Growth and Mortality of Suckling Rabbits

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Summary

Rabbits are usually smaller and mortality is higher in large litters. The aim of the study was to estimate effects on mortality and growth in rabbits. The study was carried out in Slovenian SIKA sire line. In total, 430 kits of 60 does were included. In the analyses the effects of parity, number of liveborn kits and number of teats were analysed. Initial weight was included in the model for mortality, while age was included in the model for growth. Parity, litter size and teat number affected all traits, except on mortality. Body weight varied according to age. A total of 430 kits were observed, corresponding to an average litter size of 7.8 kits born, 7.3 kits born alive and 6.2 kits weaned. The birth to weaning mortality was 15.35% and mortality has steadily declined with age. Average weight up to age of three days was 75 g and at weaning 1035 g. Kits in smaller litters had a higher growth rate.

Key words

rabbit, growth, mortality, litter size

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Received: June 29, 2011 | Accepted: July 12, 2011

Aim

Reproductive performance of rabbit does, as well as growth rate and mortality, are the factors that define the productive potential of rabbit farm. Effects, such as litters size, birth weight and chance of individual kit to find an available teat during lactation, affect mortality and growth in suckling rabbits. The purpose of study was to determine the impact of parity, litter size at birth, number of teats on growth and mortality in Slovenian SIKA sire line rabbits. In addition, the effects birth weight on mortality was focused upon.

Material and methods

Animals and housing. Rabbits of Slovenian SIKA terminal sire line were kept on the experimental farm at the University of Ljubljana. Litters were born between December 2010 and February 2011. Thus, only one litter per dam was considered. The study started with 430 kits from 50 litters.

The rabbits were housed in a heated, closed building in wire-net cages. Three days before expected parturition, nests were filled with hay and were removed when kits were about 21 days old. The minimum daily light period was 16 hours. Does were fed commercial diet *ad libitum*, and had unlimited access to water. All liveborn kits were individually identified by ear notching and weighed for the first time between birth and age of two days. Later, kits were weighed once a week until weaning at 35 days. Additionally, kits lost during observational period were weighted within the day after death.

Statistical Analysis. Statistical model (Eq. 1) for body weights at different ages and mortality contained parity, litter size expressed by number of liveborn kits, and teats number as class effects. Body weights were adjusted to the average age at each weight assessment by linear regression. The model for mortality comprised weight at the start as covariate.

$$y_{ijk} = \mu + P_i + L_j + T_k + b\,(x_{ijk} - x) + e_{ijk} \quad (1)$$

where:

y_{ijk} = weights at different ages / mortality

μ = intercept

P_i = parity (1, …, 6)

L_j = litter size (1, …, 7)

T_k = number of teats (1,2,3)

b = regression coefficient

x_{ijk} = age at each weight assessment (for weights) or initial weight (for mortality)

e_{ijk} = random error

Litters with no kits alive on the day of first weighings were excluded. Because the number of litters with less than six kits born alive was low, they were combined into one group designated as group "5-". Litters with more than 10 liveborn kits appeared seldom and were joined into group "11+". Maximum age differences were three days at the first and four days at later stages of experiment. Cross fostering was recorded, but it was ignored while it happened only once.

Data were analysed with GLM procedure in statistical package SAS/STAT (SAS User's Guide, 2002).

Results and discussion

The average litter size at birth (Figure 1) was of 7.83 born kits per litter. The number of stillbirths together with kits lost up to the first recording was 0.49 kits per litter, resulting in 7.33 kits born alive. Two thirds of rabbit does had 8 to 10 kits born per litter, while close to 80% of litters had six to 10 kits born alive. There were 15.4% losses from birth to weaning, having 430 kits at the beginning and 364 kits at the end of the experiment. Therefore, 6.21 kits were weaned per litter on the average. At most, 10 kits per litter were raised up to weaning. Larger litters with six or more kits weaned per litter appeared 3-times more frequent than smaller ones.

