THE EFFECT OF DIETS SUPPLEMENTED WITH *SACCHAROMYCES CEREVISIAE BOULARDII* PROBIOTIC YEAST ON THE REPRODUCTIVE PERFORMANCE OF PREGNANT AND LACTATING SOWS

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Abstract. The aim of this study was to assess the efficacy of Levucell SB 10, a probiotic containing *Saccharomyces cerevisiae boulardii* strain, on the health status and productivity of sows and their litters. A total of 243 gilts and sows (PIC) were allocated into two experimental groups, as follows: untreated controls – 125 (C) and Levucell SB 10–118 ($1.0x10^9$ cfu/kg of feed of the gestation and lactation diets). Homogeneity of the groups was satisfied with regard to the parity (2.74 and 2.78). The treatment started from d 1 of gestation to d 28 of lactation.

Considering the results it can be concluded that the sows of poor health who received feeds with the probiotic supplement are characterised by better fertility and mating effectiveness compared to the control group sows. The addition of the probiotic supplement to the sow diet contributed to the downward trend for the sows' reproductive problems (abscess, abortion). However, it did not have any influence on the sows' condition and the length of parturiency. There were no gestation and lactation diet treatment differences for sow back fat thickness (breeding, farrowing or weaning). There were no differences ($P \leq 0.05$) in total number of pigs born, born alive, stillborn or born mummified. The sows on this diet also showed a trend for a larger size of litter but as the number of weak piglets was higher ($P \leq 0.05$) the average size of litter on the 21st and 28th days of life did not differ between the test groups.

Keywords: sows, probiotic yeast, reproductive performance.

RACIONŲ, PAPILDYTŲ PROBIOTINĖMIS MIELĖMIS *SACCHAROMYCES CEREVISIAE BOULARDII*, POVEIKIS PARŠINGŲ IR ŽINDANČIŲ PARŠAVEDŽIŲ REPRODUKCINĖMS SAVYBĖMS

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Santrauka. Tyrimo tikslas buvo įvertinti probiotiko „Levucell SB 10“, sudėtyje turinčio *Saccharomyces cerevisiae boulardii* kamieno mielių, poveikį paršavedžių ir jų vadų sveikatingumo būklei bei produktyvumui. Iš viso 243 kiaulaitės ir paršavedės (PIC) analogo principu buvo suskirstytos į dvi bandymo grupes: kontrolinę, negavusią priedo – 125 (C) ir tiriamąją „Levucell SB 10“ grupę – 118 ($1,0x10^9$ cfu/kg pašaro, paršingumo ir žindymo laikotarpio racionuose). Bandymas truko nuo pirmos paršingumo dienos iki 28 žindymo dienos.

Atsižvelgiant į tyrimo rezultatus galima daryti išvadą, kad silpnesnės sveikatos paršavedės, gavusios pašarų su probiotiko priedu, pasižymėjo didesniu vislumu ir kergimo veiksmingumu palyginti su kontrolinės grupės paršavedėmis. Probiotiniai priedai paršavedžių pašaruose turėjo įtakos paršavedžių reprodukcinių sutrikimų (abscesų, abortų) mažėjimo tendencijai, tačiau neturėjo jokios įtakos paršavedžių būklei ir paršiavimosi trukmei. Nebuvo nustatyta paršavedžių lašinių storio skirtumų tarp paršingumo ir žindymo laikotarpiu racionus gavusių bandomosios ir kontrolinės grupių (veisimo, paršiavimosi arba nujunkymo metu). Nebuvo nustatyta ($p \leq 0,05$) bendro atsivestų, gyvų, abortuotų arba apsigimusių paršelių skaičiaus skirtumų. Pastebėta, kad eksperimentinį racioną gavusios paršavedės vedė daugiau paršelių, tačiau, įvertinus didesnį silpnų paršelių skaičių ($p \leq 0,05$), vidutinis tiriamųjų grupių vados dydis 21-mą ir 28-tą dieną nesiskyrė.

Raktažodžiai: paršavedės, probiotinės mielės, reprodukcinės savybės.

