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Risk factors for stillbirth and foetal mummification in four Brazilian swine herds

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Abstract

The objective of this study was to identify the risk factors of stillbirth and foetal mummification in 565 farrowings of four commercial pig farms in Brazil. Stillborn piglets were observed in 31.3% of the litters and the stillborn risk was 5.6%. Mummified foetuses occurred in 42.1% of the litters and the mummification risk was 3.4%. The potential risk factors were included in multivariable logistic regression models as categories: herd (1–4); parity (1, 2–5 and >5); litter size (<10, 10–12 and >12 piglets); farrowing length (≤3 or >3 h); presence of mummified foetuses (yes or no); farrowing induction (yes or no); use of oxytocin (yes or no); use of vaginal palpation (yes or no); body condition score (<3, 3 and ≥4), and placental production index (PPI) (≤5 or >5) which was measured as the ratio of total foetal weight to total placental weight. Duration of farrowing and use of farrowing induction, oxytocin or vaginal palpation were not included in the model that investigated the risk factors of foetal mummification. Two models were used to investigate the risk factors of stillbirth, one with and the other without the inclusion of farrowing length. When compared to sows of parity 2–5, sows of parity >5 had 1.7- and 1.6-times higher odds ($P < 0.05$) for stillbirth in the models with and without the inclusion of farrowing length, respectively. In both models, sows with more than 12 piglets/litter had 3.6-times higher odds of stillbirth occurrence compared to sows with less than 10 piglets ($P < 0.05$). Sows with prolonged farrowing (>3 h) had 2.0-times higher odds of stillbirth occurrence than sows with short farrowing ($P < 0.05$). Sows with more than 12 piglets/litter had 14.5-times higher odds of mummification compared to sows with less than 10 piglets ($P < 0.05$).

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Sows of parities 1 and >5 had 3.5- and 2.0-times, respectively, higher odds of mummification in comparison to sows of parity 2–5 ($P < 0.05$). Sows with low PPI had 1.7-times higher odds of mummification compared to those with high PPI ($P < 0.05$). A large litter, a high-parity and a prolonged farrowing increased the risk of stillbirth. The probability of having a mummified foetus was increased in very young and older sows, when having a large litter and a litter with a less efficient placenta.

Keywords: Mummified; Stillborn piglets; Farrowing; Parity; Litter size; Placenta

1. Introduction

Annual sow productivity is measured in terms of the number of piglets reared per sow per year (Dial et al., 1992; Muirhead and Alexander, 1997). Litter size at birth is determined by ovulation rate, fertilisation rate, embryo and foetal survival. Foetal losses and pre-weaning mortality are among the most important causes of losses in commercial swine herds (Dial et al., 1992). Foetal losses (mummified foetuses and stillborns) can vary from 5 to 15% (Van der Lende, 2000).

Several factors have been associated with stillbirth like infectious diseases, gestation length, parity, litter size, farrowing length, birth interval, birth weight, dystocia, stress due to high environmental temperatures or transfer to the farrowing house, human interference on the assistance of parturition, body condition score and nutritional deficiencies (Leenhouwers et al., 1999; Tantasuparuk et al., 2000; Lucia Jr. et al., 2002; Schneider, 2002). Foetal mummification has been associated with infectious diseases, parity, litter size, uterine capacity, environmental temperature and mycotoxins (Dial et al., 1992; Mengeling et al., 2000; Schneider et al., 2003).

High placental efficiency, measured as the ratio of foetal to placental weight, has been suggested to allow smaller placentae to maintain relatively larger foetuses, thereby contributing to uterine capacity and litter size (Biensen et al., 1998; Wilson et al., 1999). Heritability of placental efficiency has been superior to that observed for uterine capacity or litter size (Vallet et al., 2001). When selecting gilts that had either a higher (group A) or lower (group B) than average placental efficiency and monitoring them during two parities, Wilson et al. (1999) observed that group A sows had an increase in litter size of nearly three pigs per litter compared to those of group B (12.5 versus 9.6). Much emphasis has been put on selection for weight or size of placentae to provide a useful method for increasing uterine capacity and hence the litter size (Vallet et al., 2002; Vonnahme et al., 2002).

