UNIVERSITI PUTRA MALAYSIA

STUDIES ON PIGLET DIARRHOEAS

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UNIVERSITY PERTANIAN MALAYSIA

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BY

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STUDIES ON PIGLET DIARRHOEAS

I. Evaluation of oral glucose-electrolyte fluid therapy in the treatment of piglet diarrhoeas.

II. The efficacy of peroral versus intramuscular route of administration of an antibacterial in the treatment of piglet diarrhoeas.

III. The influence of weather changes on prevalence of piglet diarrhoeas.

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To my Mum, Dad and family : thank you for the comfort I always find in you all.

To God be the glory.

Lim Suit Fun

ABSTRACT

Study I

A glucose-electrolyte formulation was used to evaluate the benefits of incorporating fluid therapy in the treatment of non-specific piglet diarrhoeas in a commercial intensive piggery. A total of 35 litters comprising 286 piglets of which 144 showed clinical diarrhoea was assigned to three treatment and one untreated control groups. The three treatment groups comprised piglets which were treated with antibacterials, fluids, and antibacterials plus fluid respectively.

The study showed that the combination of antibacterials plus fluid therapy resulted in a reduction in the mean number of diarrhoeic days as compared to treatment with either antibacterials or fluid. The latter two methods of therapy showed comparable results. The study indicated that fluid therapy is beneficial in piglet diarrhoeas.

Study II

The oral route of antibacterials was found to be superior to the intramuscular route in treatment of diarrhoeas in that the duration of diarrhoea was significantly reduced in response to the oral route.

Study III

Weather conditions were shown to have a direct bearing on the prevalence of diarrhoeas. The prevalence of diarrhoeas was higher on cool, rainy days and particularly so when such weather conditions were prolonged for several consecutive days. Conversely, a lower prevalence of diarrhoeas was observed on warm, sunny days.

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INTRODUCTION

Piglet diarrhoea is often a major cause of concern for pig farmers. Farmers tend to rely heavily, if not solely, on the use of antibacterial therapy to combat these diarrhoeas. Such indiscriminate use of antibacterials is not always effective as diarrhoeas are not necessarily caused by bacterial pathogens. In addition, the widespread use of antibacterial agents in the pig industry as feed additives or as therapeutic agents has resulted in the build up of multiple drug resistance patterns in organisms, including common enteric pathogens like Escherichia coli and Salmonella (2,9,10,18,30,34,35,45,47,49).

However, common to all diarrhoeas are the varying degrees of dehydration resulting from the loss of water, electrolytes and nutrients. In recent years, it has become increasingly apparent that this all important factor of dehydration has not been adequately attended to. Several workers advocated the routine use of fluid therapy in treatment of piglets diarrhoeas (6,16,29). This study was conducted to evaluate the effect of fluid and electrolyte therapy in piglets diarrhoeas in an intensive commercial piggery.

On most farms, antibiotics or other chemotherapeutic agents are routinely used in the treatment of piglet diarrhoeas. As most preparations available are in the injectable form, therapy is usually effected via the intramuscular route. While this route is less time consuming, it has been found to be less satisfactory in ensuring adequate dosage in the gut lumen when compared to the oral route of administration (21). In this study, a comparison was made on the efficacy of these two routes of administration of an antibacterial in the treatment of piglet diarrhoea.

Inclement weather has been incriminated as an important predisposing stress factor in enteric diseases. Attempts were made in the study to determine the climatic influences on the prevalence of piglet diarrhoeas.

LITERATURE REVIEW

Gut Physiology

The newborn piglet is well able to cope with water and electrolyte absorption; sodium, chloride and water content of faeces decrease in the passage through the colon (4). Even in weanling pigs, the large intestine especially the spiral and descending colon, is the main site for absorption of fluid and electrolytes. An appreciable amount of water is also absorbed by the stomach (25). In adults, the proportion of water absorbed from the colon is less than in the newborn (4).

Aetiology And Pathogenesis of Piglet Diarrhoea

Piglet enteritis usually occurs within the first week of life in those animals having little or no resistance as well as those 10 days old or older and having a waning passive resistance (21). Nutritional enteritis or "milk scours" which occurs around 3 weeks of age is thought to be non-infectious and the result of an upset in the milk production of the sow (6). Non-infectious diarrhoea may occur soon after weaning and is due to the stress of weaning while at a later stage, post weaning diarrhoea is thought to be due to bacterial, viral and protozoal complications (29).

