RESEARCH PAPER

Genetic parameters of some production traits of the synthetic breed Cunistar-MDL (Minimum Disease Level)

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Abstract

This study aimed to present the first results of genetic analysis of the selection experiment for production traits of a synthetic breed, Cunistar-MDL (Minimum Disease Level), achieved in a private farm in Côte d'Ivoire. Production parameters studied were weight at birth (W0), individual weight at weaning or at 30 days (W30), individual weight at 60 days (W60), and individual weight at 90 days (W90). Average daily gain before weaning (ADG0-30) and daily average gain after weaning (ADG30-6O) were also analyzed. The results revealed that total number of animals born alive per calving was 7.50. Mortality rate before weaning was 16.91 %, while mortality rate after weaning was 2.00 %. The average weight of the litter at birth was 156.80 grams. At weaning, kits had an average weight of 530.62 grams. In general, all traits measured were significantly influenced by non genetic factors as sex, birth year, birth season and mother's age. Heritability values ranged from 0.56 for weight at 90 days (W90) to 0.81 for weight at 30 days (W30). For growth they varied between 0.33 for average daily gain before weaning (ADG0-30) and 0.57 for average daily gain after weaning (ADG30-60). Phenotypic correlations between weights at different age ranged from -0.09 (correlation between W0 and W60) to 0.83 (correlation between W60 and W90). Genetic correlations ranged from -0.43 (correlation between W0 and W60) to 0.84 (correlation between W60 and W90). For growth in both periods (pre-weaning and post-weaning), phenotypic and genetic correlations were moderate and positives.

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Introduction

In Côte d'Ivoire, rabbit breeding is a new speculation. Indeed, this type of breeding remained traditional since a long time ago and is mostly practiced around major cities by farmers, retired civil servants and European expatriates (Kacou, 1987; Bodji, 1992). Development of rabbit production is unfortunately hampered by several social, religious or otherwise factors that need to be overcome. Indeed, rabbit meat is relatively expensive and totemic for some ethnic groups.

The actual galloping demography and urbanization constitute a potential market for rabbit meat consumption. Rouvier (1980), Matheron (1982) and Rochambeau (1988) summarized most results obtained from experimentations of rabbit crossbreeding in Europe. However, very few experimentations of crossbreeding and selection of rabbit have been achieved in Africa and especially in Côte d'Ivoire. All research works performed are related to breeding techniques and different pathologies (Gbikpi, 1992; Tohani, 2003). Therefore, there is a significant shortage of data about genetic parameters of production and reproduction for rabbit in Côte d'Ivoire. Our selection experiment aimed to determine genetic variability of some production traits and their phenotypic and genetic links.

In this paper, we present the first results of this selection experiment of the synthetic breed Cunistar - MDL (Minimum Disease Level) in Côte d'Ivoire.

Materials and methods

Description of the breed Cunistar-MDL

The synthetic breed Cunistar was obtained from crossbreeding between a local breed with some reproductive imported from Germany, since 1997. Having noted a high mortality at birth of the first products, crossbreeding was achieved between the imported breed and the local one to create the breed named Cunistar-MDL (Minimum Disease Level). It is characterized by a variable coat colour (black, white, grey, fawn, and beige). Its ears are erect or drooping with a length from 12 to 13 cm. The eyes have an iris of variable colour (red, blue, black and grey). The Fur is dense and fine. The size varies from 40 to 50 cm. Adult weight is between 4.6 and 5 kg in males and from 3.8 to 4.2 kg in females. Male presents a good conformation, a great sexual appetite, high adaptability. Its sexual maturity is from 20 to 22 weeks. Female is very prolific with high lactation, sexual maturity is from 17 to 18 weeks. Gestation period is from 29 to 31 days, with 8 to 10 kits per litter. Age of reform is from 2 to 3 years for females and 4 years for males, if they have no pathology (FACI, 1998).

Animals of the study

The study was conducted in a private farm. 461 rabbits from the synthetic breed Cunistar-MDL were used. Eight (8) males and 26 females representing parental generation gave birth to 427 kits. Reproductive males had an average age of 15 months and an average weight of 3.5 kg while reproductive females had an average age of 10 months and an average weight of 3 kg. Because of mortality due to health and nutrition problems, a decrease in litter size during lactation was observed. Each year five males and 10 females were selected. Non selected animals were sold to other breeders or for slaughter.

