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PROBIOSIS IN SOWS BY ADMINISTRATION OF BACILLUS TOYOI SPORES DURING LATE PREGNANCY AND LACTATION: EFFECT ON THEIR HEALTH STATUS/PERFORMANCE AND ON LITTER CHARACTERISTICS

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ABSTRACT: *This study evaluated the effect of oral administration of Bacillus toyoi spores to sows, on their health status and performance, as well as on their litters' characteristics. One hundred and sixty gilts and sows were allocated into two experimental groups, i.e. Controls and Toyocerin (same feeding as the control group plus 0.5 kg of Toyocerin per tone of feed, equal to 0.5x10^9 Bacillus toyoi spores per g of feed). Treatment started from 14 days prior to the expected farrowing and terminated at the day of weaning. Homogeneity of the groups was satisfied with regard to the parity. From the results of the study it was shown that Toyocerin supplementation of the feed decreased sow's weight loss during the suckling period. Certain blood and milk parameters were significantly improved, as shown by higher serum cholesterol and total lipids concentrations and higher milk fat and protein content at mid lactation. As a consequence, a positive effect was also noticed as regards litter health and performance characteristics in terms of the decrease in piglet diarrhoea score, the decrease of pre-weaning mortality thus leading to increase in the number of weaned piglets per litter and the increase in piglet body weight at weaning. Moreover, Toyocerin improved the health status of lactating sows (lower prevalence of dysgalactic sows and sows with MMA syndrome) and tended to improve sow post weaning fertility as shown by the tendency for fewer returns to oestrus.*

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INTRODUCTION

The intestinal tract of healthy animals is colonised by a great number of different microorganisms, whose balance, promotes digestion (Walker and Duffy 1998) and absorption of nutrients (Tannock 1988). In general, the composition of microflora in the adult animal is considered to be almost constant (Tannock 1990). However, production animals and especially the sow are subjected to many stressors during their breeding life, i.e. repeatedly services, farrowings and lactations under different housing, management and feeding conditions, and this affects intestinal microflora balance (Robertson and Tournout 1994). Likewise, sows gain body weight during pregnancy and lose some of it during lactation (Robertson and Tournout 1994, Whittemore 1998). Nutrient intake by the sow during gestation and lactation highly influences the litter characteristics at birth and at weaning (English et al. 1984, Whittemore 1998). In-feed antibiotics, at a growth promoter dosage, have been proved to enhance sow's performance and to improve the viability of their progeny (Kantas et al. 1997, Giannakopoulos et al. 2001a). However, the recent demand for reduction of use of antibiotics in animals and the forbiddance of growth promoters from EU, has provoked the investigation of alternatives, such as probiotics, for improving sow health status and enhancing their performance.

Probiotics have been defined as live microbial cell preparations or microbial cell components with a positive effect on health and performance of the macroorganism (Salminen et al. 1999). Such feed supplements beneficially affect the host animal by improving its intestinal balance (Fuller 1992, Tournut 1994). Administration of probiotics to re-establish the ideal balance between beneficial and pathogenic microorganisms is preferred during periods of stress, where this balance can be altered (Fox 1988). In the past decade the genus Bacillus, along with Lactobacillus spp., non-enterotoxigenic *E. coli*, Bifidobacterium spp. and Streptococcus spp. have been used as probiotics. In pigs, most of the relative studies have been performed in piglets, especially at the critical period of weaning (Alexopoulos et al., 2004a). However, information about the effect of probiotics on the health of the sow and whether this effect can extend to her offspring, is limited.

The aim of this field study was to assess the efficacy of Toyocerin, a probiotic containing *Bacillus toyoi* spores, during the critical periods of sows' late pregnancy and lactation on certain blood and milk parameters, as well as on their health status and performance.

MATERIALS AND METHODS

Experimental substance

The experimental substance used was a commercial batch of the probiotic Toyocerin (Asahi Vet. S.A./Spain) containing 1x10^9 *Bacillus toyoi* spores per gram. The product is officially listed in Annex II of Directive 70/524/EEC for use in pigs.

Trial farm

The study was carried out from April to July 2004 on a commercial farrow-to-finish pig farm in Greece, with a capacity 950 sows of the same genetic background (Topics Hybrids/ The Netherlands). The farm had its own feed mill.

