CHARACTERIZATION OF THE FRENCH RABBIT BREED FAUVE-DE-BOURGOGNE IN AN INTENSIVE SYSTEM

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ABSTRACT

A characterization of the French local breed Fauve-de-Bourgogne was realized on a population of 48 rabbits (11 males and 37 females) gathered from five different amateur farms located in the French regions of Alsace, Lorraine and Bourgogne. We checked the growth of future breeders, the female reproductive performances and their feed intake during the first 10 days of lactation, as well as the kit survival and growth. Fauve-de-Bourgogne female rabbits have an adult weight of about 4.3 (±0.43) kg and reached 84% of the adult weight around 5 months old. Under a reproductive rhythm of 42 days, reproductive performances were low. Fertility rates averaged 60% and litter sizes at birth averaged 4.3 (±2.7) newborn. On average, females weaned (at 35 days) 3.4 (±2.4) kits weighing 720 (±170) g. In the absence of antibiotics supplementation, kit survival was as high as 83% and growing animals reached 1649 (±192) g at 65 days old.

Key words: Genetic resources, local breed, biodiversity, *Oryctolagus cuniculus*.

INTRODUCTION

Together with the increase of public concern to improve animal welfare, intensive farming faces the challenge of raising animals with the minimal use of antibiotics as possible. One strategy to reduce antibiotic dependence is to keep a herd of diseases resistant individuals. According to Hamilton *et al.* (1990), to resist numerous parasites, hosts species should preserve an array of genotypes (*i.e.* high genetic diversity). However, artificial selection tends to erode genetic diversity, and this is the case for the domestic rabbit. First because most rabbit selection programs used a limited genetic background as the base population (New Zealand White and California), and secondly because selection herds are managed in a close population with no introduction of foreign individuals (Garreau *et al.*, 2015). The burden of such strategy is a reduced effective population size, the accumulation of inbreeding and a degraded fitness in the selection herd (Pekkala *et al*., 2014).

In addition to the erosion of genetic diversity, the use of antibiotics to sustain performance and health is a common practice extended in almost every selection and production farms since the advent of professional animal production (Kirchhelle, 2018). The artificial selection (loss of genetic variety and fitness) coupled with a systematic use of antibiotics results in a population that is dependent on the use of chemical treatments to function properly. In this context, the use of local breeds raised in a variety of antibiotic 'free' environments together with commercial populations may help to increase the array of genotypes needed to avoid pathogens affecting intensive production systems. Another strategy is to cross commercial and local populations to boost genetic diversity, increasing thus the population adaptive response (Spielman *et al.*, 2004), while benefiting from the achievements of breeding programs. The obtained outbreed individuals are expect to better resist infections and to perform well at different set of environmental conditions (Kargo *et al*., 2011).

In France, there is at least 10 local rabbit breeds (FAO, 2015) with a population size big enough to allow their multiplication and use under intensive farming systems. One of such breed is the Fauve-de-Bourgogne, a medium-size breed that presents a reasonable prolificacy and growth rate (Bolet *et al.*, 2004), being also renowned among amateurs farmers as a robust breed. However, there is still a lack of scientific information concerning growth and the reproductive potential of using this breed under intensive conditions to increase the genetic array of a herd (*i.e.* mixed breed population). In this sense, we

characterized a population of the French rabbit breed Fauve-de-Bourgogne, raised under intensive farming conditions, to be potentially used as a pure breed or as a crossbred with commercial rabbit lines in systems promoting an augmentation of the genetic diversity at the herd level.

MATERIALS AND METHODS

The French Committee no. 115 for Ethics, Science and Animal Health approved all procedures.

Origin of Fauve-de-Bourgogne rabbits

We gathered a population of 48 Fauve-de-Bourgogne rabbits (11 males and 37 females) from five different farms located in the French regions of Alsace (n = 24), Lorraine (n = 17) and Bourgogne (n = 7). Animals were born between April and June 2018 and most individuals had between 78 and 94 days at their arrival at our experimental farm (n = 38). Ten animals had between 107 and 152 days old. They are sons and daughters of 14 males and 19 females. Sires and grand-sires of our animals were not related.