Introduction. Gastric microflora is known to play an important role in maintaining good health and high productivity in pigs, which spurs a growing interest in probiotic dietary supplements that contribute to improving the well-being and performance of animals. Probiotics have been used in pig nutrition for many years. Probiotic supplements include bacterial cultures, applied alone or in combination, as well as selected yeast species, such as

Saccharomyces sp.

According to the results of probiotic bacteria investigation, probiotic supplements deliver two-fold health benefits. The first is the nutritive effect which involves a decrease in the production of toxic metabolites in the gastrointestinal tract and an increase in the production of enzymes, vitamins and anti-bacterial substances. The other mechanism of activity delivers health or sanitary effects by increasing the resistance of intestinal mucosa to pathogens and stimulating natural immune system responses. The use of probiotic supplements reduces the incidence of diarrhea of both bacterial (*E. coli*) and viral (rotavirus) origin (Musa *et al*., 2009). When administered to sows, probiotics inhibit the transfer of intestinal pathogens to the offspring (Simon, 2010).

Probiotic supplements containing yeast have a different mechanism of action. *Saccharomyces cerevisiae* yeast increases the counts of desirable lactic acid bacteria and reduces the populations of *E. coli* bacteria. Live yeast cells have been found to enhance digestion and the secretion of selected enzymes in the gastrointestinal tract. Probiotic yeast boosts immunity against pathogenic bacteria and their toxins (Auclair, 2000, Scharek *et al*., 2007, Schierack *et al.*, 2008). Whereas the health promoting effects of probiotic supplements administered to piglets have been investigated by numerous researchers, few experiments analyzed the effects of probiotics on the health and performance of sows. As part of recommended practice, sows are administered probiotic supplements in the perinatal period and during lactation. Research results suggest that the inclusion of probiotics in the regular dietary regime of pregnant and nursing sows could deliver significant benefits. However, the relevant findings are inconclusive, and further research is required in this area (Alexopoulos *et al.*, 2004, B□hmer *et al,* 2006, Jurgens *et al,* 1997, Kim *et al,* 2008).

The aim of this study was to determine the effect of diets supplemented with *Saccharomyces cerevisiae boulardii* (Levucell SB) probiotic yeast on the health and reproductive performance of pregnant and nursing sows.

Materials and Methods

The experiment was conducted in a commercial pig farm in north-eastern Poland, under standard housing and management conditions. All facilities (mating, sow and farrowing units) were fully equipped, including adequate ventilation and heating systems. Housing conditions were compliant with current veterinary standards.

The experimental material comprised sows (primiparous and multiparous) of the same genetic line (PIC). A total of 243 animals from a continuous farrowing batch were divided into two groups, including 125 sows in the control group and 118 sows in the experimental group. The experiment covered the period from mating to weaning (lactation day 28). Homogeneity of the groups was satisfied with regard to the parity.

Table 1. **Composition and nutritive value of the sow diets**

Specification	Pregnant sow LL-1	Pregnant sow LK-3	Lactating sow LK-4
Barley, %	20.0	22.0	25.0
Triticale, %	12.5	10.0	11.0
Wheat, %	-	10.0	-
Oat, %	10.0	5.0	5.0
Corn, %	10.0	13.0	14.0
Wheat bran, %	20.0	3.5	3.0
Soybean meal, %	6.5	21.0	23.0
Sugar beet pulp, %	10.0	2.0	-
Apple meal (by-product from juice production), %	4.0	5.0	4.0
Lonacid – Acidifier, %	0.5	0.5	0.5
Specilac - (soybean replacement), %	-	-	5.0
Soybean oil, %	0.5	2.0	2.5
Premix Pregnat sow 6 %	6.0	-	-
Premix Lactating sow 6 %	-	6.0	6.0
Nutritive value			
Metabolizable energy, MJ/kg	12.50	13.5	13.8
Crude protein, %	14.0	17.6	19.6
Lysine, %	0.67	1.03	1.23
Methionine+cystine, %	0.51	0.64	0.70
Threonine, %	0.53	0.68	0.77
Tryptophan, %	0.17	0.21	0.25
Calcium, %	0.95	0.95	0.97
Digestible phosphorus, %	0.48	0.47	0.49
Sodium, %	0.25	0.24	0.25

Three types of diets were administered during the experiment (LL-1 until pregnancy day 90, LK-3 for late pregnant sows and LK-4 for lactating sows). The animals had free access to water. The composition and nutritional value of feed met the nutrient requirements of modern pig genotypes (Table 1).

