

Abstracts of papers presented during

**THE FIRST INTERNATIONAL CONFERENCE  
ON INDIGENOUS *VERSUS* ACCLIMATIZED RABBITS**

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Faculty of Environmental Agricultural Sciences, Suez Canal University  
EL ARISH - North Sinai, Egypt  
Under scientific responsibility of **I. FAYEZ M. MARAI**

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**Indigenous *versus* acclimatized rabbits in Egypt**

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In Egypt, there are five breed types of domestic rabbits. The domestic types originated from two major categories; the Baladi (native) and Gabali (desert) rabbits. From the Baladi, four breed types, namely: Giza White, Baladi White, Baladi Red and Baladi Black, were obtained through improvement. The literature shows that the differences among such breed types in productive and reproductive traits, are narrow. The Gabali rabbits are more uniform in their features, large and more fertile, but they are more fierce. In addition, they are very rare and no information was found about that breed type. Very recently, more interest in raising such breed types has arisen, because they are endangered. The literature showed that the differences in productive and reproductive traits between the indigenous and the acclimatized breed types (New Zealand White and Californian) under Egyptian conditions were fairly large for most of the traits, except respiration rate which was substantially higher in the indigenous than in the acclimatized breed types.

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**BREEDING AND GENETICS**

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**Reproduction of doe rabbits  
as affected by heat stress**

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High environmental temperatures in tropical and subtropical areas adversely affect reproduction of farm animals. The detrimental effects of high environmental temperature are more pronounced when the relative humidity is high. In females, such adverse effects are seen as delayed puberty, delayed or suppressed ovulation, and marked reduction in conception rate. The low conception rate may

be attributed to either fertilisation failure or early embryonic mortality. The detrimental effects of heat stress on farm animals can be alleviated by applying physical, physiological and nutritional techniques.

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**Some productive, reproductive and biological traits  
in two breeds of rabbits as affected by inbreeding**

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In a series of three experiments, the effects of different inbreeding rates (12.5-50 %) on productive and some biological traits of White Giant and Chinchilla rabbits in Ukrainian conditions, were studied. The studies showed that conception rate and doe fecundity, kit survival and development, blood leukocyte composition, gene frequency and transferrin locus occurrence did not show significant depression with inbreeding.

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**Effects of genotype (domestic and imported)  
on performance and meat quality of rabbits**

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Live weights of broiler (weaned at 30 days and slaughtered at two months, ) and intensively-grown rabbits (weaned at 30 or 45 days and slaughtered at three months ) of domestic breeds (Grey Giant, White Giant, Silver and Chinchilla) and imported ones ( New Zealand White and Californian) in Ukraine were 1.77 to 1.87 kg. Young Chinchilla rabbits three months reached live weight over 2.25 kg and were significantly superior to specialized imported

breeds in this parameter. The dressing percentages broilers and intensively-grown rabbits were 57 to 60 and percentages of lean were 74 to 80, respectively. No significant differences were observed between domestic and foreign breeds in the traits above, nor for development of individual organs or meat physical and biochemical parameters. Some linear measurements (chest girth, hind quarter girth, width of loin) showed high correlations (about 0.99) with meat productivity. Correlation analysis showed that preliminary selection could be carried out on the basis of live weight at one month. Dietary energy intake per kilogram live gain weight of the rabbit broiler was 29.3 to 40.9 MJ with no differences between breeds. In young rabbits (3 months old), 46.1 MJ energy were used per kilogram of live gain weight of Chinchilla, which is 5 to 14% less than in the other breeds. With reciprocal crossing of rabbits of the various breeds, no heterosis effect was found in any of the traits. The sires selected with the average live weight for the studied breed (at the level of the first evaluation class for the given age group), born and grown in average litter sizes of 7 to 9 kits, showed the highest percentages of improvement. Buck performance testing was carried out separately and based on the performance of the progeny from each of the first three kindlings of the four to seven does mated to each buck. Evaluation on the basis of average progeny performance for the entire recording period showed that quite accurate data on sire breeding value may be obtained on the basis of the results of the first kindling in the assigned doe group. Selection of does for the main herd should be carried out on the basis of the results of their own performance tests.

#### Estimation of heterosis for meat yield and carcass characteristics of F<sub>1</sub> and F<sub>2</sub> rabbit generations

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Weights of live body, carcass, carcass parts and viscera parts in F<sub>1</sub> and F<sub>2</sub> rabbit generations, were studied. Chemical analyses of protein, fat, dry matter, non-protein N and cholesterol concentration, were carried out. Moisture content and thickness of muscle fibres in the *longissimus dorsi* and *biceps femoris* were studied. The differences in carcass characteristics between the breed types of rabbits were analyzed. The differences in weights between the two groups were not significant. The non-protein N and cholesterol concentrations were lower than in other agricultural animals. Moisture content increased with age but there was no influence of sex. The cooking loss was 54.8 % in the *biceps femoris* and it was higher than in *longissimus*. Muscle fibre thickness increased with age. At the end of the fattening stage, the F<sub>1</sub> crosses had higher body weights, carcass weights and dressing percentages than their parental breeds. The correlation coefficients between the body weight and carcass weight, dressing percentage, and leg weight, were positive.