Management practices and measures

From September 2018 to May 2019, each rabbit lived indoors in wire cages (W×L×H: 62×68×50 cm). At all times, the daylight program was set to a 16/8h light/dark cycle with indoor temperatures set to vary between 15 and 28 °C. All animals had free access to water and to a commercial diet containing 12.4 MJ of DE per kg of DM, 17.6% of CP, 2.5% of EE, 31.9% of NDF, 16.5% of ADF, and 5.1% of ADL on a DM basis. Natural mattings occurred every 42 days (three consecutive attempts) and weaning at 35 days. Weaned kits were raised until 65 days of age. At parturition, females having zero born alive and those that did not produce milk adopted no kits. We individually recorded the female's live weight, reproductive performance and feed intake for the first 10 days of lactations. On males, we recorded their live weight gain. We checked the litter weight at birth and at 16 days, and recorded individual live weight of kits at 35, 50 and 65 days of age. Individual mortality was also recorded. Growing kits were housed in wire cages (W×L×H: 46×76×30 cm) to a maximum of five animals per cage with room temperatures set to vary between 15 and 28 °C. To avoid digestive troubles, growing kits received 50 g of a commercial diet at 35 days, then 90 g per day from 36 to 42 days old, 110 g per day from 43 to 49 days old and 130 g per day from 50 to 56 days old. From day 57 onwards, feed was freely available. The commercial diet offered to growing kits contained 11.3 MJ of DE per kg of DM, 15.4% of CP, 1.9% EE, 37.5% of NDF, 20.5% of ADF and 6.4% of ADL on a DM basis, but no antibiotics. At all times, growing kits had free access to fresh water.

Statistical Analyses

We used the R-software, version 3.6.0 (R core Team, 2019) to analyse our data. We used a general linear model for litter traits and kits live weight data, a mixed model (including the individual as a mixed effect) for female feed intake data, and a logistic regression model for female fertility and kits survival data. Female parity (1, 2 or 3) was the dependent variable of all models.

RESULTS AND DISCUSSION

Live weight of Fauve-de-Bourgogne rabbits of both sexes aged between 78 and 343 days are in **Figure 1**. At 149 days old (5 months), female rabbits weighed 3.6 (±0.44) kg and had a stable weight of 4.3 (±0.43) kg around 9 months. It indicates that Fauve-de-Bourgogne female rabbits could be mated as soon as they reach ≥ 3.6 kg (~80% of adult weight). We did not observed a live weight plateau in our male rabbit population.

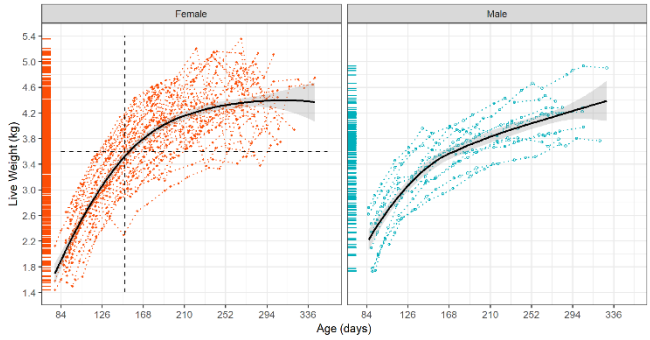

Figure 1: Individual live weight of Fauve-de-Bourgogne rabbits of both sexes in function of age. Black curves represents the estimated live weight in function of age (non-parametric local polynomial regression fitting: loess) and the shadow grey area the 95% confidence interval around the fitted curve. Dashed black segments represents the weight of female rabbits (3.6 kg) at a median age of 149 days (5 months).

Main reproductive traits of Fauve-de-Bourgogne females at parturition 1, 2 and 3 are in **Table 1**. Although not significantly, fertility rate at 2nd parity was numerically superior to values observed at 1st and at 3rd parity (+13.2 and +19.1 points, respectively). These values are in line with those reported by Bolet *et al*. (2004) for this same breed, but falls far below the fertility reported for a commercial Spanish crossbreed line (85.0%; Martinez-Paredes *et al*., 2018). The average number of kits born alive was 4.3 (±2.7) and it seems to be superior at 3rd parity respect to the 1st and 2nd parities (+2.0 kits; $P<0.10$). The number of stillborn and weaned kits were constant among parities.

