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Original Paper

Growth of suckled rabbit kits depending on litter size at birth

David Zapletal[1]*, Dominika Švancarová[1], Branislav Gálik[2]
[1]*University of Veterinary and Pharmaceutical Sciences Brno, Faculty of Veterinary Hygiene and Ecology, Department of Animal Breeding, Animal Hygiene and Biochemistry, Czech Republic*
[2]*Slovak University of Agriculture in Nitra, Faculty of Agrobiology and Food Resources, Department of Animal Nutrition, Slovakia*

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Standardization of litter size after birth is a common management practice used on broiler rabbit farms to optimize the growth intensity of kits in the litter. The aim of the present study was to evaluate the effect of the litter size at birth before the standardization performed on the subsequent growth intensity of suckled HYPLUS broiler rabbit kits. A total of 70 litters with a total of 639 newborn kits were selected for evaluation, while assessed litter sizes at birth covered 7 to 12 kits per litter. The assessed levels of litter sizes at kindling did not show significant differences in the average birth weight of the kits. Although the litter size was standardized to 8 kits for primiparous and to 9 kits for multiparous does on the first day after birth, the intrinsic litter size of does at kindling had a highly significant effect on the average live weight (LW) of 19-day old suckled kits (P <0.01). The average LW of kits at this age were higher in females which kindled 7 and 8 kits in litter compared to females in which the number of kits born in the litter was between 9 and 12. The same trend as in the case of LW was found for average daily gain values, while its higher values (P <0.01) were found in litters where does kindled only 7 and 8 kits per litter (19.1 and 17.9 g day^{-1}, resp.) in contrast to litters in which does kindled 9 to 12 kits per litter (14.0 to 15.4 g day^{-1}). The performed standardization of litter size in the involved farm thus was not a sufficient management practice to reduce the variability of the average LW of suckled kits at 19 days of age.

Keywords: broiler rabbit, does, litter standardization, nursing, pre-weaning period

1 Introduction

Generally, growth of an animal is affected by complex mechanisms, acting in para-, endo- and autocrine ways (Migdal et al., 2019) and growth as such is considerably important in rabbit meat production (Blasco et al., 2018). Growth of the new-born rabbit kits depends on the amount of suckled milk, while mainly for a small kit it is important to suck milk immediately after its birth (Szendrö et al., 2019). Rödel et al. (2008) observed that small kits consume a lower amount of milk and the differences in milk intake between the smaller and larger kits increased between days 3 to 7 *post partum*. To achieve good viability of rabbit kits, it is important for new-born kits to display an adequate birth weight compared to their littermates. In this case the kits should occupy a proper warm site in the middle of nest to maintain required body temperature (Bautista et al., 2008) and then consume sufficient amount of milk during a short nursing time; these aspects influence considerably their future growth. Moreover, rabbit kits with a higher birth weight display a higher live weight (LW) later on (Reyes-Meza et al., 2011; Szendrö et al., 2019).

Breeding programs for rabbit meat production involve usually a three-way cross of specifically selected lines in which paternal line bucks inseminate maternal crossbred does (Juárez et al., 2020). Recent genetic selection programs for reproductive traits in maternal lines of meat-type rabbits have focused mainly on the improving litter size (Pascual et al., 2013). In addition, dam lines of crossbred rabbits are selected also for the improvement of maternal capacity, including mainly high fertility and high milk production (Ludwiczak et al., 2020).

***Corresponding Author:** David Zapletal, University of Veterinary and Pharmaceutical Sciences Brno, Faculty of Veterinary Hygiene and Ecology, Department of Animal Breeding, Animal Nutrition and Biochemistry, Palackého třída 1946/1, 612 42 Brno, Czech Republic; e-mail: zapletald@vfu.cz

The quantity and quality of milk production significantly influences the pre-weaning growth intensity of rabbit kits (Ludwiczak et al., 2020). Postpartum litter standardization is currently performed on meat-type rabbit does to 7–8 or 9–11 kits per litter in primiparous and multiparous does, respectively (Dalle Zotte et al., 2013; Alfonso-Carrillo et al., 2014; Fik, 2020). One of the reasons for rabbit litter standardisation (fostering) is to give all the kits in the litter the same chance to suck (Szendrö et al., 2012), while successful standardisation (fostering) is closely related to equalizing not only the number of kits but also the weights of kits within a litter (Poigner et al., 2000). Rabbit does have most frequently 8–10 teats, whereas their number distribution differs among genotypes of does. Even though the does having higher number of teats usually do not produce more milk due to the fact that mammary gland size is not associated with the number of teats, the does with higher teat numbers show better nursing ability (Szendrö et al., 2012).

