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Effect of does parity order on litter homogeneity parameters

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ABSTRACT
In rabbits' reproductive performance, litter size, birth weight, growth, and mortality rate are among the most important indicators to define the productive potential and they are associated with parity order. Birth weight and little size are valuable parameters as related to mortality and weaning weight. Thus, it is important to study individual newborn and intra-litter homogeneity parameters. This trial aimed to consider the litter homogeneity weight at birth, both within each litter and in the whole population, in order to suggest new proper within-litter homogenisation parameters. In this study, the 1st and 6th parity order had, respectively, the lowest and highest values in litter size (8.96 vs 12.39, n), born-alive (8.36 vs 12.22, n), litter weight (456.4 g vs 719.8, g), born-alive weight, and quartiles' homogeneity. These parameters decreased in greater parity orders. No significant effects on still-born numbers and mortality rates were evidenced. All these litter homogeneity evaluation parameters appeared interesting in describing differences between parity orders. The results confirmed that does parity order influences litter size and born-alive weight, but also the intra- and inter-litter homogenisation. Litter homogenisation is crucial to ensure a proportionate share of milk, more equal growth, and better productive performances. Based on these results, we suggest for the commercial genetic centres to equalise the litters according to the birth weight, by dividing the population into quartiles and rearing kits with light birth weight in smaller litters and those with heavier birth weight in larger litters.

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KEYWORDS
Rabbit; does reproduction; parity order; litter homogeneity; kits viability

HIGHLIGHTS

- Does parity order influences litter size and born-alive weight
- Kit's quartiles distribution is a useful tool for equalisation practice

Abbreviations: Prim: primiparous does; Plur: pluriparous does; AI: artificial insemination; LS: litter size; LW: litter weight; MR: mortality rate; BA: born-alive number; SB: still-born number; BAW: born-alive weight; mn-BAW: mean born-alive weight; sd-BAW: intra-litter standard deviation born-alive weight; 1st q-BAW: first quartile born-alive weight; 3rd q-BAW: third quartile born-alive weight

Introduction

In the last decades, breeding strategies have been implemented in the rabbit industry to increase its efficiency and sustainability. In Italy, the genetic selection is operated by 'Libro Genealogico della specie cunicola' (D.M. 18.11.72) and then demanded to the Italian Breeders Association (Associazione Italiana Allevatori, D.M. 24.11.1981). However, concurrently to this activity, private companies have implemented selection lines and produced patented hybrids.

Reproductive performance of rabbit does (Castellini et al. 2010), milk production and quality (Ludwiczak et al. 2020), as well as litter size (LS) and litter weight at birth (LW), growth rate and mortality rate (MR), are useful indicators of the productive potential within a rabbit farm (Rebollar et al. 2009; Szendrő et al. 2019). In rabbits, the variation of LW, individual LW, and LS are associated with parity order; for example, LS is substantially lower in the first kindling compared to the subsequent litters (Szendrő 2000). Moreover, LS increases with parity number, while the average weight of kits born alive decreases (Xiccato et al. 2004). Individual birth weight is about 60–70 g, but it can range from 35–40 to 80–90 g (Poigner et al. 2000a,b).

Breeding strategies have successfully contributed to increasing LS and number of born kits (total or alive);

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however, weight at birth, particularly in larger litters, is still less homogeneous (Vicente et al. 1995; Lenoir et al. 2012). High birth weight represents a basic parameter in the management of a rabbit farm, because it is associated to lower MR (Szendrő et al. 1996; Di Meo et al. 2004) and to higher weight at weaning (Di Meo et al. 2004). For example, Szendrő and Barna (1984) observed an MR of about 50% in young rabbits between 35 and 45 g due to the reduction of energy reserves and consequently of the thermoregulatory capacity, while beyond this weight the MR reduced to 7%. Moreover, LS is correlated to the weight gained by suckling rabbits at weaning: indeed, kits of larger and heterogeneous litters are generally characterised by lower weight at weaning than kits of smaller litters for the corresponding weight (Poigner et al. 2000a,b; Szendrő et al. 2019). This is due to the chance of kits to find an available teat during suckling period and on their milk intake (Ludwiczak et al. 2020). LS is negatively associated to the individual milk share (Lebas 1975, Ferguson et al. 1997), due to reduced access to the teat (Szendrő and Kampits 1985) and heterogenous kits size (Lenoir et al. 2012; Blasco et al. 2017). At the same time, LS increase is connected with several problems related to the health status and welfare of does lead to high rates of mortality in their offspring, high rate of culling and a low rate of production (Minuti et al. 2020).