#### General combining and maternal abilities of post weaning body weight traits of two native breeds crossed with New Zealand White rabbits

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Data were obtained on a total of 1018 weaned rabbits, 451 straight-bred and 567 crossbred, produced from New Zealand White (NZW) as exotic breed and Baladi Black (BB) and Baladi Red (BR) as local breeds. An incomplete diallel crossing mating design excluding the reciprocal crosses between the two local breeds, was adopted. The study aimed to evaluate the heterotic effect of biweekly progeny body weight traits from weaning (at six weeks) to marketing at 16 weeks, using four different approaches, as well as, estimation of the genetic and non-genetic factors affecting these traits. NZW and BB rabbits and their crosses were generally superior to either BR or its crosses in the performance traits at most ages studied. Least squares means of maternal abilities generally displayed the same trend of superiority ranking. However, general combining abilities showed a reverse trend favouring BR up to 12 wk of age and BB afterwards. Tests of significance revealed that month of birth and litter size from 6 to 12 wk of age and feed type at 6 and 8 wk of age significantly affected body weight traits only at early ages. Parity and sex had no effect on body weight, except for a significant effect of parity at 12 wk of age.

#### Genetic and non-genetic factors influencing milk production traits from kindling up to 21 days in New Zealand White and Californian rabbits raised under semi-arid environmental conditions

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Data from 413 New Zealand White (NZW) and 401 Californian (Cal) litters raised in the Experimental Rabbitry, Suez Canal University, Ismailia Governorate, Egypt, were used to study the genetic and non-genetic factors that influence weekly milk production traits (milk yield, litter milk efficiency and milk coefficient from kindling to 21 days as well as 14-day and 21-day milk yield.) Restricted maximum likelihood (REML) was used for estimation of variance components and heritability, using unrelated sire relationships. The performance values NZW were superior to Cal rabbits. Milk yield and milk coefficient showed high variation which was higher than those obtained for litter milk efficiency in the two breeds. Year-season combination had significant effects on milk-yield at the third week and at 21 days, litter milk efficiency at 7 days, 14 days and 21 days, milk coefficient at 21 days in NZW rabbits, and milk yield at 7 days, 14 days and 21 days and milk yield at the third week in Cal rabbits. The performance of rabbit does for the traits studied increased significantly ( $P < 0.0001$  or  $P < 0.01$ ) in

winter and autumn seasons compared to summer and spring seasons irrespective of the year of production. No significant effect was detected for parity on milk production traits (milk yield, litter milk efficiency and milk coefficient) in NZW and Cal rabbits all the studied ages. Heritability estimates were low and ranged between 0.007 and 0.126 in NZW, and were low to moderate in Cal rabbits and ranged between 0.029 and 0.320.

### **Mixed model genetic analysis of litter size and weight traits in New Zealand White rabbits reared under Hungarian conditions**

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An analysis of litter size and weight traits was carried out on 546 litter records including 75 New Zealand White sires and their daughters (paternal half-sib). Traits examined included litter size at birth, at weaning (6 weeks of age), and at marketing (10 weeks of age), and litter weight at weaning and at marketing. Month of kindling had an important ( $P < 0.001$  or  $0.01$ ) influence on all the traits, except litter size at birth which was not significantly affected. Litter size at weaning and at marketing were highest and heaviest during April and May. Age of doe at kindling did not affect these traits, except litter size at birth ( $P < 0.05$ ). Sire of doe as source of variation, had little or no effect on the traits, except litter size at birth. Estimates of heritability for litter size and weight traits were low or moderate.

### **Magnitude of interaction between sire-family and location on productive and reproductive traits of New Zealand White rabbits**

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This experiment was carried out to study the magnitude of interaction between sire-family and location on productive and reproductive traits of New Zealand White rabbits. Paternal half-sib progeny of NZW were tested in two locations (near and far from the Mediterranean sea) in the middle Delta. Reproductive traits studied were gestation length, litter size at birth, litter size at weaning (4 weeks), litter weight at weaning and pre-weaning mortality, as well as productive traits including body weight of progeny at 4, 8 and 12 weeks of age and daily weight gain. A mixed model was used to estimate the significance of the interaction between sire-family and location on productive and reproductive traits. There were no significant differences between the two locations in reproductive traits, except litter weight at weaning. At the same time, the interaction between parity and sire-family and parity and litter size

at birth was significant ( $P < 0.05$ ) and highly significant ( $P < 0.01$ ), respectively, for all reproductive traits, except pre-weaning mortality. On the other hand, no significant effects of location and sire-family interaction on body weight were observed at the different ages (4, 8 and 12 weeks). The differences in body weight at different ages either between sex or parities, were highly significant ( $P < 0.01$ ). Daily weight gain during the whole period from weaning to marketing was not affected by the main effects or the interactions, except parity, sex and location by parity interaction. These results suggest the possibility of use of NZW rabbits in middle Delta area. In addition, selection could be applied for improvement of rabbit production in any farm (location) in the whole Delta area.