Ludwiczak et al. (2020) found that the amount of daily milk production, in the course of the whole lactation, was higher for does nursing a higher number of kits per litter (10 vs. 8 kits). Besides that, Palka et al. (2018) reported that the growth rate of rabbit kits in the pre-weaning period is also considerably affected by the litter size at birth. The aim of the present study was to evaluate the effect of the litter size at birth before the standardization performed on the subsequent growth intensity of suckled HYPLUS broiler rabbits.

2 Material and methods

2.1 Animals, husbandry conditions and nutrition

The study was performed on a private smaller farm of HYPLUS broiler rabbits, with an average of 80 breeding does. All breeding does were housed in the same environmental conditions using cage technology. All-wire cages for breeding females with their young until weaning were 32 cm high, 41 cm wide and 88 cm deep. Plastic nests measuring 40 × 25 × 25 cm were attached to the cages. A batch kindling system was applied in does breeding, where after each removal of the group there was a mechanical cleaning with subsequent disinfection. All rabbits included in the study received the same commercial pelleted feed for nutrition of lactating does K – Optimum (De Heus, a.s.) at the same dose with respect to the particular stage of the reproductive cycle of does. The nutrient composition of the pelleted feed used for nutrition of does is given in Table 1. Water was provided by automatic nipple drinkers *ad libitum*.

Regarding reproduction management, the does of HYPLUS PS 19 line were inseminated in respective batches with a heterospermic insemination dose derived from the commercial crossbred sires of the HYPLUS PS 59 line. Nulliparous does were first inseminated at 18–19 weeks of age. Lactating does were inseminated between the 14th and 16th day *post partum*. The proportion of does in the breeding group in terms of their parity was as follows: 25% on the 1st parity, 23% on the 2nd parity, 14% on the 3rd parity, 22% on the 4th–7th parity and 16% on the 8th and higher parity. Weaning of the kits was performed at the age of 35 days.

Table 1 Chemical composition of pelleted feed (in dry matter basis)

Item	Content
Dry matter (g kg^{-1})	1,000.0
Crude protein (g kg^{-1})	181.2
Crude fibre (g kg^{-1})	138.4
ADF (g kg^{-1})	194.7
NDF (g kg^{-1})	412.8
ADL (g kg^{-1})	52.5
Crude fat (g kg^{-1})	47.7
Crude starch (g kg^{-1})	183.0
Ash (g kg^{-1})	82.3
Calcium (g kg^{-1})	12.1
Inorganic phosphorus (g kg^{-1})	6.2
NaCl (g kg^{-1})	5.02
Gross energy (MJ kg^{-1})	18.5

ADF – acid detergent fibre, NDF – neutral detergent fibre, ADL – acid detergent lignin

2.2 Study design

The study itself was performed in four consecutive evaluated insemination batches, in which the kits were individually weighed and their live weight was always recorded on the 1st and 19th day of age from 10 am to 12 am. After the birth of the kits, the litter was standardized within 24 hours, leaving 8 kits for all primiparous and 9 kits for all multiparous does. Before the intrinsic litter standardization, all newborn kits were weighed on a digital laboratory scale with an accuracy of 0.1 g. A total of 70 litters with a total of 639 newborn kits were selected for evaluation. Further individual weighing of suckled kits was always performed on the 19th day of their age, to the nearest 1 g; in all cases, kits at this age had not yet received solid feeds. The difference between the average live weight of the kits in the individual litters between the 1st and 19th day of age was used to determine the average daily gain (ADG) of suckled kits.