For these reasons, it is of primary importance to obtain a high individual weight and an intra-litter homogeneity weight at birth in order to reduce the MR, to increase the weight at weaning and, consequently, to improve the productive potential of the farm (Szendrő et al. 2019). A relevant number of studies have been published on the relationship between parity order and LS, and on LW and at weaning (Poigner et al. 2000a,b; Di Meo et al. 2004; Szendrő et al. 2019). Bolet et al. (2007), investigated the effectiveness of genetic selection for higher uniformity of birth weight within-litter and they concluded that breeding strategies aiming at decreasing the within-litter standard deviation of birth weight have positive implications on the reproductive performance of rabbit does. A way to reduce the high MR due to low birth weight is the practice of litter equalisation, applied in many rabbit farms. In this way, the rabbit does nurse the same number of newborn kits with a similar weight. As a result of equalisation, the heavier kits do not suppress the weak contemporaries, so the latter has a similar chance of survival, having more chance to access a teat during the short nursing time (Szendrő et al. 2019). Researchers demonstrate that in the homogenised litter for birth weight, mortality in the pre-weaning period is reduced from 13.3 to 10%, compared to heterogeneous litters (Poigner et al. 2000a,b). Even though equalisation is a widespread procedure, only limited experimental results have been published (Szendrő et al. 2019).

Although the effect of the parity order on reproductive parameters has previously been studied in rabbits, the aim of our research was to study in field conditions the litter homogeneity and the possibility to introduce the quartile's distribution as a novel inter-litter homogeneity tool.

Materials and methods

The trial was carried out at the farm level, under the control of the public veterinary service, and did not need approval by the University of Bologna, Animal Care, and Use Committee, according to Italian legislation (D.lgs. 26/2014).

Rearing building, equipment and management

The trial was carried out in Martini Group S.p.A. genetic centre located in the Emilia Romagna region (Italy). The commercial hybrid line (Genetica Martini hybrid, Santa Maria Codifiume, FE, Italy) is characterised by a high specialisation in meat production (44 g/d of average daily gain with peaks up to 60 g/d), white colour and the adult body weight of 4.5 and 6 kg for females and males, respectively. Hybrid lines were homogeneous and internally selected by the genetic centre. The artificial insemination (AI) protocol adopted during the trial was composed as follows. Briefly, nulliparous does start the reproduction program when aged 19–20 weeks and weighted 3.7–3.8 kg, males when aged 10 weeks with at least 3.2 kg. The average open does' weight was 3.8 and 4.5 kg for primiparous and pluriparous, respectively. Does were AI 11 d after kindling. The does were housed in two different brick sheds with a temperature ranging between 18–28 °C, with a conditioning air system and submitted to a constant photoperiod of 16-h light and 8-h darkness. The animals were kept in individual cages from AI to parturition. Does were bred individually, in cages ($410 \times 940 \times 400\ mm^3$) made of galvanised wire net equipped with automatic drinker and manual feeder. The cages were equipped with a nest box ($410 \times 210 \times 300\ mm^3$) made of galvanised sheet walls and a double wire floor, with manual closure. The nest was prepared with a mixture of wood shavings and chopped straw, and it was

Table 1. Composition of the diets fed to does (as fed).

	Lactation[a]	Pre-weaning[b]
Chemical composition, %		
Crude protein, %	17.30	16.20
Ether extract, %	3.90	3.30
Ash, %	7.80	8.20
Crude fibre, %	15.6	17.30
Calcium, %	0.97	1.20
Phosphorus, %	0.55	0.54
Sodium, %	0.21	0.21
Lysine, %	0.78	0.77
Methionine, %	0.29	0.26
Vitamins, minerals and additives, per kg		
Vit. A, UI	15,000	15,000
Vit. D3, UI	1500	1500
Vit. E, mg	90	100
Mn, mg	50	50
Zn, mg	70	70
Co, mg	0.13	0.13
Cu, mg	10	10
Fe, mg	150	150
I, mg	3	3
Se, mg	0.10	0.10
Robenidine cloridate, mg	66	66
Formic acid, mg	1125	1125

[a]Lactation diet ingredients: wheat bran, alfalfa meal, barley, partially decorticated sunflower extraction meal, decorticated sunflower extraction meal, dehydrated alfalfa meal, wheat middling, dehydrated beat pulp, grass hay meal, cane molasses, wheat, corn oil, calcium carbonate, sodium chloride, palm oil, magnesium oxide.