### **Pre- and post- weaning litter traits as effected by Gray Flander, New Zealand White and Baladi as potential sire breeds**

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Gray Flanders (GF), New Zealand White (NZW) and Baladi (Bal), sires ( $n=10$  / breed) were mated to New Zealand White does ( $n=40$  / sire breed). Litter traits data on 818 weanling rabbits from 152 litters representing offspring of the three sire breeds, were collected. Gestation length, litter size and weight at various ages (birth, 4 weeks, 8 weeks and 12 weeks), daily litter gain (4-12 weeks), litter growth rate and pre- and post-weaning mortality rate were studied. The results showed that there were no significant differences among sire-breed groups in pre-weaning litter traits, except in litter weight at birth ( $P < 0.05$ ). Post-weaning litter traits including litter weights at 8 weeks and 12 weeks of age, daily litter gain at different intervals and litter growth rate from weaning to 8 weeks, as well as during the whole fattening period were affected ( $P < 0.01$ ). The GF x NZW litters had the heaviest litter weights at all ages, except at 8 weeks, and the corresponding weights of Bal x NZW were the lowest (490, 3 237 and 11 590 g vs. 420, 3 011 and 10 122g, respectively at birth; 4 and 12 weeks). There were significant differences ( $P < 0.05$ ) among parities for some pre-weaning litter traits (total litter size born, born alive and litter weight at birth) and non-significant differences in post-weaning traits, except litter growth rate during the period from weaning till 8 weeks and during the whole period ( $P < 0.01$ ). The Bal x NZW litters had the lowest pre- and post-weaning mortality rates. The sire-breed by parity interaction were not significant for pre-weaning traits. There were highly significant ( $P < 0.001$ ) sire-breed by parity interactions for most post-weaning traits, except litter growth rate intervals and mortality rate. Based on these results, use of GF sires to mate NZW does, under Egyptian conditions may be recommended.

### **Estimates of repeatability and some environmental factors affecting milk production in some local and exotic breeds of rabbits, using mixed procedure program**

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The aim of this investigation was to estimate the repeatability values of daily milk production (DM), total milk production (TM), litter size at birth (LSB) and litter weight at weaning (LWW) in rabbits, and to test the effects of some factors influencing these traits. The Mixed Procedure of SAS (1998) was used to analyze the data. DM and TM were recorded for 97 does at the first parity, 80 does at the second parity and 42 does at the third parity. Effects of breed (Flanders, (FL), Bouscat (B) and Baladi Red (BR)), year and day on daily milk production traits were tested. The day contributes a significant effect ( $P < 0.01$ ) in the second and third parities. The effects of breed, year, month and parity on TM were tested. The parity effect was significant ( $P < 0.01$ ). The breed effect was significant ( $P < 0.05$ ) on LWW trait. The correlation coefficients between TM and each of LSW and LWW traits were 0.22 and 0.40, 0.38 and 0.37 and 0.38 and 0.59 for the first, second and third parities, respectively.

### **Inheritance of characteristics of hair and pelt quality in two rabbit fur breeds**

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The Grey Giant and Silver rabbit breed's hair coats are characterized by original colour and used for making natural fur clothes. In Grey Giant rabbits, both iron- and grey-hare types of hair colour had six colour zones, with a light hair root zone. In Grey Giant rabbits, grey-hare fur had light-yellow colour, while in the iron-grey rabbit it was white. In the former, this zone was larger and was 12.5 to 15% of total hair length against 7.5 to 10% in the latter. In the Silver rabbits, dark- and light-types of hair colour had five colour zones. The colour type of the Silver rabbits is determined by the colour of the end section of the awn hair. It is black in dark-silver rabbits with dominating black awn hairs mixed with white ones, while in light-silver rabbits it is light with dominating white awns mixed with black ones. Percentages of this zone for both types of colour (relative to the whole hair length) were 30.3 to 38.7%, respectively. The family genetic analysis carried out to study inheritance of colour types showed that rabbits with the iron-grey

colour of the Grey Giant breed and the dark-silver colour of the Silver breed are heterozygous. Mating iron-grey males with does of the same colour, produced progenies as follows: 45.2% iron-grey, 26.6% grey-hare, 26.6% black and 1.6% white. The number of down hair follicles on a microscopic section of adult rabbit skin was 7 000 to 8 000 hairs per  $\text{cm}^2$  in the Grey Giant breed, and 10 000 to 12 000 hair follicles per  $\text{cm}^2$  in the Silver breed. The number of awn hair fibres on the adult rabbit skin surface was 100 to 200 per  $\text{cm}^2$ . Within breed, the colour of awn hairs may be zonary or uniform. The bucks of these two breeds are characterised by thicker skin and greater epidermis thickness than does. Silver bucks had denser fur than does, while a contrary trend was observed in the Grey Giant breed. Young Grey Giant hair coat density represented 71 - 83% of that in adult animals, while in young Silver rabbits it represented only 38-44% of the adult fur density.

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## **NUTRITION**

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### **Feed particle size and caecal function. Some new perspectives**

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Integral to maintaining the health of the rabbit is promoting optimal functioning of the intestinal tract and the caecum. Physically damaged organs and poor selection of feed ingredients will impair the overall health of the rabbit by providing the media for opportunistic infections. This review suggests that feed fibre particle size should correspond to the range of particle sizes that rabbits produce when chewing straw with their own teeth, the particle size range between 0.3 and 1.2 mm. Starch source ingredients (grains) should be ground so that particle size is like bread flour ( $< 0.3$  mm). Ingredients that are not palatable to the rabbits should not be used in making a feed. A high-moisture, non-pelleted starter feed is considered. Suggestions for further study are investigating the role of hair in the caecal contents, investigating caecal vs ambient temperatures and fully investigating the functioning of the system that regulates feed intake to energy requirements.

### **Studies on incorporation of urea in diets of growing Rex rabbits**

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The effects of incorporating urea in the diets at 0, 1 and 2% on body weight gain, feed conversion efficiency, slaughter traits, meat qualities, and fur qualities, were studied on 27 Rex rabbits. The results indicated that body weight gain of 1 and 2% urea groups

2.83% and 9.21% over that in the control group. Including up to 2% urea in growing rabbit diets increased feed consumption and decreased feed and protein availability, but the differences were not significant. No adverse effects of incorporating urea were seen on carcass yield and meat qualities, weight of the different organs and fur qualities, except on the weight of the lungs which was higher ( $P < 0.05$ ) in the urea treated animals than in the control group.

