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The potentials for immunostimulatory substances (β-1,3/1,6 glucans) in pig nutrition

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ABSTRACT

Two types of experiments (I and II) were carried out to test the potential of β-1,3/1,6 glucans as immunostimulatory substances in pig feed. In Experiment I, 34 sows were vaccinated against *E. coli* with 2 ml Nobivac Porcoli (Intervet) 3 weeks pre-partum. The treatment (17 sows) consisted of top dressing the feed daily with 2.5 g MacroGard, 7 days before vaccination until 2 weeks post-partum. No differences were noted in the number of piglets born dead or alive between the 2 groups, but the liveweight of the treated group on day 14 (3.91 kg) was significantly ($P<0.01$) lower than in the control group (4.50 kg). In addition, health scores in the control group were better than with the treatment ($P<0.01$). Slightly higher titers (non significant) of all determined antigens (K88ab, K88ac, K99, 987P, LT-toxoid) were found in the colostrum of treated sows while in the milk significantly higher titers of K88ab ($P<0.1$) and K99 antigens ($P<0.05$) were found in the treated sows. A stimulation of the sow's immunoreaction against vaccination seems therefore possible. Retarded recovery from neonatal diarrhoea in the treated group or lower milk production/consumption compared to the control group could have resulted in the poorer performances observed. In Experiment II, 2 x 60 piglets on sow farm I (high infection pressure), weaned at 26 days and 2 x 36 piglets on farm II (low infection pressure), weaned at 25 days, received a weaner diet (Milkivit, Trouw, Belgium) *ad libitum* supplemented or not with 0.05 % MacroGard. On farm I, the weight gain of the piglets in the treated group was significantly ($P<0.05$) higher than in the control group – after week 3. Health scores did not differ. Only on day 21 was a significantly lower antibody titer (987P antigen) noted in the serum of the treated piglets. A higher local immunity due to the glucans, resulting in a lower systemic immunity could have resulted in the lower serum titers. On farm II, no differences were noted for daily weight gain, health status or antibody titer level in the serum. In view of the increased antibody titers in the sow milk it seems possible to stimulate immunity in sows and piglets. On farms with high infection pressure, there may be scope to control the disease level by oral administration of natural β-1,3/1,6 glucans.

KEY WORDS: immunostimulatory substances, pigs

INTRODUCTION

Immunostimulants are chemical compounds that can activate the immune system of animals and hence render them more resistant to infections. Glucans from a variety of yeast cell walls have been shown to increase growth performances in pigs, probably by stimulating both specific and nonspecific immune responses, by enhanced tolerance to soyabean proteins and/or decreased inflammmatory cytokine responses (Schoenherr et al., 1994; Dritz et al., 1995; Killeen and Rosell, 1996; Raa, 1997). The exact mode of action is far from known. Oral addition of commercial β-1,3/1,6 glucans to piglets, experimentally infected with *E. coli,* resulted in an enhanced resistence to *E. coli* (Nutreco, personal communication). The objectives of this study were to reproduce the findings of this experimental model under more practical conditions.

MATERIAL AND METHODS

The experiments were carried out to test the potential of MacroGard-S™ (β-1,3/1,6 glucans extract from *Saccharomyces cerevisiae*; Biotec-Mackzymal A/S, Norway) as immunostimulatory substances in pig feed. In Experiment I, 34 sows were vaccinated against neonatal *E. coli* with 2 ml Nobivac Porcoli (Intervet International B.V., Boxmeer, NL) 3 weeks pre-partum. The treatment (17 sows) consisted of evenly spreading 2.5 g MacroGard over the daily feed portion starting 7 days before vaccination until 2 weeks post-partum. Post partum antibody titers (K88ab, K88ac, K99, 987P, LT-toxoid) in colostrum and milk were determined as well as recording the growth performances and health scores of the piglets according to the Nutreco protocol (Nutreco Nederland B.V., Boxmeer, NL). In Experiment II, 2 x 60 piglets on sow farm I (an older farm with presumably a high infection pressure) weaned at 26 days and 2 x 36 piglets on sow farm II (a new farm, low infection pressure), weaned at 25 days, received a weaner diet (Milkivit, N.V. Trouw, Belgium) *ad libitum* supplemented or not with 0.05% MacroGard. Growth performances, feed conversion ratio, health conditions and antibody titers in the blood of the piglets were noted. Antibody titers were determined according to the Porcoli-ELISA method (Intervet International B.V., Boxmeer, NL) and expressed as $\log_2$.