Cumulative mortality during observed period was 15.4% (Table 1). Mortality was the highest in the first week with 8.4%

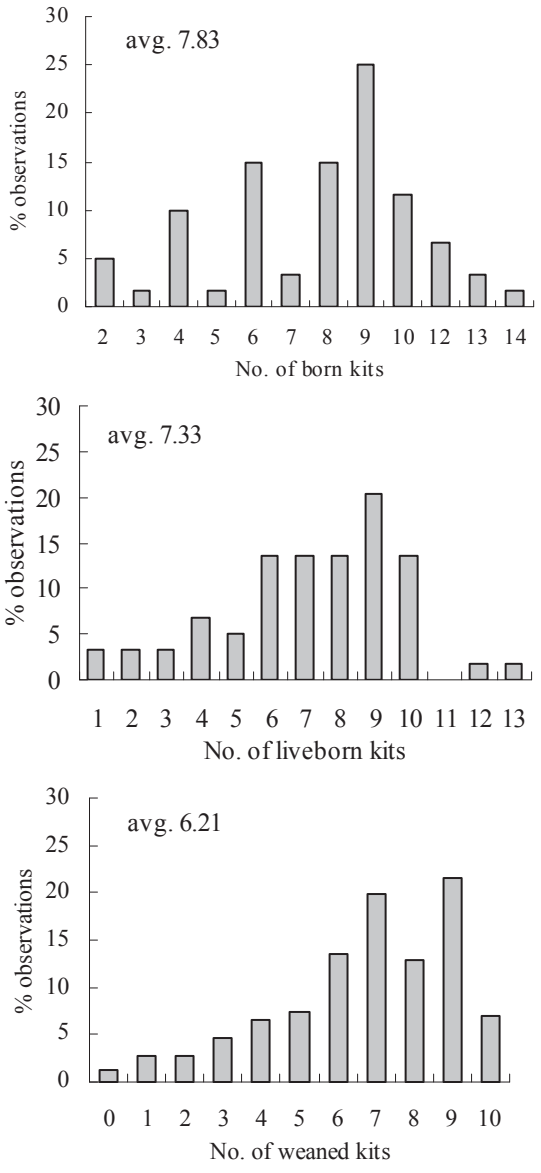

Figure 1. Litters size distribution

Table 1. Mortality of kits between birth and weaning

Age (week)	Mortality per week		Cumulative mortality		Body weight (g)	Daily gain (g/day)
	No.	%	No.	%		
1st	36	8.37	36	8.37	132	14.1
2nd	12	2.79	48	11.16	231	15.9
3rd	12	2.79	60	13.95	343	17.0
4th	5	1.17	65	15.12	551	40.7
5th	1	0.23	66	15.35	861	48.3

Table 2. Levels of significantly for effect included in the model for body weights and mortality in rabbit kits

	Parity	Litter size	Teat number	Age	Initial weight
Body weight*	<0.0007	<0.0001	<0.0008	<0.0013	/
Mortality	<0.0001	<0.0001	0.0942	/	0.4501

* maximum p-values in all body weights observed

Table 3. LSMeans for live body weight (± SEE, g) of rabbit kits by parity

Parity	Age at sequence weighting (days)					
	0-2	6-9	13-16	20-23	28-30	34-37
1 (N=106)	75^{b}± 1.7	167^{c}± 4.2	277^{b}± 6.3	389^{c}± 8.9	646^{b}± 13.3	974^{c}± 18.7
2 (N=92)	79^{ab}± 1.7	185^{ab}± 4.4	298^{a}± 6.5	430^{ab}± 9.2	698^{b}± 13.5	1027^{b}± 19.1
3 (N=119)	74^{ab}± 1.3	182^{abc}± 3.3	297^{ab}± 5.0	438^{ab}± 7.2	714^{b}± 11.0	1072^{b}± 15.5
4 (N=37)	72^{a}± 2.6	158^{abc}± 6.6	259^{ab}± 10.0	384^{bc}± 14.0	630^{b}± 22.3	1017^{b}± 31.3
5 (N=49)	77^{ab}± 2.4	178^{bc}± 6.0	311^{ab}± 9.3	453^{ab}± 18.4	749^{b}± 21.6	1068^{c}± 28.0
6 (N=27)	81^{a}± 3.3	178^{a}± 6.0	303^{a}± 12.1	451^{a}± 16.9	767^{a}± 25.7	1112^{a}± 36.5

Different letters in the same column indicate sign. ($p<0.05$) differences

kits dead, and has steadily declined with age. Some litters were checked one of two days after birth, losses before the first assessments were treated as stillbirth. Thus, mortality in the first week was most probably even higher. Average cumulative mortality in the first week was about 14%, which is slightly more than in the experiment of Poigner et al. (2000), where in first three week 13.3% of kits died. Losses in the last two weeks before weaning were relatively low, less then 1.5%.

Body weight increased rapidly in rabbits (Table 1). One week old kits weighed twice as much as at birth. They gained around 100 g per week before 21 days of age and thus, increased birth weight 5-times. Growth rate increased 2.4 times in the last two weeks of lactation while kits started to consume solid food. During the first week after birth, kits grew with the average rate of 14.1 g/d and the rate remained similar as long as the kits were on milk only. Just before weaning, kits gained almost 50 g/d.