Breeding house

Animals are monitored in a dimly lit building, made from bamboo slats (split bamboo rods) having four to six inches wide with spacing from 0.50 to 1.00 cm. The roof is sheet metal, and the floor is cemented. The building is divided into two compartments. The first compartment is 15 m long and seven meters wide; it houses reproductive and suckling rabbits. The second compartment is 16 m long and 14 m wide; it is reserved for fattening rabbits.

Reproductive are housed in hutches or cages which are 0.70 m long, 0.60 m wide and 0.75 m deep. These hutches are based on four feet by 0.50 m above the ground. Fattening rabbits housed in hutches which are one meter long, 0.80 m wide and 0.75 m deep. All

hutches are protected by fences of one square centimetre outside with an opening. Each hutch contains a trough and a metallic drinking trough installed on the two opposite sides in width direction.

Feeding

Food comes from factories of the "Société Ivoirienne de Productions Animales (SIPRA)" or those of the enterprise "Fabrication d'Aliments Composés Ivoiriens (FACI)". Animals are fed with two types of food pellets especially made for rabbits. The first called "Lapin Repro" is for lactating females and contains 14.20 % of raw cellulose on average and 16.40 % of raw Proteins.

The second called « Lapin Croissance » contains 14.70 % of raw cellulose and 15.40 % of raw protein; it is intended for reproductive males and rabbits for fattening. Each morning, reproductive received 150 g of pellets and 30 to 40 l of water. Lactating females of more than 15 days received 180 to 200 g of pellets and 40 to 50 l of water.

Kits in fattening received, according to age and litter size, 80 to 200 g of pellets. In the evening, residues of fruits (papaya, banana) were often added to pellets.

Main Pathologies encountered in the farm

Diseases encountered on the farm were:

- Sarcoptic mange: the agent responsible for this pathology is a mite of sarcopt type (variety cuniculi). This disease is characterized by skin lesions appearing like grey and adhesive crusts on head (nose, lips and chin) and legs (basis of claws, plantar surface of legs). Among kits, these lesions may prevent them from eating correctly;

- Ears scabies: the causative agent of this disease is also a mite of psoropt type (variety cuniculi). Animal shakes his head, scratching with his hind legs, becomes restless. The bottom of ear is filled with yellowish fat crusts. Ringworm caused by fungi appears. They are characterized by lesions more or less round, by hairs loss around eyes, ears and forehead;

- Acute coccidiosis: they are characterized by watery diarrhoea tinged with blood which causes rapid and deadly dehydration. Chronic coccidiosis causes growth retardation or paralysis of kits;

- Cannibalism: it is cited here as pathology because it represents an important source of mortality in this farm. In effect, some mothers kill their young because of lack of food or mere envy.

Treatments and hygiene

Rabbits were individually weighed the day of the weaning and were identified by numbers marked under the pavilion of ear. Two weeks later, males were separated from females and housed in individual cages to avoid aggressions.

Each morning, the cages were controlled and the room was cleaned. Animals were monitored by veterinary technician from the Central Laboratory of Animal Pathology of Bingerville.

Reproduction management

Reproduction is conducted according to a semi intensive rhythm of four litters on average per year. The average renewal rate of females is usually from 5 to 15% per year. Weaning takes place at an age approaching 30 to 40 days in order to prepare well the phase of transition between milk feeding and solid food. At weaning, kits have a weight of 500 g.

In female rabbits, ovulation is induced. It occurs in presence of male or female when kept in cage overlap in hot weather. Therefore, they are isolated until mating. The day of mating, females are transported in male cage, and mating takes place immediately, but for safety reasons, females remained for about thirty minutes with the male. Five days after mating, females are reintroduced to male. If it is consented, it is inferred that females have not been fertilized during last visit. Otherwise, palpitations are made in the abdominal area to ensure presence of the foetuses. This operation is conducted 15 days after mating.

Parturition, Lactation and weaning

A few days before parturition, females were isolated and the nest was prepared. A nest box of 20 x 30 x 30 centimetres containing dry straw was placed into the cage. After parturition, kits were placed into the box under the litter. During this operation, one makes sure hands are clean and free from odour. This is to prevent that the mother is not interested in kits. The first 15 days after birth, kits fed exclusively with milk. From the third week, in addition to milk, food pellets and water were added. They left the nest but remained in their mother's cage until weaning. In general, five days after weaning female is subjected to a new protrusion.