### **Dietary energy and protein transformation as a characteristic feature of metabolism and a basis for development of rabbit feeding allowances**

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The study was carried out on the Grey Giant breed of rabbits, kept in an environmentally controlled building and fed a complete pelleted diet *ad libitum*. The animals were weighed daily from 1 to 150 days of age. Samples of animals were slaughtered at 1, 10, 20, 30, 45, 60, 90, 120 and 150 days of age. Compared to the first 10 days, dry matter intake increased 5 fold at one month, 20 fold at 2 months and 44 fold at 5 months of age. The average daily amount of metabolisable energy increased 4, 8, 9, 12 and 17 times at ages of 30, 60, 90, 120 and 150 days, respectively. The protein and energy intakes increased until 1 month of age with little change from 30 to 45 days. After weaning, the intakes of dry matter, protein, and energy were stabilised. Values of average daily feed nutrient intake per kg metabolisable weight were low in the period from birth to 1 month of age. The metabolisable weight values were higher than the live weight by 2.0, 1.5, 1.4 and 1.2 times at 1, 10, 20 and 30 days of age, respectively, while they represented 90, 80, 75 and 70 % of live weight at 60, 90, 120 and 150 days of age, respectively. The highest conversion values were during the periods 1-20, 1-30 and 1-45 days. Dietary protein conversion values were characterised by sharp peaks and falls between the production periods. The correlations between conversion of feed energy into meat products and fat and protein biosynthesis rate in the body were direct ( $r = 0.64 \pm 0.19 - 0.97 \pm 0.15$ ) and highly significant.

### **Efficiency of various types of aluminosilicates in reducing radiocaesium absorption by rabbits fed diets contaminated by Chernobyl fall-out**

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Fifteen growing Grey Giant rabbits with an average 1500 g body weight, were used to evaluate the efficiency of different types of

alumino-silicates in reducing radio-caesium absorption from the gastrointestinal tract following consumption of diets contaminated by Chernobyl fall-out. Rabbits were distributed into five experimental groups and fed for 25 days a basal diet based on grass meal contaminated with 3447 Bq/kg of <sup>137</sup>Cs and containing 2.0% of clinoptilote, humolite, saponite or polygorskite. Caesium-137 radioactivity levels were measured in rabbit live body, faeces, urine and slaughter rabbit products (carcass, viscera and pelts). Feeding such clay minerals caused significant reductions in the <sup>137</sup>Cs radioactivity levels in these components. The reduction values in <sup>137</sup>Cs activity in live rabbit body and carcass were 72.5 and 64.6 % for animals fed polygorskite versus 31.1, 40.1, 20.8, 23.3 and 26.6 and 21.1% for clinoptilote, humolite and saponite, respectively, than in the controls that were fed no clay minerals. Polygorskite was the most effective countermeasure against contamination of rabbit diets by radioactive fall-out

### **Caesium-137 metabolism in rabbit body as affected by vermiculite feeding**

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Five groups of three Grey Giant rabbits with an average of 1500 g body weight were used. Rabbits were fed for 20 days a basal diet based on grass meal contaminated (from Chernobyl fall-out) with 9630 Bq /kg of <sup>137</sup>Cs without (control) or with 5, 3, 2, and 1% of modified vermiculite. The contaminated diet was studied by measuring the <sup>137</sup>Cs radioactivity level in the live body, faeces, urine, carcass viscera and pelts. <sup>137</sup>Cs radioactivity levels were decreased by about 72, 58, 44, and 53% in the rabbit live body fed the contaminated diet with 5, 3, 2 and 1% vermiculite, respectively, than in the control. When vermiculite was included in the contaminated diet, faeces <sup>137</sup>Cs radioactivity increased considerably, while urine <sup>137</sup>Cs activity level decreased several times more than in the controls. Feeding vermiculite resulted in reduction of <sup>137</sup>Cs radioactivity level by more than 90% in carcass, viscera and pelts.

### **Growth performance and carcass traits of New Zealand White male rabbits as affected by dietary protein, energy level and copper supplementation and their interactions, under Egyptian conditions**

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Growth performance, return from body gain, final margin, blood total protein, albumin, globulin, SGOT, SGPT and urea-N of New

Zealand White male rabbits increased with increasing dietary protein and energy levels. Copper supplementation increased growth rate. Interactions between dietary protein and energy, between dietary protein and copper levels, and between dietary energy level and copper levels on live body weight, were highly significant ( $P < 0.01$ ). The highest daily body weight gain was obtained in rabbit groups fed high protein-normal energy diets and in those fed high protein-200 mg copper diets. Increase of crude protein or copper level levels in rabbit diets improved the feed conversion ratio. Analysis of covariance indicated that adjusted carcass and non-carcass components were not affected by dietary protein, energy level or copper addition.

