Effect of Digested Bacterial Cell Powder (DBCP) on Performance of Primiparous Sows and Suckling Piglets

Jowaman KHAJARERN, Sarote KHAJARERN,
Saksit SRINONGKOTE* and Yasuhiko TORIDE**

Faculty of Agriculture, Khon Kaen University, Khon Kaen 40002, Thailand

* Bangkok Animal Research Center Co., Ltd., 487/1 Si Ayutthaya Rd.,
Kwaeng Thanon Phayathai, Khet Ratchathewi,
Bangkok 10400, Thailand

** Ajinomoto Co., Inc., Chuo-ku, Tokyo 104-8315

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Abstract Effects of the oral administration of digested bacterial cell powder (DBCP) prepared from *Brevibacterium lactofermentum* in primiparous sows and suckling piglets were studied. The administration of DBCP to gestating sows resulted in more piglets per litter at farrowing. The administration of DBCP decreased *Escherichia coli* count in feces of sows and tended to increase total protein, beta-lactoglobulin, gamma-lactoglobulin levels in sows' colostrum. These effects of DBCP may be caused by the immunopotentiating activity of peptidoglycan, which is contained in DBCP. Giving DBCP to sows from the sixteenth day of gestation through lactation and to suckling piglets through creep feed achieved the best litter performance (the biggest litter size and the highest litter weight at weaning).

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Key words : Peptidoglycan, Diarrhea, Immunopotentiator, Sow, Piglet, Litter size

In our previous report, digested bacterial cell powder (DBCP) derived from *Brevibacterium lactofermentum* was shown to be effective in reducing diarrhea morbidity and mortality in suckling piglets⁶⁾. DBCP showed strong activity in stimulating macrophage cells. It was suggested that peptidoglycan, a cell wall component of bacteria, was the active substance for stimulating immunity against infectious diarrhea.

It was also reported that the administration of DBCP to sows could reduce the incidence of diarrhea and improve the survival rate in suckling piglets⁸⁾.

The present study investigated the effects of DBCP administration to sows on the litter performance, *Escherichia coli* count in feces and the

composition of sow colostrum. The appropriate period of DBCP administration to achieve the best litter performance was also studied.

Materials and Methods

DBCP preparation

DBCP was prepared by treating autoclaved whole cells of *Brevibacterium lactofermentum* ATCC 13859 with lysozyme and protease as described in the previous report⁶⁾.

The following sow trial and the piglet trial were conducted in a commercial farm in Thailand.

Sow trial

Forty-five Landrace × Large White primiparous sows were divided into 3 groups and fed diets shown in Table 2 individually.

Primiparous sows were used in order to avoid parity effects. The first group of 15 sows were used as the control. The second group of 15 sows were provided with DBCP from 83 days of the gestation period until the end of the lactating period. The third group of 15 sows were provided with DBCP from 16 days of gestation period until the end of the lactation period.

Colostrum of sows was sampled during the first 3 days of lactation and the contents of total solid, crude fat, crude protein and ash were determined. The protein was fractionated to determine beta-lactoglobulin and gamma-lactoglobulin contents⁴.

Feces samples of sows were collected at the start, 3, 13, 16 and 18 weeks of the trial period. *Escherichia coli* in the samples were counted

using MacConkey agar plate^{1,3}.

Piglet trial

After farrowing, the sows in each group were divided into three treatments with 5 sows per treatment. Suckling piglets of each treatment was given creep feed 1) without both DBCP and antibiotics, 2) with DBCP and 3) with antibiotics as shown in Table 1. The same creep feed was given to the suckling piglets in a litter by group feeding. The antibiotics used in creep feed were furazolidone (220 ppm) and Oxytetracycline (150 ppm). The dosage of DBCP to sows was 300 mg/day/head. The DBCP supplementation in creep feed was 0.01%. The compositions of diets are shown in Table 2.

