Studies on Piglet Diarrhoea Associated With Enterotoxigenic *Escherichia Coli* and Its Control By Vaccination

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ABSTRACT

Piglet neonatal diarrhoea occured in all the piggeries studied in Indonesia. Field studies demonstrated the prevalence of diarrhoea in all piggeries were at range from 13.4% to 43.7% with and average 24.7%. The majority of piglets with diarrhoea were in the first 2 weeks of life. Mortality of piglets were at rates between 12.2% to 31.6% with an average 17.9%. The distribution of piglet mortality preceded by diarrhoea recorded in an intensive study in a piggery G for a seven week period showed a high positive correlation with diarrhoea (r^2 = 0.79; P<0.01), thus confirming that diarrhoea has a significant influence on mortality during the neonatal period. Piglet neonatal diarrhoea was found to be associated with enterotoxigenic *Escherichia coli* (ETEC) expressing either the 987P, F41, K99 or K88 fimbrial antigen. *E. coli* expressing for more than one fimbrial antigen K88, K99 and K99 F41 were also found in a limited numbers. *E. Coli* 987P predominated, all were non haemolytic, majority were associated with O-group 20, less frequently with either O_9 or O_{141}. *E. coli* F41 isolates were non haemolytic and associated with either O-group 101 or O-group 9. *E. coli* K99 isolates were associated with either O-group 20, 64, or O-group 101. *E. coli* K88 isolates were haemolytic and associated with either O-group 108, 138, 149 or 157. Attempts to control piglet neonatal diarrhoea associated with ETEC by antibiotic treatments on farm were reported unsuccessful. Antibiotic sensitivity assays of *E. coli* isolates bearing either K88, K99, F41 or 987P fimbrial antigen confirmed a high level of multiple antibiotic resistant between 4 to 6 antibiotics, including streptomycin, ampicillin, oxytetracycline, kanamycin, neomycin, trimethoprim and suphamethoxazole and sulphonamides. *E. coli* K99 showed higher level resistant up to 9 of antibiotics tested. As an alternative to chemotherapy with antibiotics, a vaccination strategy was investigated. An inactive multivalent ETEC vaccine containing K88, K99, F41 and 987P fimbrial antigens and somatic antigens of O-group 9, 20, 64, 108, 138, 149 and 157 was prepared. Field trials to control piglet neonatal colibacillosis were conducted in some piggeries. The local field isolate vaccine was compared to a similar commercial vaccine acquired from abroad which content 5 important fimbrial antigens. Pregnant sows were injected intramuscularly with 2 ml of vaccines 6 weeks and again 2 weeks before expected date of farrowing. Piglets born from vaccinated and unvaccinated sown were allowed to suckle their own mothers. Pregnant sow vaccination produced a highly significant reduction diarrhoea and mortality rates.

Key words : piglets, diarrhoea, *E. coli*, control, vaccine.

INTRODUCTION

Colibacillosis is a general term for the disease caused by *Escherichia coli (E. coli)*. This disease may take either enteric or non-enteric forms. The disease is classified into four categories, namely : enterotoxic, enterotoxaemic, septicaemic and locally invasive colibacillosis (Moon, 1974). The first three are considered important diseases in food-producing animals and have a world-wide distribution (Tzipori, 1981, 1985a, b).

Enterotoxic colibacillosis follows infection with proliferation of enteropathogenic *E. coli* strains in the intestine, whereby they produce enterotoxins which stimulates hypersecretion of body fluids from the small intestine. Enterotoxic colibacillosis is also known as enteric colibacillosis, enteric *E. coli* infection, *E. coli* diarrhoea or cholera-like *E. coli* infection. This disease represents a major problem in the livestock industry, especially in dairy calves and piglets which are raised under intensive husbandry conditions (Gyles et al., 1971; Schnoenaers and Kaeckenbeck, 1975; Acress et al., 1977; Harnet and Gyles, 1983). Neonatal diarrhoea caused by enteropathogenic *E. coli* remains one of the most important causes of mortality in newborn animals and it remain unresolved and difficult to control especially in the less developed countries of the world. Diarrhoea disease in calves and piglets is thought to be widespread in many parts of Indonesia, where dairy cattle and pigs are raised under intensive conditions and poor management (Suastawa, 1983; Hartaningsih and Hassan, 1985; Supar and Hirst, 1985; Supar, 1986).

