reproductive rhythm (artificial insemination at the 11th or 25th day after kindling) and age at weaning (at 23 or 35 days of lactation) and interaction, on evolution of body condition and reproductive performance of rabbit does. 250 primiparous does were assigned to one of four treatments in a 2 x 2 factorial design: I1S23, I1S35, I2S23 and I2S35. Does representative of each group were slaughtered at successive stages to evaluate reproductive performance and/or body condition. A reduction (extensification) of reproductive rhythm increases the fertility of females (+13.7%; $P < 0.05$) and the adipose stores at 2nd parturition (+27.9%; $P < 0.05$). Early weaning has no effect on reproductive performance of the does, but reduce significantly adipose mobilisation from 1st to 2nd parturition (-40.5% vs. -56.5% in groups weaned at 23 and 35 days respectively; $P < 0.001$). The effects of a reduction of reproductive rhythm and age at weaning on corporal condition of the does add together.

EVOLUTION OF THE NUTRITIONAL STATUS OF RABBIT DOES AFTER PARTURITION AND RELATION WITH THEIR FECUNDITY.

THEAU-CLÉMENT M., FORTUN-LAMOTHE L. *theau@germinal.toulouse.inra.fr*

One hundred and thirty five lactating primiparous rabbit does were inseminated 1, 4, 12, 19 days *postpartum* or 2 days post-weaning (30 days *post partum*). During the lactation (1 to 19 days), the increase in the needs for the does results in the increase of daily feed intake, the reduction in the proteic (carcass) and lipidic body reserves (fat périrénal) and blood indicators showed that the metabolism is directed towards reserves catabolism. In addition, the

productivity (number of segmented ova 24 hours/AI) measured 24 hours after the insemination increases from the kindling to 12 days *post partum* despite, the progressive mobilization of the body and in particular lipidic reserves during lactation. These results suggest that at the moment of the insemination, the lactation stage is a factor of fecundity control stronger than the nutritional status.

EFFECT OF DIFFERENT FEED RESTRICTION OF RABBIT DOES DURING THE REARING PERIOD ON THEIR SUBSEQUENT PRODUCTIVITY. BRIENS C., GRENET L., SALAUN J.M. *cbriens@ccpa.fr*

From 13 weeks old and till the 1st parturition (24 weeks), 3 groups of 72 rabbit does HYL A received 135 (S135) or 150 g / day (S150) of a weaning feed (S) or 140 g/day of a rabbit doe feed (M), and thus received respectively 324, 360 or 357 Kcal DE/day. Each feed was given *ad libitum* during the week before the 1st AI. From the 1st parturition, each female received M feed except during the week before weaning (S feed). For S135, S150 and M140 groups, rabbit doe weighted respectively at 18 weeks of age 3364^a, 3561^b et 3563^b g ($P<0,001$), and, over 5 reproductive cycles without female replacement, their mean fertility (75,8^a vs. 76,0^{ab} vs. 81,2%^b $P=0,09$), prolificacy (9,21^a vs. 9,52^{ab} vs. 9,92^b nés totaux / mise bas $P=0,005$) and 35 days litter weight (7988^{ab}, 7788^a, 8038^b g $P=0,038$) were higher in the M140 group which produced 16% more weaned rabbits.

EFFECT OF 2 DIFFERENT FEEDING PROGRAMS FOR YOUNG DOES BETWEEN 11 AND 18 WEEKS. VERDELHAN S., BOURDILLON A., DAVID J.J., HURTAUD J., LÉDAN L., RENOUF B., ROULLEAU X., SALAUN J.M. *sandrine.verdelhan@cybelia.fr*

The aim of our study was to test 2 different feeding programs for young rabbit does between 11 and 18 weeks. The first program was a feed restriction, and the second program was a specific *ad libitum* food with a very low energetic level (1550 kcal/kg). 2 field trials have been conducted on 2 different commercial strains. In the first trial there was no significant difference between the 2 programs. In the second one, the

young does were lighter with the *ad libitum* food. However, their results in fertility, prolificacy and weaning were better. Therefore, it is possible to feed young does with a specific *ad libitum* food, and this specific program could be a solution to satisfy nutritional requirement of the young doe.