Friable feed was bagged, and bags were marked as I (control) or II (experimental). Feed was produced 1–2 weeks before feeding, and its chemical composition (AOAC, 2000) was analyzed to ensure even distribution of ingredients. The experimental factor was a probiotic preparation containing live cultures of *Saccharomyces boulardii* (Levucell SB 10, Lallemnad) yeast. Diets were supplemented with the yeast preparation in the amount of 100 g/t of the feed (equal to $1.0x10^9$ cfu/kg of feed of the gestation and lactation diets).

The following parameters were monitored throughout the study:

1. sow breeding parameters (average reproductive cycle, farrowing rate, culling – number and cause, back fat thickness (P2) – measured during mating, parturition and weaning, duration of parturition and lactation). Back fat thickness at point P2 was measured with the RENCO LEAN–METER back fat scanner.

2. piglet rearing parameters (total number of piglets, piglets born alive, weak-born piglets, stillborn piglets, mummified fetuses; piglet weight, litter weight, culling and mortality rates).

The results were verified statistically by one-way analysis of variance and Duncan's test. Arithmetic means (x), standard errors of the mean (SEM) and significance levels (P) were determined. The results were processed with the use of STATISTICA software.

Results and Discussion

The results of the experiment are presented in Tables 2 and 3. The average reproductive cycle of control and experimental sows (Levucell SB) reached 2.74 and 2.78, respectively. Experimental sows were characterized by higher mating success (70.34%) than control group animals (66.40%). Relatively low mating success values (approximating 70%) could be attributed to high incidence of disease at the farm (streptococcosis, dysentery, adenomatosis, spirochetosis, mycoplasma pneumonia, pleuropneumonia, swine erysipelas, porcine parvovirus infection, contagious atrophic rhinitis, colibacteriosis, stable European PRRS strain, stable North American PRRS strain, circovirosis) and the introduction of a large number of commercially acquired gilts into the herd. Sows in the disease-ridden farm fed a diet supplemented with probiotics were characterized by higher farrowing rate than control group animals. The experimental factor had no significant effect on culling rates during the experiment (Table 2). Probiotic supplementation alleviated certain reproductive problems in sows (abscess, abortion), but it did not affect the animals' health condition or the duration of parturition.

Natural immunity mechanisms are often weakened during pregnancy, lowering the immune response to pathogens and increasing the animals' susceptibility to disease. Probiotic supplements added to diets for pregnant sows boost cell-mediated immunity by stimulating the proliferation of different classes of lymphocytes. A study conducted by Shierack et al. (2009) demonstrated that the supplementation of diets fed to pregnant sows with probiotic bacteria *B. cereus var. toyoi* stimulated the proliferation of CD21+, CD4+ and CD8+ lymphocytes, the key elements of the porcine immune system. Probiotics also stimulate humoral immunity by increasing the production of antibodies.

Table 2**. Effect of probiotic on sow performance**

	Control	Levucell SB 10 MB*	SEM	*P-value*
Number of sows, n	125	118		
primiparous	57	51		
multiparous	68	67		
Average sow parity	2,74	2.78		
Culled sows, %				
abscess	5.60	2.54	1.277	0.232
abortion	3.20	0	0.818	0.050
lameness	0	0.85	0.412	0.304
mortality	0.80	0	0.412	0.332
Farrowing rate , %	66.40	70.34	2.991	0.511
Parturition lenght, h	2.53	2.68	0.088	0.439
Back fat (P2), mm				
breeding	19.90	20.44	0.731	0.718
farrowing	22.76	22.70	0.428	0.941
weaning	18.28	18.20	0.382	0.921

* 0.1 g/kg of diet for pregnant and lactation sows

The above has been validated by studies investigating the health effects of dietary supplements containing *Bacillus cereus var. toyoi* NCIMB 40112 probiotic bacteria fed to pregnant and nursing sows (Scharek *et al.,* 2007). A significant increase in IgA immunoglobin levels was observed in the feces of experimental pigs. The blood levels of IgG antibodies were not elevated, suggesting that probiotic bacteria affect gut-associated lymphoid tissue (GALT). Other experiments (Alexopoulos *et al*., 2004) have shown that the use of the probiotic supplement BioPlus 2B (*Bacillus licheniformis* and *Bacillus subtilis*) enhanced the health and fertility of sows. A higher number of control group animals (13.0%) not receiving the supplement were diagnosed with the MMA syndrome in comparison with experimental sows (5.7%). In the group of pigs fed with BioPlus 2B, higher mating success also was observed in the successive reproductive cycle.