The pig population in Indonesia was about 7 million, and the pig population is steadily increase at average 9% annually. Domestic consumption in recent years was about 1.4 million pigs per year (Indonesian Directorate General Livestock Services, 1988). Non oil exports are being vigorously encouraged by the Government of Indonesia to broaden the export commodity base as a hedge against reliance on the major commodity-oil. Recently, large pig production units have been developed on islands of Batam and Kalimantan. These units produced pigs for overseas markets especially for Singapore (Pusat Penelitian dan Pengembangan Peternakan, 1991). Another area which has a high pig population is North Sumatra Province which supplied pigs to Java as well as exports markets.

Associated with the development of commercial pig industry is the emergence of problems which are the inevitable of intensification. One of the most serious problems on the most farms studied is neonatal diarrhoea. The majority of losses occur in the first or second week life. Moreover, diarrhoea may persist in a groups of older animals for several weeks contributing to the increased production cost though medication to control the disease. The significant of the disease was indicated by the high mortality rate of 20% to 30% within the first 3 weeks of life (Supar et al., 1988).

Pig producers have come to rely on the use of antibiotics for the treatment of piglet diarrhoea. Antibiotics are administered either orally or given by intramuscular injection. However, control of the disease is reported to be unsatisfactory and the diarrhoeal cases and mortality of piglets remain high (Mudigdo and Peranginangin, 1983; Hartaningsih and Hasan, 1985). Antibiotic sensitivity studies of enteropathogenic *E. coli* from piglets with diarrhoea have shown multiple resistance up to 9 antibiotics (streptomycin, neomycin, kanamycin, tetracycline, oxytetracycline, erithromycin, trimethoprim/sulphamethoxazole, chloramphenicol, sulphonamides) (Supar et al., 1990). It is likely that the common antimicrobial drugs used by pig producers are no longer effective for treatment of piglet neonatal diarrheoa.

In view of inefficacy of antibiotics to control piglet neonatal diarrhoea associ-

ated with ETEC, studies on the development of a multivalent vaccine of *E. coli* to control the disease were carried out.

MATERIALS AND METHODS

Prevaccination studies

Two piggeries (IB and R) in Bogor West Java were visited weekly for seven weeks (June-July 1988). Three piggeries (G, BT, L) in Kapuk, Jakarta Capital Territory were visited weekly for seven weeks (June-July 1988) and five small piggeries (AT, SH, AS, BS, TM) were visited once only. Two medium piggeries (D and TW) in Bandung were visited once in Februari 1988. Two lage piggeries (KJP and KJT) in Tangerang West Java were visited weekly for a month (Januari 1991 and March 1991 respectively). Five large piggeries (DG, SM, MJ, JV, SK, SL) in Medan North Sumatra were visited in May 1991. The pigs were cross bred being derived from original Landrace, Large White, Yorkshire, Duroc, Lieske, Petren, Harmshire padigree Stock imported from the USA and Europe.

Sows were identified by ear tags code numbers. The date of birth of farrowing sow and the number of piglets borne was recorded on a pen card hung on each farrowing pen. The daily piglet mortality in each litter was recorded on the pen card by the pigman, the clinical signs which preceded piglet death were observed and marked as diarrhoea and others relevant data were recorded at the time of piggery visits. Diarrhoea cases were recorded by an examination of each litter during piggery visits.

Rectal swabs were collected from all diarrhoeic piglets and some from normal piglets. Each swab sample was put into Amies' transport medium and transported to the laboratory for *E. coli* isolation.

