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EFFECT OF BREEDING SYSTEM AND FARM HYGIENE ON PERFORMANCES OF GROWING RABBITS AND LACTATING DOES OVER TWO REPRODUCTIVE CYCLES

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Abstract: The aim of this paper was to study the effect of the intensive breeding system (IBS: insemination 4 d post-partum and weaning age at 25 d) *vs.* the semi-intensive breeding system (SIBS: insemination 11 d post-partum and weaning age at 35 d) on lactating does' performance and the combined effect of the type of farm hygiene (cleaned and disinfected or not) on the performance of growing rabbits from weaning until 56 d of age. A total of 58 New Zealand×Californian rabbit does (29/reproductive rhythm) and 168 young rabbits per combination weaning age×type of farm were selected at random over two consecutive reproductive cycles. Mortality during lactation presented higher values (*P*=0.067) in young rabbits weaned at 35 d than in those weaned at 25 (19.1 *vs.* 9.60%). In the first cycle, the number of kits weaned per litter was similar for both reproductive rhythms (7.89 and 8.01 for IBS and SIBS, respectively), whereas in the second cycle, the number of rabbits weaned was lower in rabbit does that weaned their litters later (6.90 *vs.* 9.06; *P*=0.049). Weight at parturition and at weaning, fertility, parturition interval, numerical productivity and the number of young rabbits born dead and weaned were not affected by treatments. The fattening mortality was higher in the second cycle than in the first (20.2 *vs.* 14.5 %, *P*=0.051), in the farm without cleaning and disinfection between cycles (20.0 *vs.* 14.2%, *P*=0.032) and in the animals weaned at 35 d than at 25 d (20.0 *vs.* 14.7 %, *P*=0.063). Animals weaned at 25 and 35 d of age both had a peak of mortality around two weeks after weaning. The average weight of rabbits at 56 d was not signigicantly different between the animals weaned at 25 or 35 d (1805 *vs.* 1787 g, respectively; *P*=0.64). However, the feed efficiency in the whole fattening period was higher in young rabbits weaned at 25 d than in those weaned at 35 d (0.392 *vs.* 0.298 g/g; *P*<0.001).

Key Words: breeding system, weaning age, disinfection, mortality, performance.

INTRODUCTION

The reduction of lactation time of rabbit females allows the improvement of their energy balance (Xiccato *et al*., 2004 and 2005) and productivity (Nicodemus *et al*., 2002). However, the effect of weaning age on mortality and performance of growing rabbits is not clear. Lebas (1993) observed that weaning rabbits at 35 instead of at 25 d of age reduced the fattening mortality. This is in agreement with Gidenne and Fortune-Lamothe (2001) who found a greater mortality from 32 to 45 d of age in rabbits weaned at 23 d compared to those weaned at 32 d of age (17.2 *vs.* 9.2%). Also Ferguson *et al*. (1997) observed that rabbits weaned at 14 d showed a lower feed intake, lower growth rate and higher mortality than those weaned at 28 d of age. On the other hand, Xiccato *et al*. (2000) did not detect any effect on mortality of a weaning age of 21, 25, 28 or 35 d. Furthermore, when weaning age was brought forward from 32 to 14 d (Prud'hon

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and Bel, 1968) or to 18 d of age (Piattoni and Maertens, 1999) the weight at the end of the fattening period was not affected due to their compensatory growth, with no effect on mortality. Similar results were obtained by De Blas *et al*. (1981) when weaning age was brought forward from 35 to 25 d. Furthermore, other factors affecting mortality rate, such as the health status of the farm (García *et al*., 2005) could also interact with weaning age (Romero *et al*., 2007).

The aim of this study was to verify the effect of the breeding system (insemination 4 *vs.* 11 d post parturition and weaning age 25 *vs.* 35 d, respectively), the farm (disinfected or not) and the period (two consecutive reproductive cycles) on performance of lactating and fattening rabbits without any medication.

MATERIAL AND METHODS

Lactation trial

Fifty-eight New Zealand x Californian rabbit does were assigned to two different breeding systems during two consecutive reproductive cycles carried out from September to December of 2005. In each cycle, half of the rabbit does were inseminated at 4 d after parturition, and the weaning age was 25 d (IBS: intensive breeding system). The other half of the females were inseminated at 11 d post-partum and their litters were weaned at 35 d of age (SIBS: semi-intensive breeding system). Those females that were not pregnant were reinseminated 35 or 42 d later, in the IBS or SIBS, respectively. In the first cycle, there were 44 rabbit does that had one parturition, 7 rabbit does with two parturitions and another 7 rabbit does with three parturitions. Seminal doses, with more than 20 million spermatozoa in 0.5 mL of a commercial diluent (Magapor S.L.), were made using a pool of fresh heterospermic semen from bucks selected for growth performance. To induce ovulation, does were given an intramuscular injection of 10 µg buserelin (Suprafact, Hoechst Marion Roussel, S.A., Madrid).