The aim of this work was to identify the risk factors of stillbirth and mummification in swine farms.

2. Material and methods

The study was conducted in four commercial swine farms with breeding-herd inventories ranging from 2000 to 5000 sows. Two farms were located in the south region

and the other two in midwest region. Sows, ranging from parities one to nine, were of PIC Camborough 22 line, in two farms, and of Dalland C40 line in the other two farms. These farms were chosen because their productive indexes were within the average of Brazilian farms shown in the PigChamp's report. Moreover, they were located in the two regions of major concentration of swine production and had the two most used genetic lines in Brazil. Data were recorded from January to May 2003, by the same technicians, during approximately 25 days in each farm. Data were collected from a random sample of sows whose farrowing was occurring during the period of observation. Sows were transferred to farrowing rooms, approximately one week before the predicted farrowing date, where they were housed in individual farrowing crates. The number of farrowing crates on each farrowing room ranged from 12 to 60. The farrowing crates had the floor completely or partially slatted (concrete, metal grid or plastic).

Camborough 22 sows were fed 1.8–2.3, 2.3–2.5 and 2.7–3.2 kg per day of a gestation diet (3200 kcal DE/kg and 13.5% of protein) at 0–5, 6–90 and 91–113 days of gestation, respectively. Dalland sows received 2.0–2.2, 3.0–3.2 and 2.0 kg of a diet with 2900–3200 kcal DE/kg and 14–15% of protein, at 0–85, 86–110 and 111–113 days of gestation, respectively. Sows received no feed on the day of parturition. Water was supplied ad libitum at all stages of gestation.

Data regarding parity, farrowing length, litter size, number of piglets born alive, stillborn and mummified foetuses, litter birth weight, piglet birth weight, placentae weight, occurrence of interventions such as farrowing induction, vaginal palpation or oxytocin administration, were recorded. Farrowing induction was obtained by an injection of a synthetic analogue of PGF2alfa in sows with at least 112 days of gestation. The decision about performing or not performing interventions during farrowing was taken by the farm staff.

All stillborn piglets were necropsied. Prepartum stillborn were those that died a few days before parturition (Muirhead and Alexander, 1997), whose organs were autolytic with evidence of imbibed haemoglobin pigment (Sims and Glastonbury, 1996). Piglets that died during farrowing and had a normal aspect were classified as intrapartum stillborn. Piglets having lungs that floated were not considered as stillborn because this indicated that they were born alive (Sims and Glastonbury, 1996).

Litter size included piglets born alive, stillborn and mummified. The farrowing length was defined as the time (hours) between the expulsion of the first and the last piglet. The sows continued to be monitored until all the placentae were expelled. The rear area of the farrowing crate, with the floor slatted, was covered with a piece of cardboard, to prevent loss of placentae or of mummified piglets. All the piglets and placentae were individually weighed. As it was not possible to identify, in 100% of the cases, the placenta of each piglet, the litter birth weight (including born alive and stillborn piglets) was divided by total placentae weight originating a placental production index.

Descriptive statistics were generated by UNIVARIATE procedure (SAS, 2000). Frequency distributions of sows with stillborn piglets or mummified foetuses within each potential risk factor were obtained through FREQ procedure (SAS, 2000). The possible collinearity among variables studied was determined by tests of association such as Chi-square test or by correlation analysis (PROC CORR; SAS, 2000).

By applying a multivariable logistic regression model (LOGISTIC procedure; SAS, 2000) the relative contribution of each factor to the probability of a sow having stillborns or mummified foetuses was determined. Backward elimination was used to determine which factors could be excluded from the model based on a likelihood ratio Chi-square statistic corresponding to $P = 5\%$ at each step.

Dependent variable was defined as the presence of at least one stillborn piglet (models of stillbirth risks) or one mummified foetus (model of mummification risk). All potential risk factors were included in the models as categories: herd (1–4); parity (1, 2–5 and >5); litter size (<10, 10–12 and >12 piglets); farrowing length (≤3 or >3 h); presence of mummified foetuses (yes or no); farrowing induction (yes or no); use of oxytocin (yes or no); use of vaginal palpation (yes or no); PPI (≤5 or >5), and body condition score (<3, 3 and ≥4).