Each swab was inoculated onto a Mac Conkey agar plate and 5% sheep blood agar (SBA) and incubated at 37°C overnight. All haemolytic *E. coli* colonies were wubcultured on nutrient agar slope and incubated at 37°C overnight for K88 antigen detection the following day by slide coagglutination reaction (Murray, 1987). Five to eight lactose fermenting colonies on the Mac Conkey agar from each sample were subculture onto Minca+Iso Vitalex agar slope and incubated at 37°C overnight (Guinee et al., 1976; 977). These were used for detection of K99, F41 of K99 F41 fibrial antigens the following day by slide coagglutination reaction (Murray, 1987). Any *E. coli* negative for K88, K99, F41, K99F41 was subcultured into tryptic soy broth (TSB) (Difco) prepared in a test tube and incubated statically at 37°C for 7 to 10 days. The pellicles or deposits were plated onto 5% SBA and incubated at 37°C overnight for detection of the presence of 987P fimbrial antigen (Guinee et al., 1980).

Vaccine studies

Field isolates of *E. coli* expressing either K88, K99, F41, or 987P fimbrial antigens which originated from piglets with diarrhoea from piggeries in Bogor and Jakarta were selected to produce a whole cell vaccine. These isolates were associated with O-groups 9, 20, 64, 108, 138, 149, and 157. The cells were inactivated with formalin to a final concentration of 0.02% and aluminium hydroxide gel was added to a final concentration of 6% and blended to contain a final concentration of cells equal to the No. 10 tube of the MacFarland standards. A polyvalent *E. coli* vaccine containing K88, K99, F41 and 987P fimbrial antigens was prepared.

Vaccine field trials on pregnant sows to determine the efficacy of vaccine produced on reducing piglet neonatal diarrhoea and mortality. First trials were conducted in Bogor and Jakarta Capital territory areas (April 1989 - January 1990). Pregnant sows were injected with 2 ml of vaccine 6 weeks and again 2 weeks before expected date of farrowing. Piglets born from these animals

were allow to suckle their own mothers under field conditions. Farm visits were carried out twice a week to record diarrhoea and mortalities within the first two weeks post farrowing. During these visits rectal swabs were taken from all piglets with diarrheoa to determine the presence of ETEC. This vaccine was compared with a similar commercial vaccine acquired from abroad, which contained four important fimbrial antigens but lacking in a number of the O-group antigens. After data from the first trials were obtained, the second trials were conducted in Tangerang West Java, from January to August 1991, and the third trials were conducted in North Sumatra from May to August 1991.

RESULTS AND DISCUSSION

Prevaccination studies

Field studies recorded that the prevalence of diarrhoea in all piggeries occured at rate of 13.4% to 43.7% in piglets with an average of 24.7%. The majority of the piglets with diarrhoea were in the first week 56.4% and second week 29%. The prevalence of piglet mortality within the first 2 weeks of age was at the rate between 12% and 31.6% with an average of 19.0% (1008/5302) within a seven week period (June-July 1988) (Table 1). There is a clear association between diarrhoea and mortality. As diarrhoea increased so did the mortality.

Table 1. Prevalence of diarrhoea and mortality of piglets in large, medium and small piggeries recorded at prevaccination studies.

Farm	No of piglets born alive	Piglets examined			Mortality within 2 weeks of age	
		No. at visits	Diarrhoea			
			No.	%	No.	%
Large						
R. Bogor	1260	1083	145	13.4	177	14.0
IB. Bogor	810	711	98	13.8	99	12.2
KJP Tangerang	837	679	180	26.5	158	18.9
KJT Tangerang	1326	1101	316	28.7	225	16.9
G Jakarta	1631	1199	524	42.7	342	26.5
BT Jakarta	1010	826	176	21.7	184	18.2
L Jakarta	277	226	64	28.3	51	18.4
DG Medan	127	111	23	20.7	16	12.6
SM Medan	285	251	57	22.7	34.	11.9
MJ Medan	398	344	63	18.3	54	13.6
JV Medan	144	119	18	15.1	25	17.4
SK Medan	136	120	24	20.0	16	11.8
Medium						
D Bandung	68	56	13	23.2	12	16.6
TW Bandung	87	73	11	15.1	14	16.1
Small						
AT Jakarta	38	30	5	16.7	8	21.1
SH Jakarta	38	26	5	19.2	12	31.6
AS Jakarta	37	26	7	26.9	11	29.7
BS Jakarta	18	15	6	40.0	3	16.7
TM Jakarta	28	23	5	21.7	5	17.9
Total	8555	7019	1740	24.7	1536	17.95