A diet was formulated to meet the minimum protein and fibre requirements according to De Blas *et al*. (1995), De Blas and Mateos (1998) and Gidenne and García (2006). All animals were fed the same diet (Table 1) that was offered for *ad libitum* intake in late pregnancy (28 d until parturition) and throughout lactation, and restricted to 150 g/d from weaning until 28 d of gestation.

Rabbit does were housed individually in flat-deck cages measuring 600×500×330 mm. Heating and forced ventilation systems allowed the building temperature to be maintained between 18 and 23 ºC throughout the two periods. A cycle of 16 h of light and 8 h of dark was used throughout the experiment. The farm was disinfected before the trial by spraying a disinfectant (containing: 15% gluteraldehide, 10% didecilmetyl ammonium chloride, 10% cipermetrine and 100% solvents and excipients) active against Gram(+) and Gram(-) bacteria, virus, spores, fungi and micoplasms. A pesticide with acaricide, insecticide and rodenticide activities was also sprayed (containing: 56% magnesium phosphate and 100% excipients). No disinfection was done between the first and the second cycle.

At parturition litter size was standardised at 9 young rabbits. Fertility was controlled in the first and second artificial insemination. Weight of does was determined at parturition and at the end of the lactation period. Prolificacy (total number of kits born and stillborn), mortality of the young rabbits during lactation, numerical productivity (number of kits weaned per rabbit doe per year) and litter weight at weaning were measured.

Fattening trial

A total of 672 New Zealand x Californian growing rabbits were assigned at random to the four experimental treatments (2 breeding systems -IBS *vs.* SIBS-, factorially combined with the two different types of farms -disinfected or not-) during two consecutive reproductive cycles (84 per treatment and period). Growing rabbits from both breeding systems and assigned to the same hygiene treatment were housed in the same

Table 1: Ingredients and chemical composition of diet.

Ingredients, %		Determined chemical composition, % DM	
Wheat	25.0	Dry matter	90.9
Wheat bran	24.3	Ash	7.8
Sunflower meal	10.0	Crude protein	17.5
Alfalfa hay	34.0	Starch	23.0
NaOH treated straw	3.05	Neutral detergent fibre	33.0
Lard	2.00	Acid detergent fibre	17.8
ClNa	0.50	Acid detergent lignin	4.57
Min-Vit premix[1]	0.50	Ether extract	5.2
DL-Methionine	0.15	Digestible energy[2] (kcal/kg DM)	2850
L-lysine HCl	0.35	Lysine[3]	1.00
L-threonine	0.15	Methionine[3]	0.44
		Threonine[3]	0.76

[1]Provided by Trouw Nutrition España, S.A. Mineral and vitamin composition (mg/kg): Mg, 290; Na, 329; S, 275; Co, 0.7; Cu, 10; Fe, 76; Mn, 20; Zn, 59.2; I, 1.25; Choline chloride, 250; riboflavine, 2; Niacine, 20; vitamin B_6, 1; vitamin K, 1; Vitamin E, 20 IU/kg; Tiamin, 1; Vitamin A, 8375 IU/kg, y Vitamin D_3, 750 IU/kg.
[2]Values estimated according to De Blas *et al* (1992).
[3]Values estimated according to FEDNA (2003).

breeding unit (two different breeding units were used: one breeding unit for each hygiene treatment, disinfected or not). This implied that rabbits weaned at 35 d were housed in the same two breeding units (disinfected or not) in which rabbits weaned at 25 d old had already been housed 10 d before.

All rabbits were fed *ad libitum* the same diet (Table 1) and were not medicated.

Rabbits were housed in groups of four animals in cages measuring 600 deep×500 wide×330 mm high (21 cages/treatment). Building temperature was partially controlled (room temperature between 16 and 23ºC in both periods). A cycle of 12 h of light and 12 h of dark was used throughout the growth trial in both farms. One farm was disinfected before the trial and after the first fattening period by spraying the same disinfectant as in the maternity farm. In the second farm, disinfection was also done before the trial, but no disinfection was done after the first cycle.