Two of the four farms evaluated were in an expansion process and, therefore, the percentage of parity one sows evaluated in these farms was greater (52.2%) than that of the other two farms (5.9%). Furthermore, the two farms in expansion had a lower frequency of obstetric interventions (6.5% of vaginal palpation and 2.5% of oxytocin use) when compared with the other two farms (38.7% of vaginal palpation and 18.8% of oxytocin use). For this, the interaction between herd and parity order, herd and vaginal palpation and herd and oxytocin use were included in the models used to investigate the occurrence of stillbirths.

Models used to analyse the stillbirth occurrence were also run with the inclusion of body condition score ($n = 537$) and the farrowing length ($n = 356$) as potential risk factors. The lower number of animals in these two situations is explained by the fact that the exact duration of farrowing or the body condition score were not recorded for some sows.

In the model that investigated the risk factors of foetal mummification, duration of farrowing, use of farrowing induction, oxytocin or vaginal palpation were not included. This model was also run with the body condition score as a potential risk factor for mummified including only the sows having this information ($n = 537$).

The animals in the herds included in this study originated from multipliers farms that were certified as free of brucellosis, tuberculosis, aujesky's disease, classic swine fever and mange. To maintain this certification the farms were submitted to periodical evaluations to confirm their health status. PRRS has not yet been diagnosed in Brazil. Vaccination against leptospirosis and parvovirus was routinely performed in the four evaluated herds. The vaccine used protects against porcine parvovirus, *Erysipelothrix rhusiopathiae* and leptospirosis (serovars *L. bratislava*, *L. canicola*, *L. grippotyphosa*, *L. hardjo*, *L. icterohaemorrhagiae* and *L. pomona*). Gilts received the first and second dose at 180 and 195 days of age, respectively. Sows were revaccinated with a single dose prior to subsequent breedings, in average between 8 and 10 days post-partum.

Although sows were routinely vaccinated, the efficiency of vaccination strategies was evaluated by checking all prepartum stillborns and mummified foetuses for the presence of leptospirosis and parvovirosis. Gastric content and a homogenized sample of lungs, spleen, liver and kidneys of foetuses sent to the laboratory were submitted to a DNA extraction. The presence of leptospira and parvovirus was diagnosed by PCR (Mérien et al., 1992; Soares et al., 1999). The sows with at least one positive foetus were not included in the analysis of risk factors.

3. Results

There were no prepartum stillborns or mummified foetuses positive for leptospirosis. Samples from 24 sows were positive for parvovirus. After exclusion of these 24 sows, data of 565 farrowings were analysed. Table 1 shows descriptive statistics of the 565 litters included in this study. Tables 2 and 3 show the frequency distribution of litters with stillborn or mummified foetuses, respectively, according to the potential risk factors.

Stillborn piglets were observed in 31.3% of the litters and the stillborn risk was 5.6%. There was no effect of any interaction term included in the models ($P > 0.05$). Herd, presence of mummified foetuses, farrowing induction, use of oxytocin, vaginal palpation, body condition score and PPI were not significant ($P > 0.05$) as risk factors for stillbirth and were removed from the models. Table 4 shows odd-ratios and P-values resulting from the analysis with the two models used to evaluate the relationship of risk factors and stillbirth. Parity and litter size were risk factors of stillbirth in both models, that is, with and without the inclusion of farrowing length. When the analysis was performed with the inclusion of farrowing length, this factor was also significant as a risk for stillbirth ($P < 0.05$). When compared to sows of parity 2–5, sows of parity >5 had 1.7 and 1.6-times higher odds ($P < 0.05$) for stillbirth in the models with and without the inclusion of farrowing length, respectively. In both models, sows with more than 12 piglets/litter had 3.6-times higher odds of stillbirth occurrence. Sows with

Table 1
Descriptive statistics of variables related to a study on stillbirth and mummification in 565 sows in four commercial swine farms in Brazil (2003)