Kits survival during lactation dropped between the 1st and the 3rd parity from 83 to 39% ($P<0.05$). This drop is partly explained by the reduced number of females raising a litter (n = 6). In fact, one female weaned none of the seven kits it adopted and two others, raising nine kits, weaned only two. The average birth weight was 53.3 g (range: 26.2 to 72.5 g), being constant among parities.

Table 1: Reproductive traits of Fauve-de-Bourgogne female rabbits at 1st, 2nd and 3rd parity. Means (SE).

Reproductive traits	Female parity		
	First	Second	Third
Female age; median (days)			
at matting	158	198	241
at parturition	188	231	274
Females matted (n)	36	33	26
Litters produced (n)	16	19	10
Litters raised (n)	11	14	6
Fertility rate (%)	44.4 (8.3)	57.6 (8.6)	38.5 (9.5)
Number of			
Kits born alive	3.8 (0.7)	3.9 (0.6)	5.9 (0.8)
Stillborn kits	2.0 (0.4)	1.1 (0.4)	1.0 (0.6)
Raised kits†	4.9^{A} (0.4)	4.2^{A} (0.3)	8.5^{B} (0.5)
Weaned kits	3.7 (0.7)	3.1 (0.6)	3.3 (1.0)
Kits survival 0 to 35 days (%)	83.3^{A} (5.1)	72.1^{A} (5.4)	39.2^{B} (6.8)
Kits live weight (g)			
At birth (0 days)	50.7 (2.7)	55.9 (2.5)	52.5 (3.3)
At mid-lactation (16 days)	347.3^{A} (15.3)	291.2^{B} (14.6)	268.0^{B} (21.7)
At weaning (35 days)	584.2^{A} (18.2)	846.6^{B} (17.4)	709.7^{C} (26.6)

^{ABC} Means of a variable followed by distinct letters differs at $P<0.05$. †Average litter size raised by 11, 14 or 6 females at first, second and third matting, respectively

Although kits weight at mid-lactation (16 days) was higher in the 1st parity than in the following ones (+68.0 g; $P<0.05$), their weaning weight was lower with respect of the 2nd (-262 g) and the 3rd (-132 g) parities. Weaning weight of kits from the 1st parity was very low (584 g), but the values observed in the subsequent mattings (around 780 g) were close to those reported by Paës *et al.* (2019) for kits raised by primiparous females of the French hybrid line PS19 (on average 816 g) in the same facilities.

Feed intake of females during the first 10 days of lactation of parities 1, 2 and 3 are in **Figure 2**.

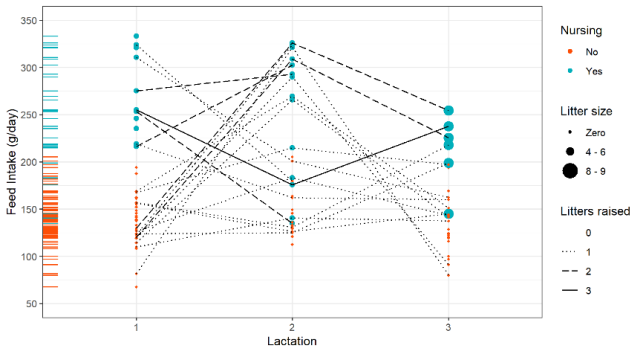

Figure 2: Feed intake (g/day) of female rabbits during the first 10 days of lactation 1, 2 and 3. Red dots represents non-lactating females and blue dots lactating females. Size of the raised litters are represented by the size of the dots (small for zero kits, medium for litters between 4 and 6 kits and big for litters of 8 or 9 kits). Lines represented the number of litters raised per female. No lines no litters, dotted lines 1 litter, dashed lines 2 litters and solid lines 3 litters.

At each lactation, feed intake of nursing females was higher than no lactating females (+137.5, +92.8 and +82.8 g/day for parity 1, 2 and 3 respectively; $P<0.01$). Among nursing females, and independently from the size of the nursed litter (range 4 to 9), the average feed intake was similar at lactations 1, 2 and 3 (272, 254 and 213 g/day, respectively). Nine females raised zero litters, 18 raised 1, 5 raised 2s and only 1 female raised 3 litters.

Performance traits of growing rabbit kits are in **Table2.**

Table 2: Growth and survival of Fauve-de-Bourgogne growing rabbits from first, second and third parity. Means (SE).