#### Use of *Lactobacillus plantarum* "BJ 0021" in growing local rabbit rations, under Algerian conditions

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Weanling rabbits were divided randomly into three experimental groups. The first group was fed a basal diet and considered as control group ( $D_0$ ). The second and third groups were fed the basal diet supplemented with *Lactobacillus plantarum* "BJ 0021" at levels  $2160 \times 10^4$  and  $4320 \times 10^4$  g/ml/day ( $D_1$  and  $D_2$ ), respectively, from 42 (weaning) to 90 (marketing) days of age. Daily gain was higher in growing rabbits fed  $D_1$  and  $D_2$ . The highest feed intake was recorded for rabbits fed  $D_1$ . Mortality rates were 40, 20 and 0% in the  $D_0$ ,  $D_1$  and  $D_2$  groups, respectively. Weights of carcass traits were not affected, except the liver weight and colon length which significantly were affected with dietary supplementation. *E. Coli* in the caecum and small intestine decreased 3 to 10 times in the  $D_1$  and  $D_2$  groups, when compared to the control group.

#### Effects of dietary protein level on performance, digestion and contribution of soft faeces to nutrient intake, in growing rabbits

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Three dietary protein levels; low (LP: 14.3%), medium (MP: 16.2%) and high (HP: 18.2%), were fed to three groups of growing New Zealand White rabbits to study the influence of dietary protein levels on performance and digestive parameters. Each group was of 15 rabbits with nearly similar age (5 weeks) and initial body weights. Feed intake and live weight were recorded weekly for 7 weeks. During the last week, faeces and urine were collected separately for apparent digestibility determination. Caecotrophy was prevented in order to estimate the daily soft faeces excretion. The increase of protein level in the diet caused substantial improvement ( $P < 0.01$ ) in live gain weight, DM intake, feed conversion rate, and

digestibility of CP and CF. At the same time, no significant differences were observed in DM, EE or NFE digestibility or faecal DM and CF concentrations, while CP concentration in faeces was significantly affected by dietary protein level. Daily soft faeces excretion increased ( $P < 0.01$ ) when protein level decreased in the diets

#### Growth performance, digestibility and carcass traits of New Zealand White growing rabbits fed barley rootlets in the diet

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One hundred and twenty New Zealand White (NZW) five week old growing rabbits (60 males and 60 females) averaging  $619.0 \pm 4.4$  g body weight were used. The aim of the study was to compare diets containing four levels of barley rootlets (BR; 0, 15, 30 and 45 %). Rabbits were divided into four groups of 30 animals each. The first group served as control. Rootlets were included at levels of 15, 30 and 45% of the diet in groups 2, 3 and 4, respectively. The experimental diets were fed to growing rabbits for eight weeks post-weaning. Live body weight and daily gain of rabbits fed 15 and 30 % BR were higher ( $P < 0.05$ ) than in the other groups. Feed conversion of animals fed diet 2 was the best ( $P < 0.05$ ), followed by diet 3. Rabbits fed diet 2 had the highest DM, OM, CF and NFE digestibility. Diets containing BR had no adverse effect on carcass traits.

#### Growth performance and carcass traits of New Zealand White male broiler rabbits as affected by some natural and synthetic dietary additives during winter and summer, under the conditions of Egypt

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Most growth performance traits studied for New Zealand White broiler male rabbits were negatively affected in summer. Final live body weight, body weight gain, daily feed intake, feed cost, return from body gain, final margin, weight of carcass, some carcass components (fore part weight and liver weight) and blood total protein, urea-N, SGOT and SGPT were lower in summer than in winter. Supplementation of heat-stressed rabbits' diets with 1 g/kg diet with Rebroton (a natural bio-stimulant composed of a dry mixture of 8 herbs; each kg contains 6g Nafa, 4.04g Tifides, 1.0g Lybzar, 0.048g Gilgn, 3.2g Benne oil, 4.8g Shenita and 60.4g Matak), 1 g/kg diet of Fertil (a natural biostimulant composed of 20% plant and seeds of *Lactuca*, 10% *Cyperus esculentus*, 20% *Raphanus sativa*, 15% *Peganum harmala*, 15% Palm pollen grains and 20% ground dry male goat testicles) or 32 mg aspirin/kg diet enhanced the previous traits. The use of such substances resulted in

greater improvement in the same traits during winter than during summer.

## PHYSIOLOGY

### Physical and biochemical changes of rabbit meat during the first five months of life

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Up to one month of age, the muscle tissue showed the highest growth rate, followed by bone tissue, while fat tissue showed the lowest growth rate. Up to two months of age, the muscle and fat growth rates were nearly equal and higher than the bone tissue. Starting from two months, the growth rate of fat tissue increased considerably and became higher than that of muscle and bone tissues. Lean represented up to 45 to 58% of the carcass in the period from 1 to 30 days, 65 to 69% in the period from 45 to 60 days, and 74 to 80% in the period from 90 to 150 days. Lean percentage in the carcass without offals and head increased to 90 - 92% from 120 to 150 days. The carcass fat percentage increased from 7 to 9% between day 10 and day 30, 9 to 10% between day 30 and 90, and reached 22% on day 150. The intramuscular fat was 40-48% of the total fat. Kidney fat [%] was 22 to 28%, while visceral fat was 20 to 22%. Percentage of bone tissue was 14 to 16% by one month of age. From 1.5 to 5 months, the bone percentage (of the carcass) decreased from 12 to 7%. Percentages of head and offals in the period from 1 day to 1 month were 25 - 15% and 15 - 11%, respectively, while at 5 months they were 6.8 and 6.3%, respectively. Analysis of chemical, biochemical and processing parameters of rabbit meat demonstrated that formation of meat quality occurred between two and four months. The highest ( $P < 0.01$ ) percentages of protein were in carcasses of 10-, 12-, 45-, and 90-day old rabbits and the lowest ( $P > 0.05$ ) were in the carcasses of 150-day old rabbits. The absolute fat increments at all age periods, were highly significant. The quantities of fat and protein at different ages showed variations in their ratios. The highest protein per fat unit ratios were 1.45, 1.45, 1.18 when rabbits were slaughtered at ages of 2, 3, and 4 months, respectively. The optimal ratio of protein to fat was assumed to be within the range from 1.3-1.5:1. The rabbit meat amino acid adequacy index (0.74 to 0.94) was slightly higher than in the meat of other farm animals. The best value of colour intensity is within the range of 240 to 280 units, which is characteristic for rabbit carcasses slaughtered at 90 to 120 days. Water-binding capacity and acidity were estimated to be within 62 - 63% and pH 6.2 - 6.8, respectively. The dressing percentage in rabbits was high and increased with age. The values were 61, 63