Variable	*n*	Median (P5–P25–P75–P95)	Mean ± S.D.
Parity (no.)	565	3.0 (1.0–1.0–6.0–7.0)	3.6 ± 2.3
Farrowing length (*h*)	356	2.6 (1.1–1.8–3.6–6.0)	2.9 ± 1.7
Litter size (no.)	565	12.0 (6.0–10.0–15.0–18.0)	12.2 ± 3.4
Born alive piglets (no.)	565	11.0 (5.0–9.0–13.0–16.0)	11.1 ± 3.1
Stillborn in litter (no.)	565	0.0 (0.0–0.0–1.0–3.0)	0.7 ± 1.1
Stillborn in litter (%)	565	0.0 (0.0–0.0–8.3–20.0)	5.6 ± 9.5
Prepartum stillborn in litter (no.)[a]	561	0.0 (0.0–0.0–0.0–1.0)	0.1 ± 0.3
Prepartum stillborn (%)	565	0.0 (0.0–0.0–0.0–7.1)	0.7 ± 2.6
Intrapartum stillborn in litter (no.)[a]	561	0.0 (0.0–0.0–1.0–2.0)	0.6 ± 1.3
Intrapartum stillborn (%)	565	0.0 (0.0–0.0–7.7–20.0)	4.7 ± 9.0
Mummified foetus in litter (no.)	565	0.0 (0.0–0.0–1.0–2.0)	0.5 ± 0.8
Mummified foetus in litter (%)	565	0.0 (0.0–0.0–6.7–16.7)	3.4 ± 5.9
Litter birth weight (kg)	565	16.2 (8.9–13.6–18.8–22.1)	16.1 ± 4.0
Piglet birth weight (kg)	565	1.4 (1.0–1.3–1.6–1.8)	1.4 ± 0.2
Total placentae weight (kg)	565	3.1 (1.6–2.6–3.8–4.9)	3.2 ± 0.9
PPI	565	5.0 (3.9–4.6–5.5–6.2)	5.1 ± 0.8
Body condition score	537	3.0 (2.0–3.0–3.0–4.0)	3.0 ± 0.7

P5–P25–P75–P95 represent 5, 25, 75 and 95% percentiles, respectively. PPI, placental production index (litter birth weight/total placentae weight).

[a] In four sows, stillborns were not classified in prepartum or intrapartum. There were missing observations for farrowing length and body condition score variables.

Table 2
Distribution of risk factors related to stillborn piglets (≥1 in a litter) in 565 sows in four Brazilian herds (2003)

Variable	Level	*n*	Sows	
			With stillborns *n* (%)	Without stillborns *n* (%)
Herd	1	133	55 (41.3)	78 (58.7)
	2	140	64 (45.7)	76 (54.3)
	3	145	55 (37.9)	90 (62.1)
	4	147	64 (43.5)	83 (56.5)
Parity	1	162	53 (32.7)	109 (67.3)
	2–5	236	100 (42.4)	136 (57.6)
	>5	167	85 (50.9)	82 (49.1)
Litter size	<10	114	26 (22.8)	88 (77.2)
	10–12	177	71 (40.1)	106 (59.9)
	>12	274	141 (51.5)	133 (48.5)
Mummified foetus in litter	No	388	152 (39.2)	236 (60.8)
	Yes	177	86 (48.6)	91 (51.4)
PPI	≤5	275	125 (45.4)	150 (54.6)
	>5	290	113 (39.0)	177 (61.0)
Farrowing induction	No	443	184 (41.5)	259 (58.5)
	Yes	122	54 (44.3)	68 (55.7)
Vaginal palpation	No	436	178 (40.8)	258 (59.2)
	Yes	129	60 (46.5)	69 (53.5)
Use of oxytocin	No	504	212 (42.1)	292 (57.9)
	Yes	61	26 (42.6)	35 (57.4)
Farrowing Length (*h*)	≤3	223	68 (30.5)	155 (69.5)
	>3	133	69 (51.9)	64 (48.1)
Body condition score	<3	122	53 (43.4)	69 (56.6)
	3	292	114 (39.0)	178 (61.0)
	≥4	123	58 (47.1)	65 (52.9)

PPI, placental production index (litter birth weight/total placentae weight). Stillborn piglets include prepartum and intrapartum deaths. There were missing observations for farrowing length and body condition score variables.

prolonged farrowing (>3 h) had 2.0-times higher odds of stillbirth occurrence than sows with short farrowing ($P < 0.05$).