Statistical analysis

Data were analyzed as a randomized

Table 1. Design of pig trial

Group 1 (15 sows) Control No DBCP	T1	Piglets (5 sows) No DBCP or antibiotics
	T2	Piglets (5 sows) Fura 220 ppm OTC 150 ppm
	T3	Piglets (5 sows) DBCP 0.01%
Group 2 (15 sows) DBCP 300 mg/day/sow from 83 days of gestation to lactation	T4	Piglets (5 sows) No DBCP or antibiotics
	T5	Piglets (5 sows) Fura 220 ppm OTC 150 ppm
	T6	Piglets (5 sows) DBCP 0.01%
Group 3 (15 sows) DBCP 300 mg/day/sow from 16 days of gestation to lactation	T7	Piglets (5 sows) No DBCP or antibiotics
	T8	Piglets (5 sows) Fura 220 ppm OTC 150 ppm
	T9	Piglets (5 sows) DBCP 0.01%

DBCP : Digested Bacterial Cell Powder

Fura : Furazolidone

OTC : Oxytetracycline

Table 2. Composition of experimental diets

Ingredients	Sow feed		Creep feed
	Gestation	Lactation	
Broken rice	66.84	60.36	39.43
Rice bran	15.00	15.00	3.00
Soybean meal	11.00	15.00	15.50
Soybean (extruded)	—	—	12.00
Fish meal	4.00	6.50	8.00
Skim milk	—	—	12.00
Dextrose	—	—	6.00
Rice bran oil	—	—	1.50
SMO (Flavoring)	—	—	0.50
Dicalcium phosphate	1.60	1.60	1.00
Vitamin-mineral mixes*	0.50	0.50	0.50
DL-Methionine	0.10	0.11	0.12
L-Lysine HCl	0.16	0.18	0.15
Salt	0.40	0.35	0.30
DBCP ^a	±	±	±
Limestone	0.40	0.40	—
Antibiotics ^b			±

* NRC (1984)

^a DBCP=Digested Bacterial Cell Powder^b Antibiotics=oxytetracycline plus furazolidone

Table 3. Effect of digested bacterial cell powder (DBCP) on sow performance

Item	Group 1 Control	Group 2 DBCP 300 mg/d 83 d-G and L	Group 3 DBCP 300 mg/d 16 d-G and L	Pooled SE
Number of sows	15	15	15	
Piglets per sow at farrowing*	9.07 ^b	9.20 ^{ab}	9.93 ^a	0.324
Piglets survived per sow at farrowing*	8.80 ^b	9.13 ^{ab}	9.73 ^a	0.362
Survival rate at farrowing, %	97.06	99.28	97.98	2.130
Total weight of piglets born alive per sow, kg	14.44	14.88	15.26	0.625

* ^{a,b} Means with different superscripts within the same row were different $P < 0.05$.

complete block design using the GLM procedure of SAS (1985).

Results

Sow trial

The effects of DBCP administration to sows on litter performance are shown in Table 3. Giving DBCP from 16 days of gestation (Group 3) significantly increased the litter size at

farrowing ($P < 0.05$).

The nutritive composition of sow colostrum is shown in Table 4. Although there were no significant difference among three groups for all the items, DBCP treated group tended to show higher protein content, which may be attributed to higher content of beta-globulin and gamma-globulin. The administration of DBCP to sow significantly decreased the *E. coli*

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count in feces of sows as shown in Table 5. In Group 2 and 3, the decrease was observed about one week after the DBCP administration was started (on 83 days of gestation for Group

2 and on 16 days of gestation for Group 3).

Piglet trial

The effects of DBCP supplementation in sow feed and creep feed on the performance of

Table 4. Effect of digested bacterial cell powder (DBCP) on composition of sows' colostrum

Constituents	Group 1 Control	Group 2 DBCP 300 mg/d 83 d-G and L	Group 3 DBCP 300 mg/d 16 d-G and L	Pooled SE
Total solid, %	21.04	21.48	21.69	1.020
Fat, %	9.86	10.16	10.02	0.370
Protein, %	3.49	3.98	4.02	0.216
Beta lactoglobulin, %	0.85	0.98	1.01	0.059
Gamma lactoglobulin, %	0.74	0.82	0.94	0.058
Ash, %	0.87	0.91	0.89	0.037

Table 5. Effect of digested bacterial cell powder on *Escherichia coli* count in feces of sows (Bacterial count, *E. coli*/g feces)

Time of testing	Group 1 Control	Group 2 PG 300 mg/d 83 d-G and L	Group 3 PG 300 mg/d 16 d-G and L
Initial	5.68×10^9	5.72×10^9	5.69×10^9
3 weeks	5.72×10^{9a}	5.16×10^{9a}	8.42×10^{7b}
13 weeks	5.82×10^{9a}	6.16×10^{7b}	2.86×10^{6c}
16 weeks	6.12×10^{9a}	3.26×10^{6b}	3.41×10^{6b}
18 weeks	5.96×10^{9a}	3.14×10^{6b}	3.28×10^{6b}

^{a, b, c} Means with different superscripts with the same row were different $P < 0.05$.