[b]Pre-weaning diet ingredients: partially decorticated sunflower extraction meal, wheat bran, barley, dehydrated beat pulp, dehydrated alfalfa meal, alfalfa meal, wheat middling, grapeseed extraction meal, grass hay meal, cane molasses, decorticated sunflower extraction meal, calcium carbonate, corn oil, sodium chloride, magnesium oxide.

attached to the front side of the maternal cage just before kindling. Until the 10th day of pregnancy, they are fed *ad-libitum* with the 'Lactation diet', then with the 'Pre-weaning diet'; the latest contained almost the same ingredients as the first one but at different inclusion rates. The chemical composition and nutritive value of the diets followed the recommendations of De Blas and Mateos (1998), listed in Table 1. The chemical analysis of the two diets was made according to the AOAC official methods (AOAC International 2016) for dry matter (oven drying method), ash (muffle furnace incineration), ether extract (solvent extraction), crude protein (Kjeldahl method) and crude fibre (Weende method) determinations.

Animals and experimental measurements

The measurements were performed twice in spring, within 15 days from each other, according to the insemination protocol used in the genetic centre, previously explained. All the parturient does that were in the centre on those dates were enrolled in the study. Does' individual weight was not recorded to avoid an excess of stress to the commercial farm animals. A total of 531 does, delivering 5301 kits, at different parity orders were involved; 176 (33.15%) primiparous and 355 (66.85%) pluriparous (from the 2nd to the 17th parturition). The proportions of the pluriparous were the following: 15.63% 2nd, 15.63% 3rd, 10.73% 4th, 11.86% 5th, 6.78% 6th, 3.39% 7th, 5.46% 8th, 4.33% 9th and 3.77% from the 10th to the 17th parturition, that due to low numerosity were grouped in the same group (1.88% 10th, 1.13% 11th, 0.38% 12th, 0.19% 13th and 0.19% 17th parturition).

Within 24 hours from the delivery, the reproductive and litters data, for example, LS, born-alive number (BA), and still-born number (SB) per delivery, were recorded. Each born-alive kit was individually weighed using an electronic scale of 3000 g capacity and 1 g resolution (Soehnle, Nassau an der Lahn, Germany). Total LW was calculated as the sum of all individual alive newborn weights within the litter. The MR was calculated as SB/LS $\times$ 100. The other parameters evaluated in the present study were (i) number of born-alive kits $<$45 g (BAW $<$45 g *n*); (ii) percentage of born-alive kits $<$45 g (BAW $<$ 45 g %); (iii) Mean born-alive weight (mn-BAW); (iv) standard deviation born-alive weight (sd-BAW); (v) and (vi) 1st and 3rd quartiles born-alive weight number (1st and 3rd q-BAW *n*); (vii) and (viii) 1st and 3rd quartiles born-alive weight number (1st and 3rd q-BAW %).

Considering the entire sample, mn-BAW, intra-litter sd-BAW, and 1st and 3rd q-BAW resulted on average 59.39, 12.57, 51, and 58 g, respectively. The 1st and 3rd q-BAW thresholds were used for comparing each BAW grouped by parity order. The born-alive distribution parameters 1st–3rd q-BAW, $<$1st q-BAW, $>$3rd q-BAW, number (*n*) and percentage (%) were evaluated. Kits included in 1st–3rd q-BAW represented the population part most homogeneous in weight; this part is between the 25% lighter ($<$1st q-BAW $=$ 51 g), and the 25% heavier ($>$3rd q-BAW $=$ 68 g).

Statistical analysis

This study aimed to describe litter homogeneity parameters into a commercial farm in one-shot data collection, so no effects on replicate and seasonality were considered.

The variables LS, BA, SB, MR, LW, BAW $<$45 g *n*, BAW $<$45 g %, mn-BAW, sd-BAW and 1st and 3rd q-BAW, and related parameters, were firstly tested for normality and homoscedasticity with the Shapiro–Wilk's and Levene's test, respectively. One way ANOVA procedure was employed to test the effect of parity order on the aforementioned parameters. Significant differences were declared for $p < .05$, highly significant for $p < .01$

and trends for $p<.10$ were noticed. Tukey's multiple comparison test was used for paired comparison of parity order means and the level of significance was determined at $p<.05$. All data were processed using R Studio.