Data collection and statistical analysis

Measurement readings have led to constitution of a data base on the production parameters that were used in the analysis. These are data carrying on animals identification, weekly weighed for most animals, the main physiological events (mating, abortion, birth, death), the demographic variables (inputs, outputs), and the dates of these events.

Production parameters studied were weights adjusted for age including weight of kits at birth (W_0), individual weight at weaning or at 30 days (W_{30}), individual weight at 60 days (W_{60}), and individual weight at 90 days (W_{90}). In addition to individual weight at different age, average daily gain before weaning (ADG_{0-30}) and average daily gain after weaning (ADG_{30-60}) were analyzed.

Regression procedure was used to select the main fixed effects (group, sex, year and month of calving) as well as interactions that influenced weights and growth. The effects that influenced data significantly ($P < 0.05$) were included in the animal model.
Genetic and non genetic effects for weights and growth were analyzed using the following animal model: $Y_{ijklmn} = m + sex_i + year_j + season_{ik} + group_l + age_m + year*season_{ijk} + g_n + e_{ijklmn}$,

where m represents the overall average, sex_i is the fixed effect of sex (male or female), $year_j$ is the fixed effect of birth year, $season_{ik}$ is the fixed effect of the birth season, $group_l$ is the fixed effect of group, age_m is the fixed effect of mother's age, $year*season_{ijk}$ is the fixed effect of interaction of birth year by birth season, g_n is the random effect of animal and e_{ijklmn} is the random residual error. Genetic parameters were estimated using the program "Derivative Free Restricted Maximum Likelihood (DFREML)" (Meyer, 1998). Data structure did not allow inclusion of maternal genetic effects in the model (no pedigree information for mothers).

Results

Reproduction and production parameters

The total number of animals born alive per calving was 7.50. Mortality before weaning was 16.91 %, while mortality after weaning was 2 %. Reproduction parameters observed indicated a high gestation rate (75%) of females and a calving index of 9.

Basic statistics carrying on production traits showed that the average weight of the litter at birth was 156.80 ± 30.30 g. At weaning, kits had an average weight of 530.62 ± 160.33 g. Large variations were observed for weights at different age (W_0, W_{30}, W_{60} and W_{90}) and for pre-weaning growth (ADG_{0-30}) and post-weaning growth (ADG_{30-60}) although homogeneity have been observed at birth (Table 1). This homogeneity is explained by the fact that individuals had the same birth weight.

Non genetic effects

Non genetic factors of variation (group, sex, birth year, birth season and mother's age) have significant effects in general ($p < 0.05$) on all variables. However, sex have no significant influence on weight at birth (W_0), average daily gain before weaning (ADG_{0-30}) and average daily gain after weaning (ADG_{30-60}). Birth year had no significant effect on weight at 90 days (W_{90}). Birth weight varied according to group, birth year and birth season (Table 2).

Table 1. Basic statistics carrying on production traits.

Variables	Mean	C.V. (%)	Max	Min
W_0 (g)	156.80 ± 30.30	12.95	200	100
W_{30} (g)	530.62 ± 160.33	30.22	1000	250
W_{60} (g)	1801.74 ± 338.81	18.8	2650	1000
W_{90} (g)	2148.93 ± 308.33	14.35	2950	1250
ADG_{0-30} (g/day)	12.45 ± 4.91	39.44	27.33	3.83
ADG_{30-60} (g/day)	42.31 ± 8.65	20.44	66.66	18.33

W_0: birth weight; W_{30}: weight at 30 days of age (or at weaning); W_{60}: weight at 60 days of age; W_{90}: weight at 90 days of age (or final weight); ADG_{0-30}: average daily gain before weaning; ADG_{30-60}: average daily gain after weaning; C.V.: Coefficient of variation; Max: Maximum; Min: Minimum

Table 2. Non genetic effects on measured traits.

Source of Variation	Traits					
	W_0	W_{30}	W_{60}	W_{90}	ADG_{0-30}	ADG_{30-60}
Group	***	***	***	***	***	***
Sex	ns	*	***	***	ns	ns
Birth year	***	***	***	ns	***	***
Birth season	***	***	***	***	***	***

W_0: birth weight; W_{30}: weight at 30 days of age (or at weaning); W_{60}: weight at 60 days of age; W_{90}: weight at 90 days of age (or final weight); ADG_{0-30}: average daily gain before weaning; ADG_{30-60}: average daily gain after weaning.