The age distribution of piglet mortality preceded by diarrheoa in a piggery (G) recorded in an intensive study for a four month period (June to September 1988) are shown on Table 2. These data were statistically analysed (Steel and Torrie, 1987). The distribution of piglets with diarrhoea and the associated mortality showed a high positive correlation ($r^2 = 0.79$; $P<0.01$), thus confirming that diarrhoea has a significant influence on mortality rate during the neonatal period.

Piglet neonatal diarrhoea was found to be associated with ETEC. *E. coli* expressing either the 987P, F41, K99, or K88 fimbrial antigen were isolated from more than 90% of piglets with diarrhoea. *E. coli* expressing a combination of more than one fimbrial antigen (K88K99, K99F41) were also found in limited numbers. In addition,

Table 2. Age distribution of piglets mortality preceded by diarrhoea in 1631 piglets born alive in piggery G in Jakarta recorded at prevaccination studies (June - September 1988)

Age (days)	Diarrheoa		Deaths		No of piglets Remaining in each group
	No.	%	No	%	
0					1631
1	40	2.49	25	1.53	1606
2	38	2.49	60	3.73	1546
3	76	5.07	47	3.04	1499
4	49	3.34	33	2.20	1466
5	33	2.29	28	1.90	1438
6	38	2.69	28	1.94	1410
7	26	1.87	26	1.84	1384
8	30	2.21	28	2.02	1356
9	24	1.80	26	1.91	1330
10	27	2.06	25	1.87	1305
11	15	1.16	11	0.84	1294
12	17	1.13	12	0.92	1282
13	12	0.94	10	0.78	1272
14	13	1.03	9	0.71	1263
15	12	0.96	9	0.71	1254
16	5	0.40	4	0.32	1250
17	6	0.48	9	0.72	1241
18	7	0.57	9	0.73	1232
19	9	0.73	3	0.24	1229
20	6	0.49	5	0.41	1224
21	8	0.65	2	0.16	1222
23	4	0.32	3	0.24	1219
24	5	0.41	2	0.16	1217
25	3	0.24	4	0.33	1213
26	6	0.49	3	0.24	1210
27	6	0.49	0	0	1210
28	3	0.25	4	0.33	1206
29	2	0.17	3	0.24	1203
30	3	0.25	4	0.33	1199
31	1	0.08	0	0	1199
Total	524	432			

haemolytic *E. coli* which lack either the K88, K99, F41 or 987P fimbrial antigen, but associated with either K81, K85ab or K85ac capsular antigen were isolated from limited numbers of piglets with diarrhoea.

The predominant challenge in both piggeried studied was *E. coli* 987P. All of these isolates were non-haemolytic and associated with a limited number of O-serogroups. The majority of the isolates were associated with O-group 20, less frequently with either O-group 9 or 141. *E. coli* F41 from piglets were all non-haemolytic and associated with either O-group 101 or 9. All *E. coli* K99 from piglets were non-haemolytic and associated with either O-group 20, 64, 101. *E. coli* K88 were all haemolytic and associated with either O-group 108, 138, 149 or 157. Haemolytic *E. coli* that lack of K88 fimbrial antigen but express either K81, K85ab or K85ac capsular antigen were associated with O-group 115, 138, 141, or 157. *E. coli* K88 K99 isolates were haemolytic and were associated with O-group 108, whereas *E. coli* K99 F41 were non haemolytic and associated with O-group 101. Piglets with diarrheoa excreting *E. coli* bearing either K99, F41 or 987P were aged up to 14 days, but were predominantly in their first week of life. *E. coli* K88, however, were excreted by piglets with diarrhoea over a wide age range from one day old to post weaning.