2.3 Statistical analysis

The data were assessed by the STATISTICA CZ version 10 software. To test the normal distribution of the data within the assessed groups, the Shapiro-Wilk test was used. Normality was found in all monitored variables. One-way ANOVA was used for determination the differences in the LW and ADG of kits among evaluated groups of litters. If ANOVA showed significant differences among evaluated groups, a HSD post-hoc test was used. Significance was considered at $P < 0.01$.

3 Results and discussion

To evaluate the effect of litter size before its standardization on the growth intensity of suckled kits, litter sizes from 7 to 12 kits born were selected in the present study, whereas the lowest number of litters for the evaluated litter size was 4 (litter size of 12 kits born). As can be seen from Table 2, the assessed levels of litter sizes at kindling did not show significant differences in the average birth weight of the kits. The average number of total born kits in the litter within the assessed doe population of HYPLUS PS19 line, including the sizes of litter that were low in the population (litter size of 5, 6, 13, 14 and 17 kits), was 9.4 kits litter^{-1}. By contrast, Tůma et al. (2010) in their previous study observed in same commercial line (genotype) of does the average litter size of 8.3 kits litter^{-1} during one year in the production rabbit farm.

Although the litter size was standardized to 8 kits for primiparous and to 9 kits for multiparous does on the first day after birth, the intrinsic litter size of does at kindling had a highly significant effect on the average LW of 19-day old suckled kits ($P < 0.01$). The average weights of kits at this age were higher in females which kindled the 7 and 8 kits in litter compared to females in which the number of kits born in the litter was between 9 and 12. In addition, values of LW in 19-day old sucked kits of the present study were similar to that (340–353 g) found by Castellini et al. (2003) in kits of dams (New Zealand White does) in which the litter size was standardized to 6 kits after kindling. A similar LW of kits at 21 days of age was found also by Šimek et al. (2019) in the Blanc de Hotot breed. In contrast, the significantly lower LW of 19-day old kits found Castellini et al. (2003) in litters, where *post partum* standardization was performed to 8 kits (292 g). Slightly lower LW of kits at 21 days of age also reported Fik et al. (2018) in the Nitra rabbit breed.

The exact same trend as in the case of LW was found in the present study for ADG values, while its higher values ($P < 0.01$) were found in litters where does kindled only 7 and 8 kits per litter (19.1 and 17.9 g day^{-1}, respectively) in contrast to litters in which does kindled 9 to 12 kits per litter (14.0 to 15.4 g day^{-1}), whereas does nursed a similar number of kits in the assessed litters. Ludwiczak et al. (2020) found that the individual kit´s weight gain from day 2 to 21 was not affected by the litter size of does (8 vs. 10 nursing kits litter^{-1}). It has been found that correlation between the weight gain of litters (from kindling to 21 days) and the milk production of does is very strong, $r = 0.9$ (Fortun-Lamothe et al., 2003). Maertens et al. (2006) state that the highest milk yield of nursing does occurs at 18 to 20 days *post partum*, while in multiparous females exposed to intensive reproductive rhythm, milk production peaks usually 2–3 days earlier. Volek et al. (2014) reported that milk efficiency of does, expressing the amount of weight gain of kits relative to their total milk intake, reached for the evaluated period of 21 days *post partum* the values of 0.49 and 0.51 g g^{-1}; in that study, milk efficiency was demonstrably influenced by the used diet of lactating does. This finding is confirmed by the common knowledge that per 1 g of LW gain, a suckling rabbit kit needs to receive approximately 2 g of doe's milk. The increase in milk yield of does with the litter size is frequently reported in studies and this is explained by the fact that kits stimulate the activity of mammary glands by suckling (Maertens et al., 2006; Chrenek et al., 2007). Thus, it could be assumed that does with a higher size of born kits in the litter should not be significantly limited by their subsequent milk yield. However, as can be seen from the findings of the present study, the higher size of litter in does contrarily led to a lower litter weight gain of suckled kits, although litter standardization was performed in all of the evaluated litter sizes in the present study. The lower growth intensity of kits, respectively the milk yield of does in litters, where 9–12 kits were born, to some extent confirms the findings of Pascual et al. (2013), that when does are subjected to the intensive reproduction rhythm, it can make them unable to meet the energetic needs for lactation of multiple litters. Thus, milk production can decrease as the priority of restoring reserves for future litter starts to raise. Moreover, if does are simultaneously pregnant and lactating, they must subdivide the ingested nutrients for the maintenance requirement, growth of foetuses and milk for suckling kits, and thus nutritional competition can happen. This situation can be detrimental to the foetuses and suckling kits and to the does as well (Parigi-Bini et al., 1992; Szendrö et al., 2019).