Every week a group of 40 sows was moved from the gestation house to one farrowing house (approx. five days prior to expected farrowing). Each farrowing building had two separate rooms each of 20 farrowing pens (10 in the right and 10 in the left side with a walkway in the middle). All pens were equipped with commercial crates for the sow including a creep area for the piglets. The sow area had a slatted floor, while the creep area had a concrete one. All pens were also equipped with nipple drinkers and with separate removable feeders for the sows and the piglets. Each farrowing room was automatically air-conditioned/ventilated keeping the temperature between 19 and 24°C. In each pen, extra heat was provided to the newborn piglets, using infra-red electric lamps placed in the creep area. Each compartment was cleaned daily and, when vacant, thoroughly washed and disinfected. Introduction of ready-to-farrow sows to the room was not earlier than 2-3 days' time after disinfection. Weaning of piglets took place every Thursday. At weaning day the sows were moved to the breeding stock house and penned separately in individual cages with slatted floors. They were monitored daily for signs of oestrus. At oestrus each sow was subjected to double insemination with fresh semen (12 and 24 hours after the detection of heat by a teaser boar). The «Do-it-Yourself AI system» was applied in the farm.

During the trial crossfostering was only performed within the same treatment group. From the 7th day of age until weaning a creep feed free from any antimicrobials, performance enhancers, probiotics or acidifiers was offered to the suckling piglets.

The farm had a previous history of pre- and post-weaning diarrhoea syndrome due to *E. coli* infection as evidenced by appropriate microbiological and histopathological examinations. Moreover, the farm had a previous history of *Isospora suis* infection in suckling piglets, which was being efficiently controlled by oral administration of toltrazuril (Baycox® 5% / Bayer, Germany) at third day of age. The farm was free of *Brachyspira hyodysenteriae*, *Brachyspira pilosicoli,* Salmonella spp., Cryptosporidium spp., *rotavirus* and *coronaviruses*. Breeding animals were vaccinated against Aujeszky's disease, parvovirus infection, erysipelas, atrophic rhinitis and *E. coli*. Piglets were also vaccinated against Enzootic pneumonia. For the control of endo/ectoparasites, all adults were treated with ivermectin twice a year.

Animals and treatments

According to the routine program of the farm each weekly batch consisted of approx. 40 pregnant gilts and sows. Fourteen (14) days prior to the expected date of farrowing the animals of each weekly batch were allocated into two experimental groups, as follows: (a) Control group: No treatment and (b) Toyocerin group: Same feed as in the controls plus Toyocerin at a dose of 0.5 kg per tonne of feed (equal to 0.5 x 10^9 viable spores per g of feed) administered from the day of allocation (14 days prior to the expected farrowing) up to the weaning day. Homogeneity of the groups was satisfied with regard to the parity. Each of the gilt/sow and each piglet of their litters were identified (ear-marked). Two (2) weekly batches of sows due to farrow were totally employed, so that finally a total of 160 gilts/sows were allocated to the two experimental groups (80 per group or 40 per weekly batch).

In order to reduce the risk of spore cross-contamination, the controls and the treated animals were bred in a separate room within the building. As shown by temperature and humidity measures taken daily throughout the trial, no systematic differences occurred between the different farrowing buildings and rooms.

Feeding of the animals

A lactation feed was used for feeding the gilts/sows during the trial. A creep feed was also used for feeding piglets during the suckling period. Both feeds were typical, balanced ratios, based on maize, barley, soyameal, fishmeal and fat of plant origin. The feeds were free from any antimicrobials, performance enhancers, probiotics or acidifiers for a period of at least two months before the start of the trial.

The feeding program applied to gilts/sows was a typical one according to recommendations described by NCR (8th edition, 1998). Creep feed was offered to piglets *ad libitum.*

Every batch of feed was prepared about 3 weeks prior to its use and of every feed preparation three samples were taken for chemical analysis. Protein, calcium and phosphorus content were determined, according to the official methods of the Association of Official Analytical Chemists (AOAC, 1990).

Biosecurity measures

The experimental diets were manufactured in the feed processing factory that belongs to the owner of the trial farm. To prevent cross contamination with Bacillus toyoi spores, the diets were manufactured in treatment sequence from control group to Toyocerin group. There was no supplementation of the diets with any other antimicrobial feed additive. At all times, pigs were maintained in their respective treatment groups (i.e. there was no mixing). Control pigs were allocated a separate set of cleaning (clothing, boots and shovels) and feeding (scoops, barrows) equipment. Risk was further reduced by employing a different member of staff to manage the control animals. Biosecurity was maintained by providing separate foot dips for control vs. Toyocerin treated animals.