Antibiotic sensitivity assays of 500 *E. coli* bearing either K88, K99, F41 or 987P showed a high level of multiple antibiotic resistance to between 4 to 6 antibiotics including streptomycin, ampicillin, oxytetracycline, kanamycin, neomycin, trimethoprim-sulphamethoxazole and sulphonamides. *E. coli* K99 showed the highest level of resistant to up to 9 of the antibiotics tested. Oxytetracycline appeared to be ineffective; 90% to 99% of each

Table 3. Linkages of a multiple resistance to antibiotic of 500 of E. coli K88, K99, F41 and 987 isolated from piglets with diarrhoea

	AM	S	N	OT	E	K	SXT	C	SSS	GM	FT	PB
500												
AM	139	122	109	131	25	109	52	62	125	1	1	–
S		310	228	302	67	216	90	75	285	–	1	–
N			272	270	60	219	90	76	270	1	–	–
OT				479	101	221	94	76	333	1	1	–
E					116	38	17	9	90	–	1	–
K						226	101	72	205	–	1	–
SXT							109	61	105	–	–	–
C								81	75	1	1	–
SSS									333	1	1	–
GM										1	–	–
FT											1	–
PB												–

Am : Ampicilin
S : streptomycin
N : Neomycin
OT : Oxytetracycline
E : erythromycine
K : Kanamycin
AXT : Trimethoprim/sulphamethoxazole
C : Chloramphenicol
SSS : Sulphonamides
GM : Gentamicin
FT : Nitrofurans
PB : Polymicin B sulphate

E. coli tipe was resistant to this drug (Table 3). It was likely that gentamicin was effective to be used to treat piglet diarrheoa in the field. This antibiotic was used to treat piglet diarrheoa in the piggery G. The emergence of resistance to gentamicin in *E. coli* K88, K99 and 987P up to 64% (116/180) occurred after this drug had been used continuously for three months.

The multiple resistant pattern in each *E. coli* fimbrial type was different from one to the others. This was possibly a reflection of a unique set of resistant determinants carried by different plasmids in each of the types. The multiple antibiotic resistant pattern for each *E. coli* type in each piggery was also slightly different from one to the others. This was likely due to selection pressure of different ranges of antibiotics used in each piggery to treat piglets with diarrhoea.

Pregnant sows were injected with 2 ml of vaccine 6 weeks and again 2 weeks before their expected date of farrowing did non cause abortion. No side effect of any kind was reported from both locations either of the field trial.

Field trials of the polyvalent vaccine prepared to control neonatal colibacillosis were conducted in piggery G in Jakarta and in piggery IB in Bogor were shown in Figure 1 and Figure 2 respectively. This vaccine was compared with the commercial vaccine. Both polyvalent vaccines produced a highly significant reduction in diarrheoa and mortality rates. Locally formulated vaccine (vaccine B) gave better protection than that of imported similar *E. coli* vaccine. These data clearly indicated that vaccination of sows with an appropriate *E. coli* containing fimbrial antigens vaccine is an effective method to control neonatal colibacillosis in piglets. Further trials of the locally formulated vaccine B conducted in two piggeries in Tangerang, West Java were shown on Table 4, 5 and from North Sumatra on Table 6.

CONCLUSIONS

1. Mixed infections with different *E. coli* expressing either K88, K99, F41, K99F41, K88K99 or 987P fibrial antigens were commonly found within a group of piglets or from one piglet. *E. coli* expressing 987P fimbrial antigen predominated in all piggeries studied. This existence of mixed infections contributes to the complex nature of enteropathogenic colibacillosis in piglets, may be of importance in the epidemiology of the disease in these animals and highlights the need for multivalent fimbrial antigen vaccine.
2. Antibiotic treatment in the piggeries studies appear to have little effect on reducing piglets neonatal diarrhoea and mortality. The failure of antibiotic to control preweaning piglet diarrhoea and mortality in the field is readily explained by high level of multiple resistance of each of ETEC isolate studies. When antimicrobial drug pressure was exerted on piggeries which had high population of ETEC associated with neonatal diarrhoea, antibiotic resistant ETEC rapidly emerged.
3. The vaccine study has demonstrated that a killed whole cell bacterin vaccine is highly efficacious in controlling piglet neonatal colibacillosis as alternative to, and should replace antibiotic therapy. Where possible local ETEC isolates should be used in the vaccine to include all O-antigen types represented. In Indonesia it is most probable that all antigen types are present on most farms, thus a multivalent vaccine should be applied.