Mortality was recorded daily during the fattening period. In the non-disinfected farm average weight gain and feed intake up to 56 d of age were also recorded in animals weaned at 25 or 35 d during the first reproductive cycle.

Chemical Analysis

Procedures of the AOAC (2000) were used to determine the concentrations of DM (934.01), ash (967.05), CP (968.06), ether extract (920.39), and starch (amyloglucosidase-a-amylase method, 996.11). Dietary NDF, ADF and ADL were determined sequentially by using the filter bag system (Ankom Technology, New York) according to Mertens (2002), AOAC (2000; procedure 973.187) and Van Soest *et al* (1991), respectively.

Statistical analyses

The results obtained for the lactation trial were subjected to a repeated measures analysis using the MIXED procedure of SAS (Littell *et al*., 1996), and including in the model the reproductive rhythm (2), the period (2) and their interaction. A compound symmetry structure was fitted as it showed the highest value of the Schwarz Bayesian criterion (Littell *et al*, 1998). It considered that measures at all times had the same variance, and that all pairs of measures on the same animal had the same correlation. Parity order was used as linear covariate.

Data of the fattening trial were analysed as a completely randomised design with treatments arranged in a factorial structure in which the main sources of variation were the weaning age (2), the type of farm (2), the period (2) and their interactions, using the General Linear Model (GLM) procedure of SAS (Statistical Systems Institute Inc., Cary, NC). The cage was used as the experimental unit in the analysis of the fattening performance.

RESULTS AND DISCUSSION

Lactation trial

Parity order included as linear covariate had no effect on either of the traits studied in the lactating trial. The treatments had no effect (Table 2) either on the weight of the rabbit does at partum (4183 g, on average) and at weaning (4427 g, on average) or on the fertility (91.6%, on average). A similar effect was observed by Xiccato *et al*. (2005) when comparing does inseminated 2 or 11 d after parturition, finding that the reproductive rhythm had no influence either on weight or on fertility of rabbit does.

The number of young rabbits born alive increased in the second period (10.1 *vs*. 8.60; P=0.030), probably because that in the second cycle all the rabbit does had more than two parturitions. This result agrees with Quevedo *et al*. (2004) and Xiccato *et al*. (2004) who reported an increase of the females' prolificacy in the second parturition of the over the first. No significant differences between treatments were detected

Table 2: Effect of breeding system and period on lactating does' performance.

	Breeding System[1]		Period				
	IBS	SIBS	1	2	rsd[2]	P_{BS}[3]	P_P[3]
Number of animals	29	29	58	53			
Rabbit does' weight at:							
Parturition, g	4201	4166	4215	4155	142	0.65	0.32
Weaning, g	4465	4390	4394	4461	172	0.44	0.28
Number of young rabbits:							
Born alive	9.01	9.72	8.63	10.10	3.23	0.23	0.030
Born dead	0.60	0.33	0.48	0.45	1.35	0.31	0.902
Weaned	8.47	7.46	7.94	7.99	1.97	0.12	0.95
Young rabbits' mortality during lactation, %	9.6	19.1	12.5	16.1	12.2	0.067	0.36
Litter weight at weaning, g	3564	6535	4715	5364	761	<0.01	0.019
Parturition interval, d	48.6	52.6	50.1	51.1	19.7	0.21	0.801
Numerical Productivity[4]	67.9	62.2	64.9	65.2	21.9	0.38	0.96
Fertility, %	94.3	88.9	91.8	91.5	20.7	0.12	0.94

[1]IBS: intensive breeding system, SIBS: semi-intensive breeding system.
[2]rsd: residual standard deviation.
[3]P_{BS}: Probability of breeding system, P_P: Probability of period, Interaction $P_{BS\times P}$ was not significant (P>0.10) for the traits studied except for number of young rabbits weaned (P=0.062).
[4]Number of young rabbits weaned per rabbit doe per year.

for the number of kits born dead per litter, parturition interval and litter size at weaning (0.46, 50.7 d and 7.96 kits, on average, respectively). As a consequence, numerical productivity (65 young rabbit weaned per doe and year, on average) followed a similar trend, and differences between treatments did not reach significant levels. In a previous study, Nicodemus *et al*. (2002) compared the same reproductive rhythms over an 8-month production period, and observed that numerical productivity increased up to 73.4 kits weaned per cage and year in the intensive system as against 61.6 kits weaned per cage and year (P=0.003) in the semi-intensive rhythm. However, in the current study, natural mating was performed, and the does that failed to mate, to conceive or lost their pups, were immediately given the opportunity to remate, which led to a reduction of parturition interval. In the present study, only two cycles were analysed and rabbit does were inseminated 4 (IBS) or 11 (SIBS) d post-partum and those females that were not pregnant were reinseminated 35 or 42 d later, respectively.