Parameters recorded and calculated

The following data was recorded for each gilt/sow: allocation date, farrowing date, weaning date, post-weaning oestrus date and return to oestrus date. Then, the weaning-to-oestrus interval, the return-to-oestrus rate and the return-to-oestrus interval were calculated per sow. Gilt/sow body weights were also recorded at allocation day, at farrowing and at weaning.

Sow and litter daily feed intake were recorded as the calculation of the amount of feed offered daily minus the remaining amount of feed in the feeder next morning.

The health status of gilts/sows and their litters were assessed regularly and any abnormal signs or medication given were recorded. Clinical signs, such as reduced appetite evident by consumption of less than half of the daily quantity of feed for at least two days, fever, as assessed by rectal temperature higher than 39.4° C at two consecutive recordings 18 and 24 hours post partum, evidence of clinical mastitis recorded as changes in the appearance of the mammary glands and secretion, presence of purulent or blood-tinged vaginal discharge occurring after the 5th day post-partum or post-partum dysgalactia syndrome were the conditions recorded. Sows with MMA syndrome were defined as those exhibiting at least two of the previously mentioned symptoms.

Two blood samples were taken from all sows at day 1 and 15 of the suckling period between 09.00 to 11.00 h. They were collected from the jugular vein and were analysed for the determination of cholesterol and total lipids concentrations by the procedures recommended by the Association of Official Analytical Chemists (AOAC 1990). Additionally, two milk samples were collected from all sows at day 3 and 14 of the suckling period, between 09.00 to 11.00 h. They were collected by manual expression, from teats two to six, after stimulation of the neuroendocrine milk ejection reflex by the piglets and were analysed for their fat, cholesterol (% of fat), protein, lactose and total solids content by the procedures recommended by the Association of Official Analytical Chemists (AOAC 1990).

For each litter the following data was recorded: number of piglets born alive, dead and mummified; number of piglets weaned, number of piglets that died during lactation and reasons for piglet mortality, as well as litter body weight at birth and at weaning. A diarrhoea score was calculated on litter basis after a daily monitoring of each litter using a scale from 0 to 3 (0= no diarrhea, 1 = slight, 2 = middle, 3 = acute). Then all partial scores were added per pen for all days of lactation and the sum was divided by the days of monitoring (days of suckling period) to give finally the daily diarrhoea score of the litter per suckling period.

GCP and GLP statement

The trial was carried out according to the Good Clinical Practice for the Conduct of Clinical Trials Guidelines (GCP, July 2001) and Good Laboratory Practice Guidelines (GLP, Council Directive 87/18/EEC and Commission Directive 1999/11/EC). The specifications of the trial satisfied all welfare needs of the animals with regard to feed, water, space and treatments according to Good Farming Practice Guidelines (GFP, Council Regulations 1999/1257/EC and 1999/1259/EC).

Statistical analysis

Sow and its litter were considered as the experimental unit. Data was analysed with the GLM procedure of SAS Package ("The SAS® System" release 8.1 for WINDOWS - 2002/ SAS Institute Inc., Cary, NC 27513, USA) testing for room, parity and experimental group effects. For parameters expressed as frequencies, chi-square analysis including Fisher's exact test was further used to determine differences between the two experimental groups. The level of significance was set at α=0.05.

Table 1. Mean (± SD) sow body weight (kg) at different times during the trial (n=number of cases)

Time	Experimental groups	
	Toyocerin	Controls
Allocation day	$243.60^a \pm 41.97$ (n=79)	$247.09^a \pm 2.14$ (n=79)
1st day post partum	$232.85^a \pm 42.74$ (n=79)	$236.77^a \pm 41.77$ (n=79)
Weaning day	$221.05^a \pm 42.80$ (n=79)	$221.34^a \pm 43.04$ (n=79)
During lactation (loss)	$11.80^b \pm 3.49$ (n=79)	$15.43^a \pm 2.88$ (n=79)

^{a,b} Means within each row with different superscripts differ significantly (P<0.05).

Table 2. Mean (± SD) sow and litter feed consumption (kg) at different periods during the trial (n=number of cases)

Period	Experimental groups	
	Toyocerin	Controls
Allocation day - Farrowing day	$41.74^a \pm 0.94$ (n=79)	$41.91^a \pm 1.14$ (n=79)
Farrowing day - Weaning day	$185.91^a \pm 20.47$(n=79) (n=79)	$181.34^a \pm 25.57$ (n=79)
Creep feed / litter during lactation	$4.66^a \pm 0.95$ (n=79)	$4.13^b \pm 1.12$ (n=79)

^{a,b} Means within each row with different superscripts differ significantly (P<0.05).