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ABSTRAK

Diare neonatal pada anak babi terjadi pada semua peternakan babi di Indonesia. Studi lapangan menunjukkan bahwa prevalensi kasus diare antara 13,4%-43,7% dengan rata-rata 24,7%. Kebanyakan anak babi penderita diare berumur sampai 2 minggu. Mortalitas anak babi antara 12,2%-31,6%, rata-rata 17,9%. Studi mengenai korelasi antara umur anak babi yang mati didahului gejala diare dan kasus diare di peternakan babi G di Jakarta menunjukkan korelasi yang positif. ($r^2 = 0,78$; $P<0,01$). Hasil analisis tersebut menunjukkan bahwa diare berpengaruh nyata terhadap kematian anak babi umur dua minggu pertama. *E. coli* enterotoksigenik (ETEC) dapat diisolasi dari anak babi penderita diare, terdiri dari *E. coli* yang mempunyai antigen perlekatan atau pili 987P, F41, K99, atau K88. *E. coli* K88 K99 atau K99 F41 juga dapat diisolasi. *E. coli* 987P bersifat tidak hemolitik merupakan isolat yang dominan, sebagian besar tergolong dalam kelompok O-group 20, sebagian kecil termasuk O-group 9 dan O-group 141. *E. coli* F41 bersifat tidak hemolitik, tergolong dalam kelompok O-group 101 dan 9. *E. coli* K99 dari anak babi diare juga bersifat tidak hemoliti, tergolong dalam O-group 20, 64 dan 101. Sedangkan *E. coli* K88 semua bersifat hemolitik tergolong dalam O-group 108, 138, 149 dan 157. Usaha-usaha pengendalian diare neonatal yang disebabkan oleh ETEC atau kolibasilosis dengan penggunaan obat-obatan antibiotika pada peternakan babi dilaporkan tidak berhasil baik untuk menurunkan kasus diare dan kematian anak babi neonatal. Uji sensitivitas isolat ETEC K88, K99, F41 dan 987P menunjukkan tingkat multi resisten yang sangat tinggi, antara 4 sampai 6 macam obat-obatan antibiotika, seperti : streptomisin, ampisilin, erithromisin, oksitetrasiklin, kannamisin, neomisin, triemthoprim-sulfamethoksazole, boat-obatan sulfonamides dan khloramfenikol. *E. coli* K99 mempunyai tingkat resistensi sampai 9 macam obat antibiotika. Oleh karena itu strategi pengendalian kolibasilosis dengan vaksin dipelajari. Vaksin *E. coli* multivalen dibuat dari galur isolat lapang *E. coli* yang mempunyai antigen pili K88, K99, F41, dan 987P, tergolong dalam O-group 9, 20, 64, 108, 138, 149 dan 157. Uji lapang untuk pengendalian kolibasilosis neonatal dilakukan pada beberapa peternakan babi. Induk babi divaksin secara intramuskular dengan dosis 2 ml pada umur kebuntingan 6 minggu prepartus dan diboos-ter dengan dosis yang sama pada umur kebuntingan 2 minggu prepartus. Sebagai pembanding sekelompok induk babi divaksin dengan vaksin *E. coli* serupa diperoleh dari luar negeri. Sekelompok induk babi tidak divaksin untuk pembanding. Anak babi yang lahir dibiarkan menyusu pada induknya di bawah kondisi lapang. Vaksinasi induk babi dan vaksin *E. coli* polivalen pada tingkat akhir kebuntingan dapat menurunkan kasus diare dan kematian anak babi yang dilahirkan. Hasil-hasil tersebut akan didiskusi-kan.

Key words : piglets, diarrhoea, *E. coli*, control, vaccine.