On the other hand, an interaction between breeding system and period on the number of young rabbits weaned was found (P=0.062; Figure 1). So, in the first period, the number of young rabbits weaned per litter were similar for the two reproductive systems (7.89 and 8.01 for IBS and SIBS, respectively), whereas in the second cycle the number of rabbits weaned was lower in rabbit does that weaned their litters at 35 d of age (6.90 *vs*. 9.06; P=0.049). These results were related to those observed for the mortality of the young rabbits during the lactation period, which showed higher values (P=0.067) in the animals weaned at 35 d (19.1 *vs*. 9.60%). Nicodemus *et al*. (2002) also found a lower litter size at weaning in young rabbits weaned at 35 d than for those weaned at 25 d (7.42 *vs*. 8.21; P=0.05). This result might indicate a higher transmission of microbial contamination through the mother or the nest could occur in animals weaned later than in those weaned earlier, as was already suggested by Schlolaut (1988).

Litters weaned at 35 d of age showed a greater weight at weaning than those weaned at 25 d (6535 *vs*. 3564 g; P<0.01). However, it must be taken into account that these results are not directly comparable, because of the difference in weaning age between systems. On the other hand, the weaning weight of the litters was around 13.7% higher in the second cycle than in the first (P=0.019), probably due to the higher proportion of does with two parturitions or more in the second period. Several studies (Xiccato *et al*., 2004; Castellini *et al*., 2006; Quevedo *et al*., 2006) have already shown that the litter weight at weaning increased with the parity order, because milk production also increased.

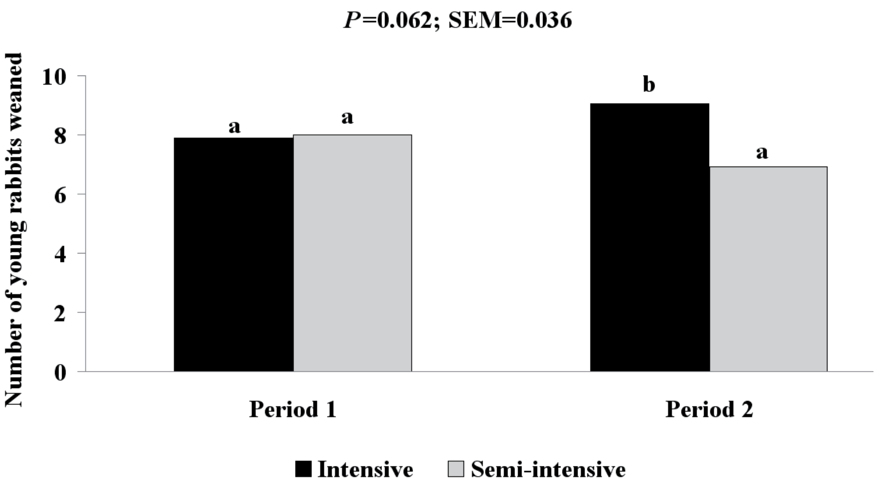

Figure 1: Interaction between reproductive rhythm and period on number of young rabbits weaned.

Table 3: Effect of breeding system, type of farm and period on mortality during fattening (%).

	Breeding system	
	Intensive	Semi-intensive
Period 1		
Disinfected farm	17.0	12.5
Non-disinfected farm	9.09	19.3
Period 2		
Disinfected farm	16.7	10.7
Non-disinfected farm	15.9	37.5
SEM[1]	4.08	
Probability		
Breeding system	0.063	
Farm	0.032	
Period	0.051	
Breeding system×farm	0.001	
Breeding system×period	0.39	
Farm×period	0.024	
Breeding system×farm×period	0.27	

[1] SEM: standard error of mean (n = 84)

Fattening trial

The effects of breeding system, farm and reproductive cycle on mortality during the fattening period are shown in Table 3. Rabbits weaned at 35 d showed a higher mortality percentage value (P=0.063) than those weaned at 25 d (20.0 and 14.7%, respectively, P=0.063), whereas those housed in the farm with no disinfection showed higher mortality than those in the cleaned one (20.0 and 14.2%, respectively; P=0.032). An interaction (P=0.001) between breeding system and type of farm was detected on mortality (Table 3), as it was higher for rabbits weaned at 35 d housed in the farm with no disinfection compared to the clean one (28.4 *vs.* 11.6%, P<0.05), whereas no effect was detected for rabbits weaned at 25 d (16.8 *vs.* 12.5% for the disinfected and no disinfected farm, respectively, P>0.05). This result might be