Results

The effect of different parity order on LS, BA, SB, MR, LW, and BAW <45 g n and % are reported in Table 2. With the exception of SB and MR, the effect of parity order was highly significant ($p<.01$) for all traits considered in the present study. Both LS and MR were at their minimum in the 1st parturition (8.96 and 8.36, respectively), then gradually increased, except for the 5th parity (LS), until the 6th parity order, when the maximum values were reached (12.39 and 12.22, respectively). After the 7th parity order, these parameters decreased significantly. Total LW significantly increased among parity orders ($p<.01$), and peaked at the 6th (719.78 g) parturition, to subsequently decrease.

Both BAW < 45 g *n* and % were significantly associated with parity order ($p<.01$). The highest values of these parameters occurred in the 1st parturition (1.83 and 18.69, in BAW <45 g *n* and %, respectively). The number of born-alive kits, which was the lowest in primiparae (8.36), increased up to the sixth parity (12.22) to decrease thereafter.

The results reported in Table 3 on mn-BAW, sd-BAW, 1st–3rd q-BAW (*n* and %), <1st q-BAW (*n* and %) and >3rd q-BAW (*n* and %) considered kits distribution relationship with the whole population. The mn-BAW was the lowest at 1st parturition. Similar results were observed in sd-BAW, where the minimum value was again in the 1st parturition ($p<.01$). Considering 1st–3rd q-BAW (*n*), differences between parity effect levels have been detected only between the 1st and 2nd (4.27 vs 5.54, respectively), and the 1st and the 6th order (4.27 vs 7.39 respectively; $p<.01$). Primiparous does had the lowest number of kits included in this range (4.27), while does at the 6th parturition had the highest value (7.39).

The 1st quartile results (*n*) were statistically different in the primiparous group compared to the 3rd and the 4th parturitions ($p<.01$). Many primiparous' kits were included in the 1st quartile (3.16), while the 3rd and 4th parity order had the lowest incidences (1.69 and 1.53, respectively). Percentage values were similar: primiparous had the highest percentage (32.69%) of kits belonging to the 1st quartile compared to the pluriparous does (15.46% on average). Complementary results were reported in values above the 3rd quartile ($p<.01$). In this case, the 1st parturition does have the lowest number of kits below the 3rd quartile (0.97 > 3rd q-BAW), while does in 3rd, 4th and 7th parity orders had the highest values (3.31, 3.75 and 3.69, 3rd q-BAW, respectively). Similar results were observed

Table 2. Effect of parity order on litter performance.

	Parity order											
Item	1	2	3	4	5	6	7	8	9	> 9	SEM	*p*
LS, *n*	8.96^{B}	10.26^{A}	10.23^{AB}	10.94^{A}	9.91^{AB}	12.39^{A}	11.00^{A}	10.52^{AB}	10.08^{AB}	9.80^{AB}	0.47	<.01
BA, *n*	8.36^{C}	9.64^{B}	9.64^{BC}	10.39^{AB}	9.66^{ABC}	12.22^{A}	10.76^{AB}	9.91^{ABC}	9.92^{ABC}	9.25^{ABC}	0.49	<.01
SB, *n*	0.60	0.62	0.59	0.56	0.26	0.17	0.24	0.61	0.15	0.55	0.24	.71
MR, %	6.22	6.17	6.25	4.96	2.60	1.28	2.46	6.81	1.35	4.22	2.30	.54
LW, g	456.40^{C}	582.6^{B}	616.80^{AB}	655.80^{AB}	598.50^{AB}	719.80^{A}	659.90^{AB}	610.40^{AB}	622.10^{AB}	581.40^{AB}	23.11	<.01
BAW <45 g, *n*	1.83^{A}	1.35^{AB}	0.84^{AB}	0.88^{B}	1.20^{AB}	1.67^{AB}	1.41^{AB}	0.83^{AB}	0.62^{AB}	0.90^{AB}	0.34	<.01
BAW <45 g, %	18.69^{A}	12.44^{AB}	7.67^{B}	7.20^{B}	10.31^{AB}	11.76^{AB}	10.05^{AB}	6.98^{AB}	5.51^{B}	9.51^{AB}	2.97	<.01

^{A,B,C} Values within rows with different superscripts differ ($p<.05$).
LS: litter size; BA: born-alive; SB: still-born; MR: mortality rate; LW: litter weight; BAW <45 g: born-alive weight <45 g.

Table 3. Effect of parity order on litter distribution parameters.