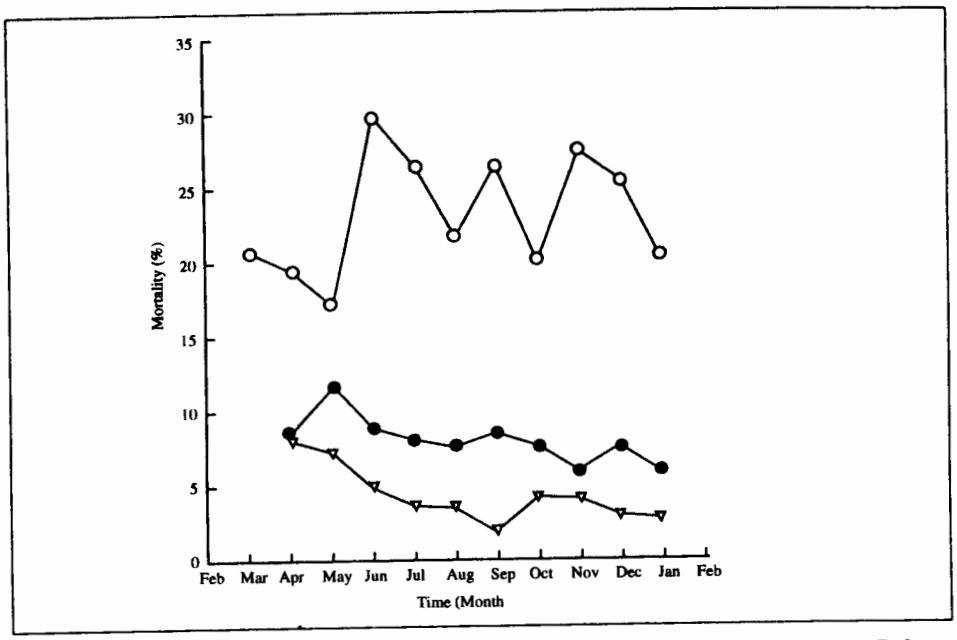

Figure 1 Reduction in piglet mortality following sow vaccination in piggery G from Jakarta. Vaccine A : Imported vaccine; Vaccine B : Local field *E. coli* formulated vaccine