Body weights (Table 2) were affected by parity, litter size, teat number of the dam, as well as age within each recording. Mortality depended on parity and litter size ($p<0.0001$). Teats number did not prove to be an important factor affecting losses in lactation ($p=0.0942$). Nevertheless, the trend was evident and needs to be checked when more records are collected. Unexpectedly, the initial weight did not show any effect on mortality. It is believed that lighter kits at birth are less competitive at suckling, obtaining less milk. Thus, they often become malnourished and even die due to starvation. The reason for unexpected results may be at least two fold. Firstly, the number of records is small in order to study mortality. Additionally, the initial weight was not weight at birth or at any other common starting point. Due to rapid growth of rabbit kits after birth, it is needed to define starting point in the future experiment more precisely.

Body weights increased by parity (Table 3). Kits were lighter in the first parity from day one to weaning. The udder of primiparous does are still developing during first lactation and are producing less milk. The initial weight as well as the weights at later stages was better in the second parity. On the other hand, the initial weights were lower in the third as well as in the forth parity mainly due to large litters. Nevertheless, the kits grew faster and the weaning weight did not differ in parities 2, 3, and 4. Initial as well as weaning weights were higher for kits born in fifth and sixth litter, which were smaller. The milk supply with elderly rabbit does was sufficient for their litters. Similar trends were observed by Rebollar et al. (2009) who reported that kits in the first litter were lighter than kits from later parities. Weight of kits at age of 35 days was 691 g for first parity and 755 g for fourth party.

Initial body weight of suckling rabbits as well as weights at later ages (Table 4) was affected by litter size. Average initial weight was decreasing from 85 g in litters with less than six kits to 66 g in litters with more than 11 kits. The differences were clear already at the initial weight and were increasing at all successive events up to weaning. In 35 days, weight was increased faster in smaller than in larger litters. The initial weight was lower for about 30%. Kits from smaller litters were heavier

Table 4. LSMeans for live body weight (± SEE, g) of rabbits kits by litter size

Litter Size	Age at sequence weighting (days)					
	0-2	6-9	13-16	20-23	28-30	34-37
5- (N=55)	$85^{a} \pm 2.0$	$220^{a} \pm 5.2$	$385^{a} \pm 7.9$	$564^{a} \pm 11.1$	$876^{a} \pm 17.3$	$1277^{a} \pm 24.9$
6 (N=48)	$84^{ab} \pm 2.2$	$195^{b} \pm 5.4$	$325^{b} \pm 8.4$	$482^{b} \pm 11.4$	$778^{b} \pm 17.4$	$1150^{b} \pm 24.5$
7 (N=56)	$80^{bc} \pm 2.3$	$194^{b} \pm 5.8$	$305^{c} \pm 8.8$	$451^{c} \pm 13.0$	$779^{b} \pm 19.6$	$1093^{c} \pm 25.0$
8 (N=64)	$70^{c} \pm 2.1$	$173^{c} \pm 5.3$	$292^{c} \pm 7.9$	$420^{cd} \pm 10.8$	$670^{c} \pm 16.7$	$1041^{c} \pm 23.1$
9 (N=108)	$77^{c} \pm 1.6$	$168^{c} \pm 4.0$	$276^{cd} \pm 5.9$	$394^{cd} \pm 8.2$	$677^{c} \pm 12.6$	$1006^{c} \pm 17.8$
10 (N=79)	$71^{cd} \pm 1.9$	$160^{c} \pm 4.7$	$256^{c} \pm 6.5$	$363^{cde} \pm 9.7$	$597^{c} \pm 14.6$	$937^{c} \pm 21.0$
11+ (N=20)	$66^{cd} \pm 3.5$	$128^{c} \pm 8.8$	$197^{d} \pm 13.5$	$296^{e} \pm 19.3$	$529^{c} \pm 29.7$	$812^{d} \pm 28.7$

Different letters in the same column indicate sign. ($p<0.05$) differences

Table 5. Body weight (± SEE, g) of rabbit kits alive at weaning by teat number

Teat Number	Age at sequence weighting (days)					
	0-2	6-9	13-16	20-23	28-30	34-37
8 (N=166)	$71^{c} \pm 1.4$	$166^{b} \pm 3.5$	$269^{b} \pm 5.3$	$401^{b} \pm 7.8$	$656^{b} \pm 11.8$	$988^{c} \pm 16.9$
9 (N=74)	$80^{b} \pm 1.9$	$188^{a} \pm 4.8$	$310^{a} \pm 7.1$	$440^{a} \pm 9.9$	$720^{a} \pm 15.1$	$1052^{b} \pm 21.3$
10 (N=178)	$77^{a} \pm 1.4$	$177^{a} \pm 3.5$	$294^{a} \pm 5.3$	$432^{a} \pm 7.2$	$716^{a} \pm 11.2$	$1096^{a} \pm 15.7$

because of better nourishment in both prenatal and postnatal phases. Therefore, the results are expected, while kits in smaller litters have better starting weight, get more milk and consume more solid food in the last two weeks before weaning.