	Parity order											
Item	1	2	3	4	5	6	7	8	9	> 9	SEM	*p*
mn-BAW, g	56.23^{B}	61.54^{A}	64.36^{A}	64.17^{A}	63.78^{A}	59.56^{AB}	63.07^{A}	63.51^{A}	64.63^{A}	64.53^{A}	1.64	<.01
sd-BAW, g	6.83^{B}	8.25^{A}	8.60^{A}	9.17^{A}	8.84^{A}	9.04^{AB}	9.49^{A}	7.97^{AB}	8.94^{A}	7.98^{AB}	0.51	<.01
1st–3rd q-BAW, *n*	4.27^{C}	5.54^{AB}	4.82^{BC}	5.11^{ABC}	4.66^{BC}	7.39^{A}	4.90^{ABC}	5.91^{ABC}	5.23^{ABC}	4.70^{ABC}	0.48	<.01
1st–3rd q-BAW, %	51.28	51.63	46.31	47.45	46.67	61.59	43.87	54.89	49.51	46.77	4.42	.44
<1st q-BAW, *n*	3.16^{A}	2.34^{AB}	1.69^{B}	1.53^{B}	1.77^{AB}	2.39^{AB}	2.17^{AB}	1.61^{AB}	1.58^{AB}	1.25^{AB}	0.46	<.01
<1st q-BAW, %	32.69^{A}	20.65^{B}	15.25^{B}	12.79^{B}	15.38^{B}	17.74^{AB}	16.44^{B}	13.98^{B}	13.94^{B}	12.94^{B}	4.00	<.01
>3rd q-BAW, *n*	0.97^{C}	2.00^{B}	3.31^{A}	3.75^{A}	3.23^{AB}	2.44^{ABC}	3.69^{A}	2.39^{ABC}	3.12^{AB}	3.30^{AB}	0.35	<.01
>3rd q-BAW, %	16.03^{B}	27.73^{AB}	38.44^{A}	39.76^{A}	37.96^{A}	20.66^{AB}	39.69^{A}	31.14^{AB}	36.55^{A}	40.29^{A}	5.01	<.01

^{A,B,C}Values within rows with different superscripts differ ($p<.05$).
mn-BAW: mean born-alive weight; sd-BAW: intra-litter standard deviation born-alive weight; 1st–3rd q-BAW: born-alive weight between first and third quartile; <1st q-BAW: born-alive weigth below first quartile; >3rd q-BAW: born-alive weight above third quartile.

for the percentage values ($p < .01$): only the 16.03% of kits in the primiparous group belonged to the 3rd quartile, compared to pluriparous (34.69% on average).

Discussion

The objective of the present study was to quantify the effect of does parity order on large farm inter and intra-litter homogeneity parameters. This effect was statistically significant for almost all the traits analysed, except for SB, MR, and 1st–3rd q-BAW %.

The least-square means of the different parity orders on does' reproductive performances are generally in slight disagreement compared to those reported in previous studies. The overall mean LS (~10) and LW (~610 g) was higher compared to Tůma et al. (2010) and Dalle Zotte and Paci (2013), who evaluated does reproductive parameters on the same season. Moreover, the research by Blasco et al. (2017) reported smaller LS across parity orders compared to the present study. Such differences are probably related to the different genetic types used across studies.

The association between parity order and reproductive reported in the current research is generally in agreement with the existing literature, indicating a positive relationship between parity order increase and LS and LW at birth (Szendrő 2000; Tůma et al. 2010; Minuti et al. 2020). The 1st parturition had the lowest values in LS, BA, LW, and mn-BAW, according to Szendrő (2000), Xiccato et al. (2004) and Dalle Zotte and Paci (2013). It is known that, when rabbit does begin their reproductive life, they usually have not achieved their total body development yet (Rebollar et al. 2009, Castellini et al. 2010) and, for this reason, the litter parameters (such as LS, BA, and LW) are lower compared to the subsequent parturitions. This was confirmed also in the present study, were LS, BA and LW peaked in the 6th parturition when does have already achieved adult body size. Subsequently, LS, BA and LW started to decrease. Our results are in partial accordance with Tůma et al. (2010), but on disagreement with Szendrő (2000), who reported a decrease of LS, BA, and LW after the 3rd kindling. Such differences are probably related to the meat production genetic type used.