*: significant effect (P ≤ 0.05) ; *** very significant effect (P ≤ 0.001) ; ns : non-significant effect (P ≥ 0.05)

Heritability

Heritability values obtained for weights at different age were high throughout. They ranged from 0.56 ± 0.18 for weight at 90 days (W_{90}) to 0.81 ± 0.18 for weight at 30 days (W_{30}). For growth in both periods (pre-weaning and post-weaning), heritability values were rather moderate and ranged from 0.33 ± 0.40 for average daily gain before weaning (ADG_{0-30}) to 0.57 ± 0.19 for average daily gain after weaning (ADG_{30-60}). Standard errors were high for both types of variables (Table 3).

Table 3. Estimated heritability for measured traits.

Variable	h^2
W_0	0.60 ± 0.24
W_{30}	0.81 ± 0.18
W_{60}	0.70 ± 0.19
W_{90}	0.56 ± 0.18
ADG_{0-30}	0.33 ± 0.40
ADG_{30-60}	0.57 ± 0.19

W_0: birth weight; W_{30}: weight at 30 days of age (or at weaning); W_{60}: weight at 60 days of age; W_{90}: weight at 90 days of age (or final weight); ADG_{0-30}: daily average gain before weaning; ADG_{30-60}: daily average gain after weaning.

Phenotypic and genetic correlations between different traits

For weights at different age, phenotypic correlations between measured traits were generally strong and positives, except that between W_0 and W_{60}, which was negative. They ranged from -0.09 ± 0.01 (correlation between W_0 and W_{60}) to 0.83 ± 0.03 (correlation between W_{60} and W_{90}).

Genetic correlations were also strong and positive in general, but that between W_0 and W_{60} was negative. These genetic correlations ranged from -0.43 ± 0.04 (correlation between W_0 and W_{60}) to 0.84 ± 0.08

(correlation between W_{60} and W_{90}). For growth in both periods (pre-weaning and post-weaning), phenotypic and genetic correlations were moderate and positives.

Phenotypic correlations between weights at different age and growth during the two phases (pre-weaning and post-weaning) were strong and positives. They varied from 0.17 ± 0.09 (correlation between W_{30} and ADG_{30-60}) to 0.90 ± 0.02 (correlation between W_{60} and ADG_{30-60}). Genetic correlations weights at different age and growth in both periods (pre-weaning and post-weaning) were also strong and positives. These correlations ranged from 0.35 ± 0.26 (correlation between W_{30} and ADG_{30-60}) to 0.89 ± 0.06 (correlation between W_{60} and ADG_{30-60}) (Table 4).

Table 4. Estimated phenotypic and genetic correlations for production traits.

Variables	W_0	W_{30}	W_{60}	W_{90}	ADG_{0-30}	ADG_{30-60}
W_0		0.56 ± 0.04	-0.09 ± 0.01	0.22 ± 0.06	0.59 ± 0.01	-
W_{30}	0.64 ± 0.04		0.58 ± 0.06	0.46 ± 0.07	-	0.17 ± 0.09
W_{60}	-0.43 ± 0.04	0.74 ± 0.14		0.83 ± 0.03	0.65 ± 0.06	0.90 ± 0.02
W_{90}	0.07 ± 0.08	0.56 ± 0.20	0.84 ± 0.08		0.49 ± 0.08	0.76 ± 0.04
ADG_{0-30}	0.82 ± 0.09	-	0.79 ± 0.11	0.52 ± 0.21		0.16 ± 0.09
ADG_{30-60}	-	0.35 ± 0.26	0.89 ± 0.06	0.75 ± 0.13	0.39 ± 0.25	

Phenotypic correlations are above the diagonal; genetic correlations are under the diagonal.

W_0: birth weight; W_{30}: weight at 30 days of age (or at weaning); W_{60}: weight at 60 days of age; W_{90}: weight at 90 days of age (or final weight); ADG_{0-30}: daily average gain before weaning; ADG_{30-60}: daily average gain after weaning.

Discussion

The objective of this study was to present the first results of genetic analysis of selection experiment for production traits from the synthetic breed Cunistar – MDL, in Côte d'Ivoire. The results showed that weights at different age, average daily gain (ADG) from pre-weaning and post- weaning are heritable traits in this synthetic breed.