and 69% at 3, 4 and 5 months, respectively. The radioactive caesium content in rabbit meat was 28 to 41 and 11 to 18 times lower, respectively, than the requirements specified by the Health Ministry, when fed diets supplemented with minimum (5%) and maximum (30%) grass meal contaminated with caesium.

### Productivity of New Zealand White doe rabbits as affected by re-inseminating interval

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This study was carried out with New Zealand White (NZW) 64 does divided into four groups and mated at 1, 14, 21 and or 30 days after parturition over a 1-year production cycle to examine the effects of re-inseminating intervals on productive and reproductive performance. The re-inseminating interval had important effects ( $P < 0.001$ ) on conception rate, litter size, number of litters per doe per year, number of kits weaned per doe per year, and litter weight at birth and at weaning. Overall conception rate increased with the increase in parturition to re-inseminating interval. The conception rate values were 38.5, 27.9, 53.1 and 84.4% for intervals of 1, 14, 21 and 30 days, respectively. The numbers of litters per doe per year were 4.2, 1.6, 3.7 and 5.1 for 1, 14, 21 and 30 days groups. Litter size was significantly affected by treatment and consequently the number of kits born per doe per year was also affected significantly and increased as re-inseminating interval increased (22.7, 7.9, 28.4 and 41.4, respectively). Kit mortality rate at birth was lower for 30 day treated groups when compared to the other groups (13.3% vs. 27%, 22.7% and 21.6% for the 30, 1, 14 and 21 days groups, respectively). The number of kits weaned per doe per year for treatments 1, 14, 21 and 30 days were 16.0, 6.1, 22.3 and 36.0 respectively. The does inseminated at 30 days postpartum had larger litters at birth (8.01) and at weaning (6.9), higher milk yield at day 24 (167.1 g) and mean kit weight at weaning (437.4 g) than in the other experimental groups.

### The relationship among ovarian steroid hormones and litter traits and milk yield of New Zealand White and Californian rabbits

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Two exotic rabbit breeds (New Zealand White [NZW] and Californian [Cal]) were used in the present experiment to determine concentration of steroid hormones (progesterone,  $P_4$  and 17 beta-oestradiol,  $E_2$ ) before mating and during pregnancy days 10, 17, 24 and 29 of gestation. Litter size, litter weight and milk yield (litter traits) were recorded at birth, 7, 14, 21 and 34 days (weaning) for each doe on a within breed basis. The results showed, generally, that



NZW had slightly better values than Cal rabbits. Litter size born alive significantly affected litter traits in the two breeds, except litter size at weaning, litter weight at weaning, milk yield at 21 days and milk yield at weaning which were not affected. Breed group, level of progesterone and the ratio between oestrogen and progesterone had no effects on all doe traits studied for the two breeds, while oestrogen levels showed significant effect only on litter size at weaning. Correlations between steroid hormone levels and productive traits were weak. The types of relationship between most of the traits under study were, in general, linear and quadratic.

### **Detrimental effects of hot summer climate on acclimatised kit rabbits during the suckling period**

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The study was carried out on 24 lactating non-pregnant pure-bred New Zealand White doe rabbits in the third parity of the first production year. The experimental work included two periods, each lasting 35 days. The first was carried out on 12 does that kindled in January (winter, 19.5°C), while the second was carried out on the other 12 does that kindled in July (summer, 34.8°C). The July rabbits were exposed to very severe heat stress from birth to weaning at 35 days during which significant decreases in litter size, kit weight and kit weight, were observed. In addition, there was a significant decrease in daily milk yield from each doe, milk intake per kit, milk efficiency and a significant increase in mortality rate. Correlation coefficients between litter size and litter weight at birth and some productive traits in rabbits during the suckling period were also studied

### **Reproductive performance of male New Zealand White rabbits as affected by water quality**

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Thirty NZW male rabbits of 7-8 months of age were used to study the effects of drinking agricultural drainage water (ADW) on their reproductive traits. The rabbits were divided randomly into three equal groups. The first group was watered with tap water (control), the second group drank 50% ADW+50% tap water (TW) and the third group was watered 100% ADW. Libido and semen ejaculate volume (ml) were not affected by drinking ADW. Sperm motility (%), sperm cell concentration, total sperm output and seminal potassium and calcium concentrations decreased significantly, while dead spermatozoa, sperm-abnormalities, acrosomal integrity and

sodium concentration (mg/100 ml) increased significantly with ADW treatment. The histological structure of the testis showed interstitial congestion and slight degeneration in the seminiferous tubules, with 50% tap water + 50% ADW. Rabbits that drank 100% ADW showed testicular atrophy, degenerated cells and lumina of seminiferous tubules empty of spermatozoa.