Table 6. Effect of digested bacterial cell powder (DBCP) supplementation in sow feed and creep feed on the performance of suckling piglets

	No DBCP added Control			DBCP 300 mg/d 83 d-G and L			DBCP 300 mg/d 16 d-G and L			Pooled SE
	T ₁ None	T ₂ + Anti	T ₃ + DBCP	T ₄ None	T ₅ + Anti	T ₆ + DBCP	T ₇ None	T ₈ + Anti	T ₉ + DBCP	
Survival rate at weaning, %*	77.01 ^b	95.29 ^{ab}	96.70 ^{ab}	97.77 ^a	100 ^a	100 ^a	97.93 ^a	100 ^a	100 ^a	5.663
Total wt. of piglets at weaning/sow, kg*	54.48 ^c	56.65 ^c	58.31 ^{bc}	60.88 ^b	65.46 ^{ab}	64.34 ^{ab}	64.28 ^{ab}	67.74 ^a	68.80 ^a	4.577
Diarrhea morbidity, %*	72.27 ^a	21.86 ^b	19.00 ^b	22.04 ^b	2.21 ^b	2.21 ^b	6.19 ^b	2.08 ^b	2.08 ^b	2.120
Lasting of diarrhea, days*	10.8 ^a	4.6 ^b	5.0 ^b	5.1 ^b	2.1 ^b	2.4 ^b	4.6 ^b	2.8 ^b	2.5 ^b	0.758

^{a, b, c} Means with different superscripts within the same row were different $P < 0.05$.

suckling piglets are shown in Table 6. Supplementing DBCP or antibiotics in creep feed decreased diarrhea morbidity in piglets. The treatment with DBCP administration from 16 days of gestation until the end of lactation period together with DBCP supplementation in creep feed (T₉) showed the best litter performance (the highest survival rate and litter weight among the treatments).

Discussion

Neonatal diarrhea is one of the most important causes of economic loss in pig industry. Enterotoxigenic *E. coli* is among the major causes^{2,5,9}. Attempts have been made to apply peptidoglycan (or muramyl dipeptide) derived from cell wall of gram positive bacteria for the prevention of infectious diarrhea. Sasaki *et al.*⁷ reported that the oral administration of peptidoglycan derived from *Bifidobacterium thermophilum* to piglets increased IgA-bearing cells of lamina propria and decreased the *E. coli* count in the small intestine.

The present study also confirmed that DBCP, which contained peptidoglycan derived from *Brevibacterium lactofermentum*, could effectively reduce the *E. coli* count in feces of sows. The administration of DBCP tended to increase the protein level of sow colostrum, especially the levels of beta-lactoglobulin and gamma-lactoglobulin. This tendency may be explained by the enhanced immunity caused by peptidoglycan. These effects may have contributed positively to the better performance of suckling piglets.

The present study has shown that giving DBCP from the early stage of pregnancy (16 days of gestation) could increase the number of piglets born alive. This result is consistent with the result of the previous report (DBCP administration from 60 day pre-partum). The mechanism of increasing litter size at farrow-

ing by the administration of DBCP to gestating sows is not clear. Further studies are needed to identify active substances which caused the effect.

The supplementation of DBCP to diets for gestation and lactation and to suckling piglets significantly improved the litter performance. DBCP seems to be a promising natural ingredient to improve the efficiency of pig production.

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酵素処理菌体末 (DBCP) の初産母豚および 哺乳子豚の成績への効果

J. カジャラン・S. カジャラン・S. シリノンコート*・取出恭彦**

コンケン大学, コンケン 40002 タイ国

* バンコク アニマル リサーチセンター, バンコック 10400 タイ国

** 味の素(株), 東京都中央区 104-8315

Brevibacterium lactofermentum より調製された酵素処理菌体末 (DBCP) 経口投与の初産母豚および哺乳子豚に対する影響について研究した。DBCP を妊娠期に投与する事により, 出生時の一腹あたりの子豚数が増加した。DBCP の投与により, 糞中の *Escherichia coli* 数が減少し, また母豚初乳中の全タンパク質, β -ラクトグロブリン, γ -ラクトグロブリンの量が増加する傾向がみられた。これらの DBCP の効果は DBCP に含まれるペプチドグリカンの免疫賦活効果によるものと考えられた。DBCP を妊娠 16 日から, 授乳期まで投与し, 更に, 哺乳期に哺乳期用飼料添加により投与した場合が離乳時の一腹あたり子豚数および体重において最も良い成績が得られた。

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