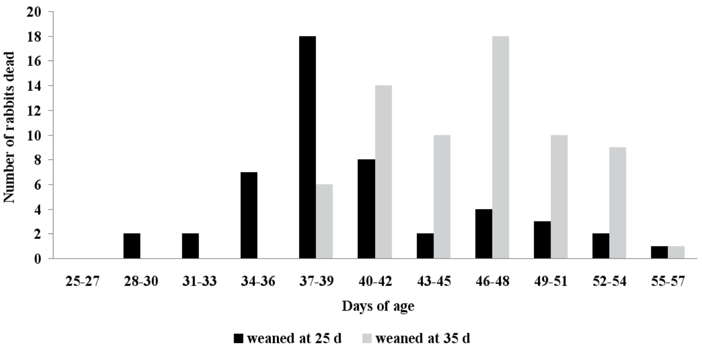

Figure 2: Effect of weaning age (25 *vs.* 35 d) on mortality distribution over the fattening period (data from periods 1 and 2).

Table 4: Effect of breeding system on fattening performance up to 56 days of age in the non-disinfected farm in the first reproductive cycle.

	Breeding system			
	Intensive	Semi-intensive	SEM[1]	*P*-value
No. rabbits/cage at 56 d	3.29	3.45	0.174	0.067
Initial weight, g/cage	1713	3261	29	0.001
Weight at 56 d, g/cage	6165	5708	179	0.073
Fattening feed intake, g/cage	10970	7552	233	0.001
Fattening feed efficiency, g /g	0.392	0.298	0.018	0.001

[1] SEM: standard error of mean (n = 21)

explained by an increase of pathogen transmission from the mother to the litter when weaning is delayed from 25 to 35 d, due to a longer contact between the mother and the litter (Schlolaut, 1988), which would have a greater effect on fattening mortality in the case of farms with poor cleaning and disinfection. However, the fact that animals weaned at 35 d were housed in the same breeding unit as those weaned at 25 d (but 10 d later) might have impaired the environmental conditions.

An interaction between the farm and the period on mortality was also found (P=0.024; Table 3), as it was similar (P>0.05) between farms in the first period, but it increased by 49% in the second reproductive cycle in the non-disinfected farm (13.7 *vs.* 26.7%, for the disinfected and non-disinfected farm, respectively, P<0.05). These results point out the importance of cleaning and disinfecting to reduce ambient microbial load and fattening mortality, especially when no medication is used (Romero *et al*., 2007).

The higher incidence of mortality occurred around two weeks after weaning in the two periods studied, independently of the weaning age (Figure 2). These results are in agreement with those obtained with rabbits inoculated with *E. Coli* 0103 whose morbility increased ten days after the inoculation independently of the age at which they were inoculated (21 or 35 d; Gallois *et al*., 2007). Furthermore, Romero *et al*. (2007) also found that mortality and caecal *Clostridium perfringens* counts increased 14 d post weaning in rabbits weaned at 28 or 42 d of age.

The effects of treatments on fattening traits are shown in Table 4. As expected, the initial weight per cage was higher in rabbits weaned at 35 d. However, the final weight per cage at 56 d tended to be lower in rabbits weaned at 35 d, because of the higher mortality observed in animals weaned at 35 d (9 *vs.* 19%) in the conditions of this trial. In fact, when the average finishing weight was calculated per rabbit no differences were detected between the two weaning ages. Feed efficiency was lower for animals weaned at 35 d, as mortality was higher and rabbits died later (at a higher weight) compared to those weaned at 25 d. However, the different period considered should be taken into account as feed efficiency is higher from 25 to 35 d of age than after that (Rodriguez *et al*., 1982).

CONCLUSIONS

The results of our study showed that, in our conditions, an intensive breeding system did not impair rabbit does' performance, and when weaning was brought forward from 35 to 25 d, mortality (during lactation and fattening period) and feed efficiency in the growing period were improved in a farm with a poor sanitary status. These results enhance the importance of a well programmed cleaning and disinfection, especially in non-medicated farms. On the other hand, the higher incidence of mortality occurred around two weeks after weaning in the two periods studied, independently of the weaning age and the hygiene of the farm.

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