RESULTS AND DISCUSSION

Experiment I

No differences were noted in numbers of piglets born dead or alive between the 2 groups (Table 1). The liveweight of the treated group on day 14 (3.91 kg) was significantly ($P<0.01$) lower than in the control group (4.50 kg) (Table 2). In addition, the health condition of the control group was markedly better than that of the

TABLE 1

Influence of β-1,3/1,6 glucans addition to sow feed on the number of piglets born alive and dead (mean ± SD) (n=17)

	Control	Treatment
Alive	10.1±2.7	10.1±2.1
Dead	0.2±0.7	0.4±0.6

TABLE 2

Influence of β-1,3/1,6 glucans addition to sow feed on weight (kg) of piglets 0 and 14 days post-partum (mean ± SD) (n=17)

Day	Control	Treatment
0	1.58±0.18	1.49±0.16
14	4.50±0.39[a]	3.91±0.43[b]

means with different superscripts in the same row differ significantly (P<0.01)

treated group (P<0.01) (Table 3). Non significantly higher antibody titers against all tested antigens were found in the colostrum of treated sows while in milk significantly higher antibody titers of K88ab (P<0.1) and K99 antigens (P<0.05) were found in the treated sows (Table 4). A stimulation of the sow's immunoreaction against vaccination seems therefore possible. Retarded recovery from neona-

TABLE 3

Influence of β-1,3/1,6 glucans addition to sow feed on cumulative health score of piglets during 14 days post-partum (mean ± SD) (n=17)

Control	Treatment
55.8a	136.0b

means with different superscripts in the same row differ significantly (P<0.01)

TABLE 4

Influence of β-1,3/1,6 glucans addition to sow feed on antibody titer content of sow colostrum and milk (mean)

E. coli antigen	Colostrum day 0	Milk		
			day 14 post partum	
	control	treatment	control	treatment
K88ab	14.6	15.2	6.2[a]	7.1[b]
K88ac	14.0	14.3	6.0	6.4
K99	15.8	16.0	6.8[c]	7.6[d]
987P	15.7	15.9	6.9	7.4
LT	13.2	13.5	5.7	5.7

means with different superscripts in the same row differ significantly a, b P<0.1; c, d P<0.05

tal diarrhoea (other than *E. coli* diarrhoea against which the pigs were vaccinated) or lower milk production/consumption in the treated group compared to the control group could have resulted in the poorer performances of the piglets.

Experiment 2 – Sow farm I

After 2 weeks the mean weight gain of the piglets in the treated group on sow farm I, characterised by a high infection pressure, was significantly ($P<0.05$) higher than in the control group (Table 5). The data of Schoenherr et al. (1994) and Dritz et al. (1995) also indicated that improvement in weight gain occurred only after 14 days of glucan application. Health scores did not differ (Table 6). Only on day 21 was a significantly lower titer (987P) noted in the serum of the treated piglets (Table 7). A higher local immunity due to the glucans, resulting in a lower systemic immunity could have resulted in the lower serum antibody titer.