Mummified foetuses occurred in 42.1% of the litters and the mummification risk was 3.4%. Herd and body condition score were excluded from the model used to investigate the risk factors of foetal mummification because they were not significant ($P > 0.05$). Parity, litter size and PPI were risk factors ($P < 0.05$) for foetal mummification (Table 5). Sows with more than 12 piglets/litter had 14.5-times higher odds of mummification compared to sows with less than 10 piglets ($P < 0.05$). Sows of parities 1 and >5 had 3.5- and 2.0-times, respectively, higher odds of mummification in comparison to sows of parity 2–5 ($P < 0.05$). Sows with low PPI had 1.7-times higher odds of mummification compared to those with high PPI ($P < 0.05$).

Table 3
Distribution of risk factors related to mummified foetuses (≥1 in a litter) in 565 sows in four Brazilian herds (2003)

Variable	Level	*n*	Sows	
			With mummified *n* (%)	Without mummified *n* (%)
Herd	1	133	43 (32.3)	90 (67.7)
	2	140	33 (23.6)	107 (76.4)
	3	145	61 (42.1)	84 (57.9)
	4	147	40 (27.2)	107 (72.8)
Parity	1	162	65 (40.1)	97 (59.9)
	2–5	236	55 (23.3)	181 (76.7)
	>5	167	57 (34.1)	110 (65.9)
Litter size	<10	114	7 (6.1)	107 (93.9)
	10–12	177	51 (28.8)	126 (71.2)
	>12	274	119 (43.4)	155 (56.6)
PPI	≤5	275	99 (36.0)	176 (64.0)
	>5	290	78 (26.9)	212 (73.1)
Body condition score	<3	122	38 (31.1)	84 (68.9)
	3	292	91 (31.2)	201 (68.8)
	≥4	123	39 (31.7)	84 (68.3)

PPI, placental production index (litter birth weight/total placentae weight). There were missing observations for body condition score variable.

Table 4
Results of a multivariable logistic regression analysis of risk factors for a sow having stillborn piglets (≥1 in a litter) based on 565 sows in four Brazilian herds (2003)

Variable	Level	Model 1			Model 2		
		Odds ratio	95% Confidence interval	*P*-level	Odds ratio	95% Confidence interval	*P*-level
Parity	1	0.7	0.5–1.1	0.008	1.0	0.6–1.8	0.341
	2–5	1.0	–	–	1.0	–	–
	>5	1.6	1.0–2.3	0.002	1.7	1.0–3.0	0.031
Litter size	<10	1.0	–	–	1.0	–	–
	10–12	2.4	1.4–4.2	0.225	1.8	0.9–3.6	0.856
	>12	3.6	2.2–6.0	<0.0001	3.6	1.9–6.8	<0.0001
Farrowing length (*h*)[a]	≤3	–	–	–	1.0	–	–
	>3	–	–	–	2.0	1.3–3.3	0.003

Model 1: likelihood ratio Chi-square = 39.5; d.f. = 4; $P < 0.0001$. Hosmer and Lemeshow goodness of fit statistics ($P = 0.99$). Model 2: likelihood ratio Chi-square = 38.3; d.f. = 5; $P < 0.0001$. Hosmer and Lemeshow goodness of fit statistics ($P = 0.99$).

[a] Model 2 was run with data concerning 356 sows whose farrowing length was recorded.

Table 5
Results of a multivariable logistic regression analysis of risk factors for a sow having mummified foetuses (≥1 in a litter) based on 565 sows in four Brazilian herds (2003)

Variable	Level	Odds ratio	95% Confidence interval	*P*-level
Parity	1	3.5	2.1–5.7	<0.0001
	2–5	1.0	–	–
	>5	2.0	1.2–3.1	0.803
Litter size	<10	1.0	–	–
	10–12	5.9	2.5–13.6	0.109
	>12	14.5	6.4–33.0	<0.0001
PPI	≤5	1.7	1.1–2.6	0.008
	>5	1.0	–	–

PPI, placental production index (litter birth weight/total placentae weight). Likelihood ratio Chi-square = 93.09; d.f. = 5; $P < 0.0001$. Hosmer and Lemeshow goodness of fit statistics ($P = 0.64$).