EFFECTS OF FEEDING STRATEGY BASED ON HIGH ENERGY DIETS ON RABBIT DOES AND THEIR LITTERS PERFORMANCES. MONTESSUY S., FERCHAUD N., MOUSSET J.L., REYS S. *Severine_MONTESSUY@techna.fr*

In order to find an adapted nutritional response to does and their litters, two feeding programs were compared during three reproduction cycles. Control group is fed with a standard program used in rabbit farms to increase digestive safety (mother and weaning feed). Trial group combines 2 energetic feeds (lactation and pregnancy-weaning feed) in order to express growth potential of young rabbits before weaning, without impairing neither their viability nor the zootechnical performance of does. During all the three cycles, fertility, prolificacy, does weight and mortality between birth and weaning were similar for both groups. Trial group shows a significative effect on mean weight of rabbits: +28,4 g/rabbit at 18 days old, +44,2 g/rabbit at 35 days old ($P<0.001$).

Growth and meat

ACCURACY OF PHYSICOCHEMICAL METHODS ON DESCRIBING THE SENSORY CHARACTERISTICS OF RABBIT MEAT. COMBES S., LARZUL C., JEHL N., JUIN H., CLOCHARD M.C., CAUQUIL L., DARCHE B., ZOUBAI A., LEBAS F. *combes@toulouse.inra.fr*

The aim of this study was to correlate physicochemical characteristics of the meat and sensory attributes. Three groups of rabbits slaughtered at a live weight of 2.3 kg were used: standard, Label and "Russe". The sensory analysis indicated that the juiciness of loin meat increased in the rank order Label<Russe<standard ($P<0,001$), while tenderness in the thigh increased in the rank order Russe<Label<standard ($P<0,001$). A canonical analysis showed that tenderness in leg was correlated with Warner

Bratzler shear test of the raw loin. It is possible to distinguish the three lots with muscles and bones characteristics, but it was not possible, at the end of this study to find physicochemical measurements which can predict in a reliable way the sensory characteristics of the rabbit meat.

MUSCLE FIBRE TYPES IN RABBIT OFFSPRING IN RELATION TO DIFFERENT MATERNAL DIETARY LYSINE CONTENTS. DALLE ZOTTE A., METZGER SZ., RÉMIGNON H., SZENDRŐ ZS. *antonella.dallezotte@unipd.it*

Forty-three does was fed control (C; Lysine: 0.68%) and 43 does a lysine supplemented diet (L; Lysine: 0.80%) during pregnancy and lactation. At birth, half litters of C does were put under C does (CC group), the other half under L does (CL group). The same procedure was followed for offspring of L does (LC and LL groups). Ten CC and 10 LL rabbits were slaughtered at kindling, 10 rabbits of each group (CC, CL, LC and LL) were slaughtered at 17d of age, 10 CC and 10 LL rabbits were slaughtered at 81d of age. The *Longissimus Dorsi* muscles were removed after death and fibre type percentage (?W, ?R, ?R) and morphometric traits were determined. At kindling age, the sphericity was higher in LL than in CC rabbits ($P<0.01$). Higher dietary lysine during lactation reduced the size and the percentage of ? fibres in 17-days pups ($P<0.10$). At commercial slaughter age the LL rabbits showed lower percentage of ?R fibres ($P<0.05$) than CC rabbits.

INFLUENCE OF EXERCISE (INEVITABLE JUMP BETWEEN FEEDER AND DRINKER) ON GROWTH, CARCASS QUALITY AND ON MECHANICAL CHARACTERISTICS OF THE ATTACHMENT OF THE MEAT TO THE BONE AFTER COOKING IN THE RABBIT. COMBES S., MOUSSA M., GONDRET F., DOUTRELOUX J.P., RÉMIGNON H. *combes@toulouse.inra.fr*