Table 3. Litter health status and performance parameters (means ± SD) (n=number of cases)

Parameter	Experimental groups	
	Toyocerin	Controls
No. of piglets totally born / litter	11.33[a] ± 3.24 (n=79)	11.66[a] ± 3.30(n=79)] (n=79)
No. of piglets born alive / litter	10.72[a] ± 2.87 (n=79)	10.86[a] ± 2.83 (n=79)
No. of piglets born dead or mummified / litter	0.61[a] ± 0.81 (n=79)	0.80[a] ± 0.81 (n=79)
No. of weaned piglets / litter	9.89[a] ± 1.17 (n=79)	9.20[b] ± 1.45 (n=79)
No. of dead suckling piglets / litter	0.87[b] ± 0.90 (n=79)	1.66[a] ± 1.24 (n=79)
Pre-weaning mortality (%) / litter	7.37[b] ± 7.25 (n=79)	14.03[a] ± 10.21 (n=79)
Piglet body weight (kg) at birth / litter	1.40[a] ± 0.20 (n=79)	1.37[a] ± 0.16 (n=79)
Piglet body weight (kg) at weaning / litter	7.91[a] ± 0.67 (n=79)	7.41[b] ± 0.74 (n=79)
Suckling piglets diarrhoea score / litter	0.057[b] ± 0.163 (n=79)	0.366[a] ± 0.414 (n=79)

RESULTS

From the total number of 80 gilts/sows allocated to the each of the two experimental groups, one sow per experimental group was excluded from the trial since they did not farrow. So, the actual number of sows participating in the study was 79 for both groups. After weaning, 2 and 6 sows in the Toyocerin and Control groups, respectively, were removed due to several reasons according to the routine program applied in the farm (multiparous sows, sows with low productivity, sows with trauma or locomotor problems and anoestrous sows for a period of 30 days post weaning). The estimation of the subsequent fertility parameters was based on 77 and 73 sows, respectively for the two groups. Further, there were no significant differences between the two groups, relative to the mean (± SD) parity of animals involved (3.28 ± 1.89 and 3.34± 1.90 for the Toyocerin and the Control groups, respectively), as well as relative to the mean lactation length (26.23 ± 1.67 and 26.73 ± 2.07 days for the two groups, respectively).

From overall statistical analysis no room or parity effect was noticed for all parameters examined, but only for the experimental groups. Table 1 gives details for data relative to the mean sow body weight at different times during the trial period. There were no significant differences between the two groups at allocation, at the 1[st] day post farrowing and at weaning. However, the Tovocerin treated animals lost significantly less body weight (P<0.05) during the lactation.

The mean sow and litter feed consumption at different periods during the trial are given in Table 2. Although the sows from the Toyocerin group consumed more feed during lactation period compared with the controls, the difference was not found to be significant. However, the consumption of creep feed was significantly higher in litters from the Toyocerin group, compared with the Control group.

Table 3 gives information on litter health status and performance parameters. Although the mean total number of piglets born per litter, as well as the number of piglets born alive per litter did not differ between the two experimental groups, a significantly higher number of piglets weaned per litter was recorded in Toyocerin group, compared with the controls, as a result of the lower number of piglets dying during suckling period and the lower pre-weaning mortality observed in this group. Furthermore, the piglets of the Toyocerin group gained more body weight during the suckling period, as a consequence of a significantly lower diarrhoea score during this period.

The mean serum cholesterol and total lipid concentrations in sows at the beginning and at mid lactation period are shown in Table 4. The increase in the values normally occurring between the 1[st] and the 15[th] day post partum was more pronounced in the Toyocerin group, for both serum parameters examined.

Furthermore, the milk composition was also shown to be influenced by the treatment (Table 5). There was a significant inhibition of the reduction in milk fat and protein in Toyocerin group, compared to the controls (P<0.05), but there was no effect of treatment on the lactose and total solids content of the sow milk during the lactation period.

The sows' health status during lactation parameters, as well as sows' post treatment fertility is shown in Table 6. A higher proportion of sows with dysgalactia, and as a consequence with MMA syndrome was found in the control group, compared with the Toyocerin treated group (P<0.05). The weaning-to-oestrus interval did not differ between the two experimental groups, but a tendency for a higher proportion of sows returning to oestrus after service was noticed in the control group, compared with the Toyocerin treated sows (P=0.092).