Besides that, Volek et al. (2014) reported a slightly lower ADG of suckling broiler rabbit kits than those found in the present study. In the study of Volek et al. (2014), ADG values ranged from 12.5 to 13.9 g in relation to the diet used to feed does; however, the observed period in the mentioned study was slightly longer (21 days *post partum*) than the monitored period of the present study.

Table 2 Effect of litter size at birth on the live weight (LW) and average daily gain (ADG) of suckled rabbit kits

Number of born kits in litter	Litters (n)	LW (g)						ADG of suckling kits (g)	
		day 1			day 19				
		number of kits	*x*	SEM	number of kits	*x*	SEM	*x*	SEM
7	9	63	63.8	2.10	62	408.1A	9.83	19.1A	0.56
8	12	96	62.5	2.44	88	384.7A	6.90	17.9A	0.41
9	24	216	62.2	1.48	202	329.8B	4.34	14.9B	0.25
10	15	150	62.6	1.45	125	330.5B	5.00	14.9B	0.29
11	6	66	62.2	1.08	44	318.2B	6.21	14.0B	0.35
12	4	48	63.4	1.24	33	340.6A,B	12.35	15.4A,B	0.69
Significance			ns	–	–	**	–	**	–

x – arithmetic mean, SEM – standard error of the mean, ns – non significant, (**), A,B – means within a column with different superscript letters differ at $P < 0.01$

Based on the results obtained in the present study, the question arises as to whether rabbit farmers in our common production farms of broiler rabbits that applying intensive reproductive rhythm, especially in cases with only average hygienic housing conditions, should still prefer only high prolific maternal lines of broiler rabbits for breeding that kindle high average numbers of kits in litters (some more than 11 kits litter^{-1})? In addition to the lower ADG of suckled kits from higher litter sizes in the present study, some other troubles arise from the high average litter size for farmers – "dispose" of excess kits from a kindling batch, sometimes also higher culling rate of breeding does exposed to intensive reproductive rhythm, or deterioration of health and welfare of these does. In the case of selective breeding of dam lines of meat-type crossbred rabbits, it would be appropriate to focus on the creation of specific lines that would kindle only the limited average number of kits in litter (e.g. up to 9) and would be more selected for the higher fertilization rate, the balance of birth weight of kits, milk yield and especially for the resistance to common diseases occurring in today's common commercial farms.

4 Conclusions

Standardization of litter size after birth is a common management practice used on broiler rabbit farms to optimize the growth intensity of all selected kits in the litter during their pre-weaning period. The aim of litter standardization after birth is on the one hand to achieve a balanced group of weaned kits with respect to their LW and on the other hand to effectively use milk yield of their does respecting the related physiological functions of the rabbit doe, especially preventing its productive metabolic overloading.

The results of the present study show that although *post partum* standardization of the litter was performed to 8 kits per litter in all primiparous does and to 9 kits per litter in all multiparous does, the intrinsic litter size at birth had a highly significant effect on the growth intensity of suckling kits from day 1 to 19. Specifically, the significantly higher LW of 19 day-old kits and also higher ADG values for the monitored nursing period were displayed in those litters in which kindled 7 and 8 kits per litter as compared to litters, in which does kindled 9–12 kits per litter. Thus, the standardization of litter size in the involved farm of the present study was not a sufficient practice to reduce the variability of the average LW of suckled kits at 19 days of age. To generalize the findings from the present study, it would be appropriate to perform further studies, which would include larger numbers of litters with particular litter sizes, as well as other genotypes of does.

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