### **Interaction effects between drinking saline water and ambient temperature on T<sub>3</sub>, survival rate, kidney function and some productive traits in two breeds of acclimatized rabbits**

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Ninety New Zealand White and 90 Californian weaned, five week old, male rabbits were used. The study included two nine week periods. The first was during the winter season (19.0°C and 65% RH), while the second was during the summer season (31.0°C and 62% RH). There were 40 animals from each breed in the winter and 50 during summer. Animals of each breed within each season were divided randomly into five homogenous groups. One group drank tap water (underground water) as control which contained 650 ppm salts and the other four groups were supplied with drinking water containing 2600, 3600, 4600 and 5600 ppm salts. The adverse summer heat stress conditions induced a decline in feed intake, feed efficiency and plasma concentrations of T<sub>3</sub> and some plasma electrolytes, accompanied by an increase in water intake, water /feed ratio and water retention. Such changes end in depression of live and solids body gain. Drinking water containing high levels of salts (3600 ppm and more) under hot summer climate caused additional depression in live and solids body gain and concentration of T<sub>3</sub> and a greater increment in water intake and some plasma electrolytes.

### **Effects of selenium and/or vitamin E injection on reproductive performance of heat-stressed doe rabbits**

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Two experiments were carried out at Seds Research Station, Bani Suef Governorate (Middle Egypt) from April to July, 1999, to study the effect of selenium (Se) and/or vitamin E (Vit E) injection on the reproductive performance of heat stressed doe rabbits. In Experiment 1, 20 New Zealand White (NZW) and 20 Baladi (B) rabbits in mid-pregnancy were caged individually in an open shed and had free access to water available through stainless steel nipples. Rabbits were randomly divided into four groups (each of 5 NZW and 5 B) and fed a pelleted concentrate diet *ad libitum*. The



first group was injected intramuscularly with 0.1 mg sodium selenite /kg body weight & /week. The second group was injected subcutaneously with vitamin E (dl  $\alpha$ -tocopherol acetate, 100 IU / head & /week) The third group was injected with Se+Vit E at the same doses. The fourth group was kept as control. Se+Vit E treatment decreased ( $P<0.05$ ) foetal resorption, abortion, stillbirth and mortality rate at weaning followed by Vit E or selenium. In Experiment 2, 20 NZW and 20 B rabbits does were divided and treated as in Experiment 1. The treatments started two weeks before breeding and continued during pregnancy and lactation . Injection of Se in combination with Vit E improved ( $P<0.05$ ) conception rate, increased litter size and litter weight at birth and at weaning, and decreased ( $P<0.05$ ) stillbirth %. Selenium plus Vit E injection or Se injection alone reduced ( $P<0.05$ ) rectal temperature, respiration rate, PCV % and blood haemoglobin %. The results suggest that the harmful effect of hot climate on the reproduction of exotic or local does in middle Egypt during April to July could be reduced by selenium in combination with vitamin E injection.

### Effects of remating intervals on doe traits and embryonic mortality of New Zealand White rabbits

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Data from 759 litters produced by 115 New Zealand White purebred doe rabbits (20-22 weeks of age), under Sharkia Province, Egypt, environmental conditions, were used. Does were assigned to three remating groups: 1 day (intensive), 10 days (semi-intensive) or more than 10 days (extensive). Average conception rate of does mated at more than 10 days was higher ( $P<0.01$ ) than of those mated at 1 or 10 days post-parturition. Litter size, litter weight at birth and at weaning, litter weight gain from birth to weaning, number of live fetuses or number of corpora lutea of does mated at 10 days or more after parturition were higher ( $P<0.05$  or  $0.01$ ) than those of does mated immediately (1 day) after parturition. The other doe traits and embryonic mortality were not significantly affected by remating intervals.

### Rabbit oocyte diameter in relation to developmental competence

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This study was carried out to determine the diameters of rabbit oocytes that were able to attain their full development to blastocysts. Oocytes were recovered from the ovaries by aspiration of surface-visible follicles from untreated and PMSG (75 I.U. intramuscularly) treated does slaughtered 60 hr after treatment. Only healthy-looking cumulus oocyte complexes were used for *in vitro* maturation. They were divided into six groups based on diameter:  $<100\ \mu\text{m}$ ,  $100$  to  $<105\ \mu\text{m}$ ,  $105$  to  $<110\ \mu\text{m}$ ,  $110$  to  $<115\ \mu\text{m}$ ,  $115$  to  $<120\ \mu\text{m}$  and  $\geq$

$120\ \mu\text{m}$ . The mature oocytes were inseminated *in vitro*. The fertilized oocytes were cultured in three levels of osmolarity (285, 305 and 325 mOsm/ kg). Following *in vitro* maturation or fertilization, some oocytes were stained to assess nuclear maturation and penetration rates. The numbers of embryos that cleaved at 24 hr post insemination and developed to blastocysts after 6 days of culture, were recorded. The mean diameters were  $109.0\pm 3.2\ \mu\text{m}$  for oocytes collected from PMSG treated does and  $114.2\pm 4.1\ \mu\text{m}$  for oocytes collected from untreated does. The rates of nuclear maturation were significantly higher in oocytes  $>105\ \mu\text{m}$  than in those with  $<105\ \mu\text{m}$  in diameter. The rates of fertilization were significantly higher in oocytes with  $>110\ \mu\text{m}$  than in those  $<110\ \mu\text{m}$  in diameter. The rates of cleavage and development to blastocysts rose as oocyte diameter increased. The fertilized oocytes showed a significantly higher rate of developmental competence and lower occurrence of anomalies when cultured in medium of 305 mOsm / kg than when cultured in 285 and 325mOsm / kg. These results suggest that rabbit oocytes have acquired full developmental competence at a diameter of 110-  $120\ \mu\text{m}$  for oocytes cultured in medium of 305 mOsm / kg.