Oppositely, mn-BAW did not differ from the 2nd parturition, confirming that kits mean weight does not change across the parity order, except for the first one. In completely accordance with our results, Parigi-Bini and Xiccato (1993) observed a 10% difference in birth weight between 1st and 2nd litter (56.6 and 62.8 g respectively) and Vasquez et al. (1997) found a 6% difference in birth weight between primiparous and multiparous does. On the other hand, Zerrouki et al. (2007, 2010), Sivakumar et al. (2013) and Apori et al. (2014) recorded a longer effect of parity order with a continuous increase until the 4th–6th parturition.

It is although reported by Szendrő et al. (2019) that in larger litters the average birth weight decreased and that birth weight is related to several behavioural patterns, productive and reproductive traits, such as the kits' behaviour in the nest, their nursing and milk intake, mortality, live performance along with growth, carcase traits and meat quality and reproductive performance of rabbit does.

Our results demonstrated an increase in sd-BAW after the 1st parturition, according to the findings of Lenoir et al. (2012), where the sd-BAW increased significantly in larger litters. Moreover, Vicente et al. (1995) and Poigner et al. (2000a,b) described the same trend, but the standard deviation did not increase in the largest litters.

In our study, there was no significant effect of parity order on SB and MR, in accordance with Dalle Zotte and Paci (2013). However, both LS and birth weight affected mortality in suckling rabbits (Poigner et al. 2000a,b). Nevertheless, our results need more data for a deeper evaluation because SB and MR play an important role in genetic center management. Indeed, a proper within-litter homogenisation based on birth weight resulted in lower MR in previous studies (Garreau et al. 2008).

Primiparous does have litters with the highest number and percentage of kits below 45 g, increasing the chance of kits mortality (Szendrő and Barna 1984; Poigner et al. 2000a,b). In fact, the probability of individual survival is related to birth weight, as the kits with lower birth weight have a lower probability of survival (Agea et al. 2019). This was observed also in the current study, although the effect of parity was not statistically significant on MR. Kits with a low birth weight have many disadvantages compared to those with medium or heavy birth weight at birth. Firstly, its viability is weak. Moreover, low birth weight kits suckle less than heavier littermates, and, generally, they consume less milk (Szendrő et al. 2019; Ludwiczak et al. 2020).

To reduce mortality and to achieve more balanced growth in litters and stocks, it is advisable to equalise the litters according to the birth weight, by rearing kits with lighter birth weight in smaller litters and those with heavier birth weight in larger litters (Szendrő et al. 2019).

Without litter homogenisation, Szendrő and Barna (1984) observed that all kits with a birth weight under 35 g died during the first week of life, the mortality was higher than 50% in groups of kits weighting between 35 and 50 g, and nearly 10% or lower when the birth weight was more than 50 g. Moreover, neonates require a protective environment, adequate nutrition, and special maternal care in order to survive (Hamilton et al. 1997). If the birth weight is lower than the optimum weight, the energy reserves and the thermoregulatory capacity are reduced, and the perinatal mortality increases (Vicente et al. 1995).

Since homogeneity evaluation is important not only within each litter but also for the entire population, kits' weight at birth was compared across the different parity orders using quartiles. Litter homogeneity was related to the number of kits in the 1st–3rd quartile range: the more kits were in this range, the more homogeneous the litter was. On such an aspect, important differences among the parity orders were noticed in the present study. In particular, primiparous does have smaller litters with lighter kits, homogeneous between them, but heterogeneous compared to the remaining part of the population. On the other hand, does in other parity orders shared similar characteristics, such as larger litters and heavier kits at birth. Litters of does in the 6th parturition were the most homogeneous, while the 3rd, 4th and 7th included few light kits and many heavy kits. It is well known that there is a positive correlation between survival and uniformity of weight at birth, without affecting individual and LW (Agea et al. 2019). In fact, Bolet et al. (2007) found a negative correlation between LS and mn-BAW and an increase in mn-BAW variance in larger litters. These results are in contrast with ours because we associated larger litters with the most homogeneous BAW, according to quartiles distribution. In fact, Blasco et al. (2017) found a larger LS variation after 6th parturition, confirming our results.

Conclusions

In conclusion, considering the influences of does' parity order on LS and the differences in kits' bodyweight previously described between primiparous and pluriparous, the commercial genetic centres should equalise the litters according to the birth weight, by rearing kits with light birth weight in smaller litters and those with heavier birth weight in larger litters. We also suggest the use of quartiles to divide the kits population in order to help the equalisation practice process. Further investigation is required to compare the effect of the does within each parity order and to check the possible effects of the season and the environment on the performance of commercial genetic centres.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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