Table 4. Mean (± SD) serum cholesterol and total lipids concentrations (mg/100ml) (n=number of cases)

Parameter Time	Experimental groups	
	Toyocerin	**Controls**
Cholesterol		
1st day post partum	67.66^{a} ± 9.32 (n=79)	67.35^{a} ± 7.56 (n=79)
15th day post partum	77.95^{a} ± 7.10 (n=79)	74.38^{b} ± 7.11 (n=79)
Total lipids		
1st day post partum	254.70^{a} ± 34.77 (n=79)	252.84^{a} ± 29.68 (n=79)
15th day post partum	290.54^{a} ± 26.49 (n=79)	276.07^{b} ± 25.16 (n=79)

a,b Means within each row with different superscripts differ significantly ($P<0.05$).

Table 5. Mean (± SD) content (%) of milk composition parameters (n=number of cases)

Parameter Time	Experimental groups	
	Toyocerin	**Controls**
Fat		
3rd day post partum	6.87^{a} ± 0.35 (n=79)	6.83^{a} ± 0.27 (n=79)
14th day post partum	6.52^{a} ± 0.34 (n=79)	6.25^{b} ± 0.28 (n=79)
Cholesterol (% of fat)		
3rd day post partum	4.69^{a} ± 0.34 (n=79)	4.69^{a} ± 0.30 (n=79)
14th day post partum	4.81^{a} ± 0.37 (n=79)	4.93^{a} ± 0.43 (n=79)
Protein		
3rd day post partum	5.45^{a} ± 0.38 (n=79)	5.46^{a} ± 0.43 (n=79)
14th day post partum	4.88^{a} ± 0.37 (n=79)	4.64^{b} ± 0.50 (n=79)
Lactose		
3rd day post partum	4.92^{a} ± 0.42 (n=79)	4.85^{a} ± 0.4 (n=79)
14th day post partum	5.29^{a} ± 0.43 (n=79)	5.23^{a} ± 0.42 (n=79)
Total solids		
3rd day post partum	20.7^{a} ± 1.00 (n=79)	20.11^{a} ± 0.85 (n=79)
14th day post partum	19.36^{a} ± 0.94 (n=79)	19.33^{a} ± 0.94 (n=79)

a,b Means within each row with different superscripts differ significantly ($P<0.05$).

Table 6. Sow health status and fertility parameters

Parameter	Experimental groups	
	Toyocerin	Controls
Fever	3 /79 (3.8%) [a]	9/79 (11.4%)[a]
Reduced appetite	2 /79 (2.5%)[a]	5/79 (16.3%)[a]
Mastitis	1 /79 (1.3%)[a]	0/79 (0.0%)[a]
Metritis	0 /793 (0.0%)[a]	0/79 (0.0%)[a]
Dysgalactia	2/79 (2.5%)[b]	8 /79 (10.1%)[a]
MMA syndrome	3 /79 (5.8%)[b]	10/79 (12.7%)[a]
Weaning-to-oestrus interval (days) (mean ± SD)	5.26[a] ± 32.23 (n=77)	5.96[a] ± 4.15 (n=73)
Returns to oestrus (number of sows in category/total examined)	7 / 77 (9.1%)[a]	13 / 73 (17.8)[a*]
Return-to-oestrus interval (days) (mean ± SD)	21.86[a] ± 2.19 (n=7)	22.62[a] ± 3.10 (n=13)

[a,b] Means or percentages within each row with different superscripts differ significantly (P<0.05).
[a,a*] Means within the row with such different superscripts tend to differ significantly (P=0.092).