4. Discussion

4.1. Stillbirth

The stillbirth risk observed (5.6%) is within the range of values reported previously for commercial pig farms (Dial et al., 1992; Muirhead and Alexander, 1997; Leenhouwers et al., 2001; Lucia Jr. et al., 2002; Schneider, 2002).

4.2. Litter size

The higher odds of stillborns for litters having more than 12 piglets are in agreement with other studies (Muirhead and Alexander, 1997; Leenhouwers et al., 1999; Lucia Jr. et al., 2002; Schneider, 2002). Larger litters are usually associated with lower birth weights and prolonged farrowing (Dial et al., 1992), which contributes to increase in the risk of stillborns. In the present study, litter birth weight was not included as a possible risk factor of stillbirth because it was highly correlated ($r = 0.79$; $P < 0.0001$) with litter size. Litter size increases with parity and the number of pigs weaned reaches a plateau between four and six litters (Cutler et al., 1992). Although litter size is unknown before parturition, the number of piglets a sow can have is correlated with the number delivered in the previous farrowings (Heyde, 1992). Therefore, the farrowing of those expected to give birth to large litters can be better monitored.

4.3. Duration of farrowing

Stillbirth risk is higher in sows with prolonged farrowing (Muirhead and Alexander, 1997). Dial et al. (1992) reported that farrowing longer than 4 h had higher risk of stillborns. In contrast, Lucia Jr. et al. (2002) did not observe a higher frequency of sows with stillborns among those with farrowing longer than 4 h. In the present study, 3 h was considered the normal duration of parturition in swine sows (Plonait, 1988) and those with a farrowing length higher than 3 h had higher odds of stillbirth. Most piglets delivered early

in the farrowing are born alive. However, as the farrowing progresses, it increases the proportion of stillborn. After 80% of the pigs have been born, the number of stillbirths increases, with most of them occurring in the last three pigs (Cutler et al., 1992). Anoxia is considered as the major non-infectious cause of stillbirths (Sprecher et al., 1974) and the incidence of asphyxial problems are likely to be increased with litter size (Herpin et al., 2001). Typical signs of oxygen deprivation, often associated with damage to the umbilical cord, are probably related to stretching of the cord during expulsion of the piglet, especially for those located near the ovarian end of the uterus (Fraser et al., 1995).

4.4. Parity

Parity >5 and parity 1 sows had higher and lower odds of stillbirth, respectively, in comparison to parity 2–5 sows. An increasing number of stillborns have been reported with the increase of parity from 2 to 5 (Leenhouwers et al., 1999). In a Brazilian farm, sows of parity ≥4 had higher risk of stillbirth than those of parity 2–3 (Lucia Jr. et al., 2002). The association between higher parities and stillbirth risk could be attributed to an excessive fatness (Muirhead and Alexander, 1997) and/or to a poor uterine muscle tone that could lead to a less efficient labour and prolonged farrowing (Pejask, 1984). Another aspect that may be involved is the fact that higher-parity sows usually farrow larger litters (Dial et al., 1992). In the present study, the frequency of prolonged farrowing increased gradually as the parity increased from 1, 2–5 and >5 (16, 42 and 51%, respectively) confirming that the duration of parturition increases as sows age (Cutler et al., 1992). Furthermore, large litters (>12 piglets) were present in 36, 57 and 48% of sows with 1, 2–5 and >5 parities, respectively. According to Cutler et al. (1992), the duration of farrowing can have a greater impact on stillbirths than parity. Taken together, these observations suggest that both the smaller proportion of prolonged farrowing and of large litters seem to contribute to a lower stillbirth risk in sows of parity one. On the other hand, stillbirth occurrence in older sows is more influenced by the prolonged farrowing than by large litter size. A possibility of reducing stillbirth risk is to avoid having sows beyond the seventh litter (Muirhead and Alexander, 1997).