### Reproductive performance of male Californian rabbits as affected by season of the year and injection of oxytocin or adrenaline

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Twenty-four Californian (Cal) rabbit bucks with low fertility were used in five experiments. In Experiment 1, seasonal variation in libido and semen characteristics of bucks, were studied. In Experiment 2, effects of 0.5 IU oxytocin or 0.5  $\mu\text{g}$  adrenaline injected intravenously on libido and semen characteristics of bucks during summer and winter seasons were estimated. Experiment 3 was planned to determine the best interval after hormonal injection to observe the maximum effect. In Experiment 4, intravenous and intramuscular injections with either oxytocin or adrenaline were compared. In a fertility trial (Experiment 5), ninety Cal does were naturally mated using bucks injected intravenously or intramuscularly with oxytocin or adrenaline. Kindling rate and litter size observed. Libido and percentages of dead and abnormal spermatozoa were ( $P<0.01$ ) higher, and semen-ejaculate volume, sperm wave motion, progressive motility, sperm cell concentration and total sperm output were ( $P<0.01$ ) lower during autumn and summer than during winter and spring. Injection of bucks intravenously with oxytocin or adrenaline increased ( $P<0.01$ ) ejaculate volume, sperm wave motion, progressive motility (%), sperm abnormalities (%), sperm cell concentration and total sperm output and decreased ( $P<0.01$ ) libido, while percentages of dead spermatozoa were not affected. No significant differences were recorded in libido and semen quality between bucks injected with oxytocin and those injected with adrenaline. Reproductive performance was not better than intravenous injection when the bucks were injected intratesticularly with oxytocin or adrenaline.

Kindling rate and litter size values at birth of Cal rabbit does naturally mated with bucks injected with oxytocin or adrenaline were higher ( $P < 0.01$ ) than those mated with untreated bucks. Larger litters were obtained from does mated by bucks injected intratesticularly with oxytocin or adrenaline than by those injected intravenously with the same hormones.

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### **Rabbit doe milk production biology and its role in ontogenesis**

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Grey Giant doe milk contained 22.6 to 49.8% dry matter, 12.3 to 29.3% fat and 7.0 to 15.0% protein. The highest fat levels were seen in the first (29.3%) and last (27.5%) five days of lactation. These

values were higher by 35 to 40 % than the lactation average. Concentrations of the other constituents were also higher at the beginning and end of lactation. Averages were 1.9% lactose, 0.6 to 1.0% for calcium and 0.5 to 1.0% for phosphorus. The correlations between percentages of fat, protein, sugar and minerals and average daily milk yield, were negative. A doe with 4 to 5 kindlings per year can produce 27 kg milk. Consequently, the synthesizing ability of the doe body per kilogram live weight may be 860g protein and 50.3 MJ energy which confirms the high milk synthesizing ability of does. The direct correlation between energy level and fat concentration was estimated to be  $0.98 \pm 0.05$ , and between energy level and protein concentration was  $0.34 \pm 0.02$ . Compared to egg albumen, concentrations of lysine, threonine, leucine, phenylalanine, valine and arginine were higher by 65, 86, 85, 78, 15 and 12%, respectively, and concentrations of methionine + cystine, isoleucine, and histidine were lower by 24, 16, and 13%, respectively. Doe milk yield increased to day 20, then decreased gradually to day 30. It decreased sharply after day 40 of lactation. The does produced 3.5% of the total lactation yield during the first five days, and 10, 15 and 18% during the second, third and fourth five-day periods, respectively. Allowances per kg of weight gain in the suckling period were 13.0 to 13.1 MJ, which is much lower than in other animal species.

## ERRATUM

World Rabbit Science 1999, vol. 7.(3), Abstracts of 11<sup>th</sup> Symposium of Celle , page 122

« Influence of artificial and natural light on spermatological parameters of rabbits. »  
by M. Schüddemange, K. Lange, S Hoy.

The error is in the 4<sup>th</sup> column title. Correct table is as follow

	Natural light	16 L : 8D	8L : 16D
Ejaculate volume	0.75	0.74	<b>0.93</b>
Colour <sup>1</sup>	2.01	2.01	<b>1.65</b>
Consistency <sup>2</sup>	2.10	2.05	<b>1.62</b>
Motility <sup>3</sup>	3.16	3.26	<b>3.43</b>
Actively swimming sperm (%)	63	63	66
Spermatozoa (x 10 <sup>6</sup> )			
- Per ml	535	605	<b>651</b>
- Per ejaculate	405	473	600
Morphologically abnormal sperm (%)	11.2	<b>10.6</b>	11.5

<sup>1</sup> = 1 ivory coloured, 2 opaque, 3 transparent, 4 yellowy

<sup>2</sup> = 1 creamy, 2 milky, 3 whey-like, 4 watery

<sup>3</sup> = 0 no motility (m), 1 hardly m, 2 few m, 3 average m, 4 above average m, 5 high m.