DISCUSSION

According to the data obtained in this study *Bacillus toyoi* spores administration to sows via feed resulted in a significant reduction in the loss of sow bodyweight during lactation (3.63 kg difference). In a similar study using a preparation with *Bacillus subtilis* and *Bacillus licheniformis*, Alexopoulos et al. (2004b) attributed this difference to the higher feed consumption obtained also in the probiotic group. However, in the present study such a finding was not confirmed since no differences were noticed between sow groups regarding feed consumption during lactation period. Since in our study similar litter characteristics were obtained which indicates that sow nutrient demands were also similar to those of the study of Alexopoulos et al. (2004b), a more likely explanation could be that the probiotic tested led to a better utilisation of feed nutrients by the sow. Indeed, the significantly higher concentrations of serum cholesterol and total lipids observed in treated sows at mid lactation strongly support the previous explanation. Similar results relative to the concurrent improvement of performance and serum parameters have been noticed when growth promoters were added to sow feed (Kyriakis et. al. 1992, Alexopoulos et. al. 1998, Giannakopoulos et al. 2001a, Giannakopoulos et al. 2001b). However, there are controversial results in literature relative to the effect of probiotics on serum total cholesterol. Xiao et al. (2003) reported lowering of serum cholesterol concentration after administration of *Bifidobacterium longum* in rats, while *Streptococcus thermophilis* and *Lactobacillus bulgacicus* had no effect. According to Kiessling et al. (2002) long-term comsumption of *Lactobacillus acidophilus* and *Bifidobacterium longum* in women did not influence serum concentration of total cholesterol, but the ratio of LDL/HDL cholesterol was decreased. Adversely, Cardona et al. (2003) did not find any influence of *Bacillus licheniformis* to cholesterol metabolism in mice, but Alexopoulos et al. (2004b) using *Bacillus licheniformis* and *Bacillus subtilis* throughout lactation in sows, reported even an increase of serum cholesterol and total lipids concentrations at midlactation. However, the same author did not find any influence using the same probiotic preparation in weaners, growers and finishers (Alexopoulos, unpublished data). It seems that probiotic effect on serum cholesterol concentration depends on bacterial species, as well as on the kind and age of the species applied.

Moreover, *Bacillus toyoi* spores were found to have an indirect positive effect in piglets, arising from the sow, as shown by the reduction of the incidence of scours, evident from the lower diarrhoea score and lower mortality in the treated group compared to controls. The difference of 0.5 kg between the bodyweight of weaned piglets in the two experimental groups in favour of the treated indicated also the indirect effect of *Bacillus toyoi* spores to the piglets. According to the available literature, the direct benefit of probiotics has been well documented by several studies in pigs, mainly in weaners (Alvarez et al. 1996, Breton and Munoz 1998, Kyriakis et al. 1999, Tournout et al. 1998, Alexopoulos et al. 2004a) and suckling piglets (Bocourt et al. 2004). Indications, about the possible indirect effect of probiotics to the piglets have been also given in previous studies using *Bacillus cereus* spores (Alexopoulos et al. 2001), *Bacillus licheniformis* plus *Bacillus subtilis* spores (Alexopoulos et. al. 2004b). The most likely explanation for the indirect beneficial effect of the probiotic to the piglets is the consumption of the better quality milk. Indeed, in the present study it was demonstrated that milk from *Bacillus toyoi* treated sows contained more fat and protein at mid lactation compared with non-treated ones and for this reason it may be of a higher nutritional value. This hypothesis could be strongly supported as it has been clearly shown that mammary glands are the primary users of absorbed nutrients in lactating sows (Boyd and Touchette 1997). On the other hand, this explanation could be further supported by the fact that in our study higher concentrations of serum cholesterol and total lipids were noticed in treated sows at mid lactation, as a result of the increased feed intake leading likely to an increased fat absorption. Previous studies have also shown that the consumption of dam's milk with high fat content by the piglets has a beneficial effect in their growth (Haydon and Hale 1988, Kyriakis et al. 1992). Sows fed *Bacillus toyoi* spores are also likely to excrete faeces resembling their gut microflora e.g. less pathogenic germs and high numbers of Bacilli spores. These faeces are spread in the farrowing pen probably creating a better (or even helpful) environment for the newborn pig, to colonise in the sterile gut already in advance of delivery and before the consumption of creep feed. The above hypothesis is strongly indicated from the findings of previous works (Demecková et al. 2002, Demecková et al. 2003), where sow feed fermentation resulted in reduction of pathogen challenge of the neonatal environment. Additionally, it has been shown that *Bacillus toyoi* spores were detected in faeces and digesta of suckling piglets originating from probiotic fed sows, before pre-starter feed was offered, indicating an alternative route of uptake besides diet (Taras et al. 2005).

It is well documented that there is a high correlation between sow body condition at weaning and weaning-to-oestrus interval, as well as between the sow body condition at weaning and conception rate-survival of embryos at early stages of gestation (Dial et al. 1992), so similar results could be anticipated relative to subsequent fertility of the sows in the current study. Indeed, the return-to-oestrus rate in treated animals was significantly lower than in the controls. The fact that the service-to-repeat oestrus interval was found to be consistent with the duration of the normal oestrous cycle supports the view that this difference was rather due to the treatment and not to an infectious agent.

Conclusively, the results of this study indicated that administration of Bacillus toyoi spores at late pregnancy and lactation of sows at $0.5x10^9$ spores per g of feed improved sow certain blood and milk parameters, suckling piglet health and performance, as well as subsequent fertility of the sow.

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