Performance traits	Female parity		
	First	Second	Third
Live weight (g)			
at 35 days	584^{a} (18.2)	847^{b} (17.4)	710^{c} (26.6)
at 50 days	1074^{a} (26.6)	1261^{b} (25.9)	1170^{ab} (36.2)
at 65 days	1581^{a} (30.7)	1705^{b} (30.3)	1667^{ab} (40.7)
Average daily gain (g/day)			
35 to 50 days	30.0 (0.95)	29.6 (0.90)	30.7 (1.20)
50 to 65 days	34.6^{a} (1.12)	30.5^{b} (1.09)	35.5^{a} (1.45)
35 to 65 days	30.8^{a} (0.75)	30.0^{a} (0.74)	33.0^{b} (0.98)
Survival 35 to 65 days (%)	82.2 (5.7)	77.5 (6.0)	100 (0.0)

^{abc} Means of a variable followed by distinct letters differs at $P<0.05$.

Live weight of growing kits at 65 days from the 2nd and the 3rd parity was, on average, 105 g higher than values of growing kit from the 1st parity ($P<0.05$). The average daily gain (between 35 and 65 days) of growing rabbits from the 3rd parity was 2.6 g/day higher ($P<0.05$) than values of kits from the 1st and 2nd parity. Those values were lower (less 7.1 g/day) than those observed for the French crossbreed PS19 line raised in the same facilities (38.4 g/day; Paës *et al.*, 2019). Survival rate of growing kits from the 1st, 2nd and the 3rd parity were 82.2%, 77.5% and 100%, respectively.

CONCLUSIONS

Under intensive farming system, the reproductive performances of Fauve-de-Bourgogne female rabbits are low. The average daily gain observed and the high survival during growing period (96 kits alive at 65 days of 114 weaned kits at 35 days), in the absence of any antibiotics treatments, makes this breed an interesting genetic material to be considered in crossbreed schemes with prolific pure lines to benefit of the complementary traits of these genetics.

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REFERENCES

Bolet G., Brun J.M., Lechevestrier S., Lopez M., Boucher S., 2004. Evaluation of the reproductive performance of eight rabbit breeds on experimental farms. *Animal Research 53, 59-65.*

FAO, 2015. Domestic animal diversity information system (DAD-IS). *URL: http://www.fao.org/dad-is/dataexport/en/*

Garreau H., Fournier E., Allain D., Gunia M., 2015. Génétique et sélection. *In: Gidenne T. (Ed). Le lapin. De la biologie à l'élevage. Editions Quae, Versailles, France, 227-252*.

Hamilton W.D., Axelrod R., Tanese R., 1990. Sexual reproduction as an adaptation to resist parasites (a review). *PNAS, 87(9), 3566-3573.*

Kargo M., Madsen P., Norberg E., 2011. Short communication: Is crossbreeding only beneficial in herds with low management level? *Journal of Dairy Science 95, 925-928.*

Kirchhelle C., 2018. Pharming animals: a global history of antibiotics in food production (1935–2017). *Palgrave Communication 4, 96.*

Martínez-Paredes E., Ródenas L., Pascual J.J., Savietto D., 2018. Early development and reproductive lifespan of rabbit females: implications of growth rate, rearing diet and body condition at first mating. *Animal 12, 2347-2355*.

Paës C., Fortun-Lamothe L., Bébin K., Duperray J., Gohier C., Guené-Grand E., Rebours G., Aymard P., Bannelier C., Debrusse A-M., Gidenne T., Combes S., 2019. Onset of feed intake of the suckling rabbit and evidence of dietary preferences according to pellet physical properties. *Animal Feed Science and Technology 255, 114223.*

Pekkala N., Knott K.E., Kotiaho J.S., Nissinen K., Puurtinen M., 2014. The effect of inbreeding rate on fitness, inbreeding depression and heterosis over a range of inbreeding coefficients. *Evolutionary applications, 7(9), 1107-1119.*

R Core Team 2019. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. *URL: http://r-project.org*

Spielman D., Brook B.W., Briscoe D.A., Frankham R., 2004. Does inbreeding and loss of genetic diversity decrease disease resistance? *Conservation Genetics, 5(4), 439-448.*