Average weight, measured within the first two days after birth, was 75 g (Table 3). Final weight in the experiment, obtained at weaning, was at the average 1035 g. Average weaning weight of kits in litters with 10 or more kits did not exceeding 1000 g in comparison with kits form smaller litters, where weaning weight was between 1006 g and 1276 g. Results were comparable to that of Poigner et al. (2000). Similar trend of higher growth rate in small litters was also observed in Farougou *et al.* (2006).

All rabbits had eight, nine or 10 teats, counted after the first parturition (Table 5). If dam had 9 or 10 functional teats, kits were heavier at birth and during suckling period than kits of dams with eight teats. Kits suckling nine or 10 teats did not differ much in weight or growth. Teats number in Fayeye and Ayorinde (2008, 2010) did not affect litter weight.

Mortality changed by litter size (Figure 2a). Losses were expectedly larger in small (5-) and large (+11) litters. In small litters, the losses were almost 50%. Litters with 11 or more kits had higher losses as well (28.6%). Kits died usually due to small birth weight and malnutrition. Mortality was around 10% in litters with six kits and was doubled in litters with one additional kit. With increased litter size, mortality was reduced for close to 5% per additional kit. It would be expected an increasing trend for mortality with litter size increased. No explanation was found except uncertainty because of low number of observation. Poigner et al. (2000) checked mortality in standardized litters to six or 10 kits in two experiments. In the first experiment, losses were higher than in the second one. They reported much higher losses between birth to age of 21 days in larger litters (35.2% and 18.0%) than smaller litters with six kits (8.1% and 5.6%).

The effect of litter size on kits mortality is connected also with the chance of individual kit to find an available teat during lactation (Krogmeier and Dzapo, 1991; Poigner et al., 2000). With increasing litter size, the milk consumed by a kit is reduced (Ferguson et al., 1997). The result is higher mortality, which was

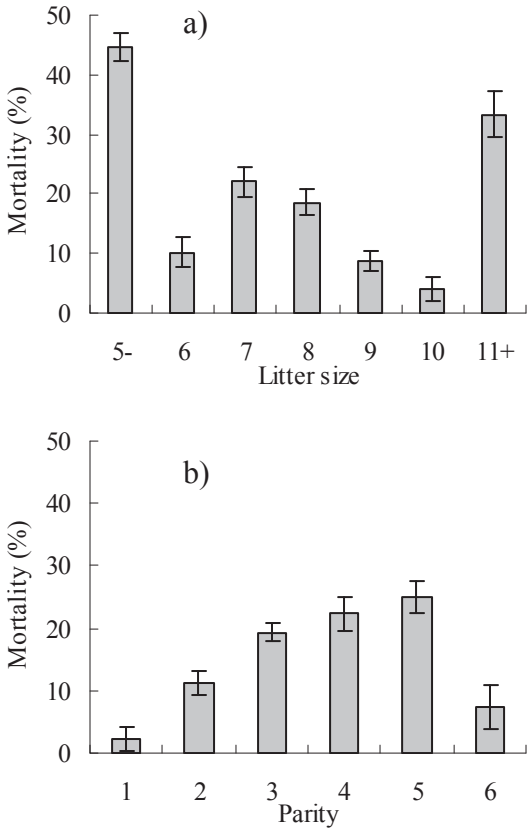

Figure 2. Mortality of kits by litter size (a) and by parity (b)

confirmed in our experiment. Higher mortality in smaller litters can be a consequence of the calculation: for example, death of only one kit in the litter of one liveborn is 100%. Mortality increased from the first to the fifth litter (Figure 2b) and felt started to decline again in sixth parity. The highest mortality (25.0%) was in the fifth litter. These losses are results of the litter size. Fifth parity litters were small (five or less kits) or large (10 or more kits). Mortality in those litters was the highest (Figure 2a).

Conclusions

Relationship between litter size and mortality was confirmed in Slovenian SIKA rabbit terminal line, as well. Furthermore, it was also found statistically significant association between litter size and growth of rabbits ($p<0.05$). Further research with larger number of animals is needed to clarify the effect of smaller litter size on mortality of rabbit kits.

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