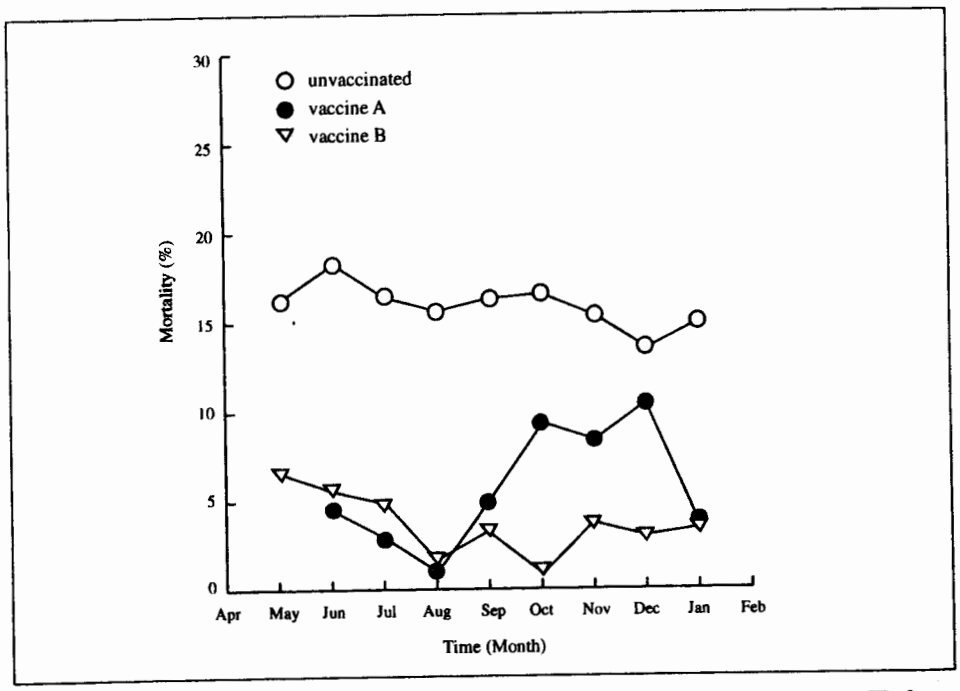

Figure 2 Reduction in piglet mortality following sow vaccination in piggery IB from Bogor. Vaccine A : Imported vaccine; Vaccine B : Local field *E. coli* formulated vaccine

Table 4. Reduction of diarrhoea and mortality of piglets up to weaning in piggery KJP (Tangerang) following vaccination of sows with whole cell E. coli vaccine B.

	Unvaccinated						Vaccinated					
	Sows	Piglets born alive	Scours		Deaths		Sows	Piglets born alive	Scours		Deaths	
			No	%	No	%			No	%	No	%
Jan'91	87	837	200	31.3	158	18.9	–	–	–	–	–	–
Feb	25	232	40	20.7	39	16.8	79	670	22	3.4	19	3.6
March	–	–	–	–	–	–	35	309	23	8.0	19	6.6
April	17	155	39	33.6	37	23.9	73	672	34	5.2	22	4.1
May	16	149	43	40.7	43	28.9	61	535	27	5.3	22	4.1
June	9	74	20	31.3	22	29.7	69	604	16	2.7	19	3.1
July	10	87	30	44.6	20	23.0	70	537	27	5.3	30	5.6
Total	164	1534	373	30.6	319	20.8	387	3387	149	4.7	147	4.2

Table 5. Reduction of diarrhoea and mortality of piglets up to weaning in piggery KJT (Tangerang) following vaccination of sows with whole cell E. coli vaccine B.

	Unvaccinated						Vaccinated					
	Sows	Piglets born alive	Scours		Deaths		Sows	Piglets born alive	Scours		Deaths	
			No	%	No	%			No	%	No	%
March	27	250	69	33.2	44	17.5	–	–	–	–	–	–
Apr	118	1076	272	20.2	181	16.8	–	–	–	–	–	–
May	32	275	61	30.3	64	23.3	86	721	28	3.8	26	3.6
June	20	157	35	23.6	30	19.1	119	1049	33	3.1	32	3.1
July	15	137	38	31.7	33	24.1	119	1059	42	4.1	40	3.8
Total	212	1897	475	31.8	352	18.6	324	2829	103	3.6	98	3.5

Table 6. Reduction of diarrhoea and mortality of piglets within the first two weeks of live in some piggeries in Medan North Sumatra following vaccination of sows with whole cell E. coli vaccine B.

Farm	Unvaccinated						Vaccinated					
	Sows	Piglets born alive	Scours		Deaths		Sows	Piglets born alive	Scours		Deaths	
			No	%	No	%			No	%	No	%
DG												
June	14	127	23	20.2	16	10.2	–	–	–	–	–	–
July	12	83	14	10.9	9	10.8	35	293	6	2.1	12	4.1
SM												
Jun	31	285	57	22.6	34	11.9	–	–	–	–	–	–
July	28	247	25	11.7	33	13.4	42	374	12	3.3	14	3.7
MJ												
June	40	398	63	17.8	54	13.6	–	–	–	–	–	–
July	13	133	17	15.2	21	15.8	73	693	27	4.0	18	2.5
JV												
June	8	72	14	21.2	8	11.1	–	–	–	–	–	–
July	15	144	8	6.7	25	17.4	13	123	–	–	2	1.6
SK												
June	13	136	24	24.0	16	11	8	–	–	–	–	–
July	12	116	12	12.9	23	19.8	4	38	2	5.2	–	–
SL												
June	16	146	19	14.7	17	11.6	–	–	–	–	–	–
July	11	87	11	14.1	9	10.3	13	101	6	6.3	6	5.9
Total	213	1974	287	16.8	265	13.4	180	1622	53	3.4	52	3.2

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