4.5. Obstetric interventions

Runnels and Clark (1992) recommend oxytocin use and vaginal palpation to minimise stillborn occurrence in cases of dystocia. These authors reported an occurrence of less than 3% of dystocia in swine females. Since obstetric interventions are more likely to be indicators of an existing problem of piglet delivery, the high frequency of vaginal palpation (22.8%) performed suggests that such intervention was indiscriminately used. In this study, vaginal palpation was more frequent in litters with <10 piglets (32%) than in those with 10–12 (24%) and >12 piglets (18%). It is likely that in small litters obstetric intervention was conducted to certify that there were no more piglets to be farrowed rather than to minimise a consequence of dystocia.

4.6. Mummification

According to Dial et al. (1992) and Muirhead and Alexander (1997) a mummification risk of 1.5% is considered normal. This normal level is lower than that observed in the

present study, which was 3.4%. In six Brazilian farms, Schneider (2002) reported values ranging from 1.9 to 5.7%. By evaluating 192 farrowings of gilts, Van der Lende and van Rens (2003) observed 6.8% of mummified foetuses. Similar to Lende and van Rens (2003), in this study placentae were carefully examined, being possible to find small-sized mummified foetuses. The identification of all mummified foetuses is important and with a detailed examination of placentae, the actual occurrence of mummified foetuses in modern swine farms is probably higher than 1.5%.

4.7. Litter size

A greater occurrence of mummified foetuses in larger litters is commonly attributed to an insufficient uterine space to maintain the development and survival of foetuses (Wu et al., 1988; Muirhead and Alexander, 1997).

4.8. Parity

According to Dial et al. (1992), younger sows could be at a risk of mummification due to a likely lower level of immunity provided by an insufficient time of exposure to endemic pathogens. Sows of parity 1 and >5 had higher odds (OR = 3.5 and 2.0, respectively) of mummified foetuses compared to parity 2–5. Considering that sows whose vaccination was inefficient were not included in the analysis, other factors than immunity level should be involved. In the absence of infectious agents, mummified foetuses are commonly observed in larger litters (Muirhead and Alexander, 1997). The presence of one mummy in an otherwise normal litter indicates a physiological death whereas the presence of multiple mummies raises suspicions of an infectious cause of reproductive failure (Sims and Glastonbury, 1996). In the present study, occurrence of mummified foetuses in litters with <10 piglets was lower than 6%, in all parities. On the other hand, in parity 1, 2–5 and >5 sows with more than 12 piglets, 52, 80 and 72% of them, respectively, had mummified foetuses. In all parities, sows with more mummies were those with larger litters. The average litter size increased gradually from sows without mummies (10.8, 11.9 and 11.1) to those having 1 (12.3, 15.5 and 13.1) or ≥2 (13.5, 15.6 and 15.4) mummies/litter for parities 1, 2–5 and >5, respectively. This emphasizes the importance of litter size as a non-infectious factor for the occurrence of mummification, in the present study.

4.9. Placental production index

In the present study, it was not possible to identify, in 100% of the cases, the placenta of each piglet. However, all placentae and all piglets were individually weighed. The placental production index (PPI), measured as the ratio of total foetal weight to total placental weight, was then investigated as a possible risk factor of foetal losses. The higher odds (OR = 1.7) of mummified foetuses in sows with PPI ≤ 5 suggests that this parameter could be important in minimising foetal losses by mummification. It could be of interest to further elucidate whether selection for this trait could be envisaged as a method to reduce foetal losses in sows with large litters.

5. Conclusions

The stillbirth risk observed in this study (5.6%) is within the range of values reported previously for commercial pig farms. The risk of mummified foetuses (3.4%) was above 1.5% considered by some authors as the normal level. This is probably due to the fact that placentae were carefully examined, that made it possible to find all the small-sized mummified foetuses. Large litter size is the major factor involved in foetal losses by stillbirth and mummification. To reduce stillborn risk, farrowing progress in sows of high-parity and in sows expected to give birth to large litters should be monitored. Increasing the replacement rate and not let the sows get more than seven to eight litters could also minimise losses by stillbirths. A smaller and relatively more efficient placenta seems important to reduce occurrence of mummified foetuses.

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