In this experiment, probiotic supplementation had no significant effect on back fat thickness measured at point P2 (body condition score). In control group sows, back fat thickness at point P2 was determined at 19.90, 22.76 and 18.28 mm during mating, parturition and weaning, respectively. No significant correlations ($P \leq 0.05$) were observed between the experimental factor and the total number of piglets, piglets born alive, stillbirths and mummified fetuses (Table 3). Sows whose diets were supplemented with probiotics showed a trend towards a greater litter size, yet owing to a higher number of weak-born piglets ($P \leq 0.05$) in this group, no variations were reported in the average size of litters aged 21 and 28 days between groups. A higher number of weak-born piglets resulted in higher mortality rates at the beginning and throughout the nursing period. The average birth weight of piglets was similar in both groups.

Table 3. **Effect of probiotic on litter performance**

	Control	Levucell SB 10 MB*	SEM	*P-value*
Lactation length, d	27.51	27.56	0.213	0.895
Litter response criteria				
1st day				
Number of piglets per litter				
Total born	11.59	12.06	0.299	0.436
Born alive	10.99	11.50	0.292	0.381
Weak	0.20	0.47^{b}	0.056	0.015
Stillborn	0.61	0.56	0.081	0.782
Mummies	0.18	0.36	0.065	0.153
Litter weight, kg	18.64	18.46	0.392	0.802
Piglet weight, kg	1.66	1.59	0.022	0.141
21st day				
Number of piglets per litter	10.34	10.30	0.046	0.650
Litter weight, kg	69.09	65.92	0.907	0.080
Piglet weight, kg	6.61	6.45	0.082	0.326
Mortality till 21st days, %	5.99^{A}	9.92	0.681	0.004
28st day				
Number of piglets per litter	10.32	10.26	0.045	0.550
Litter weight, kg	81.71	81.02	0.962	0.721
Piglet weight, kg	7.92	7.92	0.092	0.989
Mortality 21-28 days, %	0.23	0.34	0.126	0.662
Mortality till 28th days, %	6.18^{A}	10.23^{B}	0.696	0.003

a, b – $P \leq 0.05$
A, B – $P \leq 0.01$

The supplementation of diets with probiotics improves the health condition of sows and piglet rearing results. According to published data, the administration of probiotics (*Enterococcus faecium* DSM 7134) to primiparous sows between pregnancy day 90 and lactation day 28 increased feed consumption and litter size (B□hmer *et al*., 2006). The average litter weight on lactation day 28 was 11 kg higher in comparison with the litters of control group sows. In other studies, the administration of probiotic yeast to pregnant and nursing sows had a beneficial influence on piglet rearing parameters (Kim *et al.*, 2008). The litters of sows whose diets were supplemented with the studied probiotic preparation were characterized by higher daily gains in

comparison with the offspring of control group sows.

Conclusions

The following conclusions can be drawn from the results of this study:

1. The supplementation of diets fed to sows with a probiotic preparation (*Saccharomyces cerevisiae boulardii*) alleviated certain reproductive problems (abscess, abortion).

2. The farrowing rate of sows whose diets were supplemented with probiotics was 4% higher despite lower vitality levels in the experimental group.

3. The probiotic supplement fed to pregnant and nursing sows did not affect the animals' body condition score in terms of back fat thickness at point P2 or the duration of parturition.

4. The sows fed the probiotic supplement showed a trend towards a greater litter size, yet owing to a higher number of weak-born piglets in the experimental group, no variations were reported between groups as regards the average size of litters aged 21 and 28 days.

5. The probiotic supplement had no significant effect on the body weight of piglets determined at birth, and on day 21 and 28.

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