The effects of exercise (jump) were studied on growth, carcass quality of the rabbits and on the mechanical behaviour (passive stretching) of 2 tendon enthesis after cooking. After weaning (35 days), animals were divided into 2 groups. Rabbits from the exercise group (EXE) were raised collectively in high giant cages (1.32 m²),

provided with two vertical obstacles separating food from water point. Rabbit from the sedentary group (SED) were placed individually in cages of reduced surface (0.10 m²). Daily weight gain from 35 t 70 d. of EXE rabbits tended to be higher than that of the SED rabbits, but their food conversion ratio was improved (-7%). At 70 days of age, 58 animals were slaughtered. Carcass yield tended to be higher (+0,68), back proportion was higher (+0,79) while muscle to bone ratio was lower (-6%) in EXE than in SED rabbits. Adiposity, ultimate pH of the muscles *biceps femoris* (BF) and *longissimus lumborum* (LL) and water holding capacity of LL muscle were not modified by exercise. BF from EXE rabbits presented an index of red and yellow higher than that of SED rabbits. After cooking, the Achille tendon and the patellar ligament of EXE rabbits exhibited a higher rigidity (respectively, +25% and +34 %) than that observed in SED rabbit. In EXE rabbits, Achilles tendon exhibited higher elastic strain (+30 %), while patellar tendon had higher maximum force (+30%) that in rabbits SED. Thus, the practice of jump in rabbit seemed to improve cohesion of the meat to the bone after cooking.

OXIDATIVE ORIENTATION IN LEG MUSCLES IN RESPONSE TO PHYSICAL EXERCISE DURING GROWTH IN RABBITS. GONDRET F., HERNANDEZ P., EL RAMOUZ R., PONTRUCHER F., FERNANDEZ X., COMBES S. *Florence.gondret@rennes.inra.fr*

The aim of this study was to investigate the effects of repetitive jumps during growth on rabbit muscle metabolism. Rabbits were reared from weaning (35 days) to slaughter (72 days), either in isolated cages with a small space area (sedentary group, SED, n=9), or in collective giant pens equipped with vertical hurlers in front of feeders and water (exercised group, EXE, n=10). At slaughter, specific activity levels of enzymes involved in fatty acid β -oxidation (hydroxyacyl-CoA dehydrogenase, HAD) and terminal oxidation (citrate synthase, CS) were higher in *semimembranosus proprius* (SMP), *semimembranosus accessorius* (SMa), and *biceps femoris* (BF) muscles from EXE rabbits (+21% on average) than those from SED rabbits.

Lipid contents in SMA and BF muscles and adipocyte diameter in SMA were similar in both groups. In addition, glycolytic potential at slaughter and ultimate pH raised 24 h *post mortem* in BF muscle did not vary in response to physical exercise.

INFLUENCE OF THE INCREASE OF OMEGA 3 FATTY ACID LEVEL IN THE FEED BY EXTRUDED FLAX SEED INCORPORATION (TRADI-LIN®) ON MEAT LIPIDS AND HEDONIC CHARACTERISTICS OF THE RABBIT RETAIL CUTS. COLIN M., RAGUENES N., LE BERRE G., CHARRIER S., PRIGENT A.Y., PERRIN G. *copri@wanadoo.fr*

Four hundred 38 days old weaned rabbits were distributed either a control fed with 2,94% of fat and 0,06% of linolenic acid (ALA) or an isoproteic and isoenergetic high level omega 3 diet with extruded flax seeds incorporation (4,45% of lipids and 0,80% of ALA). The growth was significantly decreased with the omega 3 feed (36,4 vs. 38,2 g/d). For every treatment, the

fore legs, hind legs, backs and livers of 35 rabbits aged of 72 days were analyzed. The omega 3 levels of the retail cuts of the rabbits fed with the high omega 3 level feed were strongly higher than these ones of the control rabbits without any alteration of the hedonic characteristics. Consequently, this experimentation confirms a relationship between the omega 3 feed level and the rabbit meat composition.

RABBIT MEAT: DIETETIC PROPERTIES AND PROCESSING CHARACTERISTICS. COMBES S., DALLE ZOTTE A. *combes@toulouse.inra.fr*

This review aims to compare the properties of rabbit meat with those of species most common in human consumption. The comparison relates to the chemical composition of the different meats, their mineral and vitamin composition and the quality of lipids. The consequences of the specific characteristics of rabbit meat on its dietetic properties and on its conservation and processing characteristics are also discussed.