Fixed effects such as group, birth season and birth year are important sources of environmental variations. Results obtained in this study are in agreement with those obtained by Rouvier (1981). Indeed, seasonal changes in humidity and temperature would influence animal's growth. Consequently, growth traits should be adjusted for these environmental effects for future research. These estimated parameters are key elements in establishment of genetic assessment methods for this breed. Estimated heritability values are in most cases in the range of values reported about rabbits. They

are comparable to those obtained by Feraz and Eler (1994) for daily average gain (0.35), and Lazrul et al. (2005) for final weight (W_{90}) (0.67). However, method used for analysis in this study gave exceptionally higher values, for weight at birth (W_0). Moura et al. (2001) obtained a heritability of 0.48. This difference would be due to environmental conditions of survey.

The reduced size of studied population has a certain influence on heritability. Indeed, small population considered in this study influenced additive genetic variance that depends on genes frequency in the population. Introduction of new animals having no relationship with the herd should increase additive genetic variance and therefore heritability (Massey and Vogt, 1993). Heritability also depends on environment in which animals are raised. Higher environmental variance is, weaker will be heritability.

Genetic correlations obtained are generally consistent with experiments values from Allain *et al.* (2001), but they are slightly higher. Genetic correlation between birth weight (W_0) and daily average gain before weaning (0.82 ± 0.09) shows possibility of indirect selection for weight at weaning (W_{30}). This selection is possible by high genetic correlation between birth weight (W_0) and weight at 30 days of age (W_{30}) which is 0.64 ± 0.04. Similarly, genetic correlation between weight at 60 days of age (W_{60}) and average daily gain after weaning (ADG_{30-60}) (0.89 ± 0.06) shows possibility of indirect selection for W_{30}. This choice is possible due to high genetic correlation between W_{30} and W_{60} (0.74 ± 0.14). Negative genetic correlation between birth weight (W_0) and weight at 60 days of age W_{60} is probably due to weight loss after weaning.

Maternal genetic effects were not taken into account in the analysis model considering the structure of data base (lack of maternal pedigree). Estimated heritability values for W_0 and W_{30} are high. This is probably due to maternal effects. Snyman *et al.* (1996) indicated that ignoring maternal effects, if they have significant influence, lead to an overestimation of heritability as well as total direct heritability. Indeed, data were collected just over two years. To get unbiased estimation, it would be necessary to collect much more data over several generations. High standard errors for both types of variables still show the small amount of analyzed data.

This study was based on limited number of data, leading thus to obtain overestimated standard errors, especially for genetic correlations. However, estimations are more accurate for phenotypic correlations, which may well serve as indicators for magnitude and sign of genetic correlations (Lynch and Walsh, 1998).

This study revealed the existence of an additive genetic variance for weights at different age and growth during different periods in the synthetic breed Cunistar - MDL. However, it is necessary to continue collecting data in order to reassess genetic parameters of selection. Indeed, this study was done on a limited number of data, reducing the precision of estimations.

Conclusion

Genetic parameters obtained in this first analysis indicated that the traits "weights at different age" and "average daily gain (ADG)" are heritable in the breed Cunistar-MDL. These results will permit a selection strategy for growth at weaning. However, such a study requires considering existence of links between growth and the litter size and its components as well as economic aspects.

At short term, studies are necessary to deepen unresolved questions about keeping Cunistar-MDL rabbits, from genotypes considered to belong to this synthetic breed. Thus, studies could be directed on optimizing selection scheme used, on assessment of genetic progress obtained for growth traits. Genetic parameters of reproduction including litter size, interval between two calving and age at the puberty may also be estimated.

Definition of real selection policies for rabbit genetic resources capable to answer numerous requests from local communities is more necessary than ever. The device of study considered in this private farm level needs to be developed also in other rabbit breeders to benefit from their choice of breeding methods and their farming practices. Since there are many economic and social benefits to be learned both locally and nationally by the establishment of a well designed breeding program for the synthetic breed Cunistar-MDL. We formulate the following recommendations for the improvement of technical conditions in this farm:
- encouraging data collection of production traits, reproduction and health in order to obtain reliable parameters;
- improving breeding techniques by the use of adequate housing including spacious and easy access for cleaning and disinfection;
- improving nutrition through the use of fresh food and not only concentrate;

- reducing utilization any males in order to avoid inbreeding problems encountered in a small population.

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