TABLE 5

Influence of β-1,3/1,6 glucans addition to weaner feed on zootechnical performances of piglets during 4 weeks post-weaning (mean±SD)

Week		Control	Treatment
1	ADFI g/day	161±3	166±16
	ADG g/day	65±21	54±15
	F/G	2.69±1.00	3.20±0.59
2	ADFI g/day	303±6	319±46
	ADG g/day	187±15	217±32
	F/G	1.63±0.14	1.47±0.03
3	ADFI g/day	510±76	551±50
	ADG g/day	335±40a	433±25b
	F/G	1.56±0.44	1.27±0.05
4	ADFI g/day	324±26	345±34
	ADG g/day	195±13a	235±21b
	F/G	1.67±0.23	1.47±0.04

means with different superscripts in the same row differ significantly ($P<0.05$)

TABLE 6

Influence of β-1,3/1,6 glucans addition to weaner diet on cumulative health score of piglets during 14 days post-weaning (mean)

Control	Treatment
49.9	48.2

TABLE 7

Influence of β-1,3/1,6 glucans addition to weaner diet on antibody titer content in serum of piglets during 21 days post-weaning

E. coli antigen	Day 1		Day 6		Day 21	
	C	T	C	T	C	T
K88ab	10.6	10.2	10.7	9.9	9.6	8.7
K88ac	10.2	10.1	10.5	9.8	9.1	8.4
K99	11.8	11.9	11.6	10.9	10.3	9.6
987P	11.4	11.7	10.9	11.0	10.6^{a}	9.2^{b}
LT	9.1	9.0	8.8	8.0	7.4	6.7

means with different superscripts in the same row differ significantly ($P<0.01$)

Experiment 2– Sow farm II

On sow farm II, characterised by a low infection pressure, no differences were noted in zootechnical performances of the piglets (Table 8), and only small differences were observed in health status (Table 9) and antibody titer level in the serum (K99 antigen on day 1) (Table 10). It must be stressed that the optimal inclusion level of β-1,3/1,6 glucans is between 0.025 % and 0.05 % in the diet (Schoenherr et al., 1994; Dritz et al., 1995) which is lower than that used in the present study (0.05%).

TABLE 8

Influence of β-1,3/1,6 glucans addition to weaner feed on zootechnical performances of piglets during 4 weeks post-weaning (mean ±SD)

Week		Control	Treatment
1	ADFI g/day	241±25	250±10
	ADG g/day	149±33	154±20
	F/G	1.65±0.25	1.64±0.17
2	ADFI g/day	326±27	345±8
	ADG g/day	269±28	287±18
	F/G	1.21±0.09	1.21±0.05
3	ADFI g/day	618±51	578±16
	ADG g/day	404±36	363±78
	F/G	1.53±0.07	1.64±0.32
4	ADFI g/day	395±25	391±6
	ADG g/day	276±26	268±30
	F/G	1.43±0.05	1.47±0.14

TABLE 9

Influence of β-1,3/1,6 glucans addition to weaner diet on cumulative health score of piglets during 14 days post-weaning (mean)

Control	Treatment
38.5[a]	31.3[b]

means with different superscripts in the same row differ significantly (P<0.01)

TABLE 10

Influence of β-1,3/1,6 glucans addition to weaner diet on antibody titer content in serum of piglets during 21 days post-weaning

E. coli antigen	Day 1		Day 6		Day 21	
	C	T	C	T	C	T
K88ab	9.0	8.2	9.1	8.3	7.3	7.3
K88ac	7.9	7.4	8.6	8.1	6.8	7.0
K99	10.8[a]	9.9[b]	10.8	10.5	8.5	8.6
987P	9.0	8.6	9.8	9.6	7.6	7.5
LT	6.6	6.6	6.9	6.6	5.9	6.1

means with different superscripts in the same row differ significantly (P<0.01)

CONCLUSIONS

Considering the increase in antibody titers achieved in sow milk, it seems to be possible to stimulate immunity in sows and piglets and on farms with high infection pressure. There is thus scope to control disease level by oral administration of natural β-1,3/1,6 glucans. This is promising, as the use of antibiotics is in growing dispute. Nevertheless, there are still many unknown factors, which need to be resolved, concerning optimal dose, time and duration of administration, feed formulation and their role in the interaction of the immune response (disease susceptibility) and growth performance.

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