Recent reports showed a 21 and 22 per cent prevalence of enteropathogenic E. Coli (EPEC) from farms in Singapore (47) and Selangor (27) respectively. Besides enteropathogenic E. coli, other aetiological agents in preweaning diarrhoea in pigs include Isospora suis, rotavirus, TGEV and a corona-like virus (not TGEV) (5). In field situations, often more than one factor can be identified which may act separately or in sequence resulting in diarrhoea (1).

Infectious diarrhoea in piglets is often caused by strains of EPEC which usually produce both heat labile and heat stable enterotoxins (7,13,51). The small intestine respond to the enterotoxins by an active secretion of a bicarbonate-rich fluid (28,36,37,39,46,50). The heat labile enterotoxins, like cholera toxin, causes delayed diarrhoea by stimulation of mucosal cyclic AMP (22,36,51) while heat stable enterotoxins causes an immediate hypersecretion mediated by cyclic GMP (22,51). Like cholera, the intestinal morphology remains essentially unchanged - the only discernible change was a discharge of goblet cells (36). Virus induced piglet diarrhoeas, on the other hand, are characterised by massive infection and destruction of the epithelial cells of the small intestine resulting in villous atrophy which accounts for most, if not all of the clinical signs associated with these diarrhoeas. Three viruses have been definitely incriminated as a cause of diarrhoea in pigs: TGEV, a coronavirus distinct from TGEV and a porcine rotavirus (8). The diarrhoeas caused by these viruses is probably due to functional disorders such as malabsorption (16,19,40). The result of diarrhoea is a net loss of water and electrolytes from the gut (11,12,17,32,40).

The greatest resultant systemic water loss is from the plasma, followed by the extracellular fluid (40). This may lead to reduced peripheral circulation (40,46) and hypovolaemic shock (46). Dehydration (3,44,46) also results in hypovolaemia (40) and haemoconcentration (3,46).

Hypotonic dehydration was evident in many of the studies conducted (44, 46). Decreased serum osmolality (44) shown by a reduced plasma or serum level of sodium (33,46), chloride (33), bicarbonate (33) and/or a gain in intracellular water (40) are frequent evidence of this. Plasma potassium is usually increased (3,33,46). Metabolic acidosis is a frequently reported finding (3,46). These disturbances of fluid, electrolyte and hydrogen ions in the pathogenesis of enteric infections emphasize the importance of fluid therapy in the clinical management of this group of diseases (46). Several workers strongly recommend fluid therapy in diarrhoea (6,10,14,16,20,26,29,46,51).

Oral Electrolyte Replacement Therapy

In human cholera, both glucose (41) and glycine increase the absorption of sodium and the effects of glycine and glucose are additive (38). The increase in absorption was clearly associated with the shortest duration of diarrhoea in the groups studied (38). The application of oral fluid replacement in both cholera and non-cholera diarrhoea has been widely and successfully practised in human medicine (23).

Intraluminal glucose increases the absorption of sodium and water in the small intestine by a mechanism which appear to be intact in cholera, a diarrhoea disease characterised by intestinal secretion. Colibacillosis in pigs closely resembles cholera in that both produce enterotoxins that induce loss of fluid through the intact mucosa of the small intestine (50,51). Glucose absorption and glucose-mediated sodium absorption are intact in swine jejunum innoculated with live EPEC (51). Unlike the human studies, glycine was found to be less effective than glucose in increasing net absorption and an additive effect between glucose and glycine was not demonstrated in pigs (51). With EPEC, as in cholera diarrhoea, intestinal mucosal damage is absent (7,23,36,43,46,48,51). Thus, oral rehydration can be readily achieved as glucose dependent sodium and water absorption is not impaired (11,14,23,42,51). This results in relatively low faecal volume losses with stools of increased electrolyte concentrations (23). In contrast, faecal concentrations of electrolytes in other bacterial or viral enteritides are lower but volume losses may be high and intestinal mucosal damage may be marked (23). In such situations, one would expect oral rehydration to be less effective or may even lead to increased diarrhoea by providing an osmotic load of non absorbed glucose. However, in clinical practice, this is evidently not so as the beneficial effects of oral fluid replacement therapy in the treatment of bacterial or viral diarrhoeas in calves (10,14,15, 20,24,26,31) and piglets (16,29) have been demonstrated in several studies.

Oral electrolytes in combination with glucose-glycine mixtures (16), glucose-lysine or oral antibacterials (29) have been reported to be useful in the treatment of diarrhoea in suckling piglets (16,29) and weanlings (29). The effect of such therapy in suckling piglets apparently resulted in reduced mortality (16), reduced weight loss (16), better weight gains, more rapid control of diarrhoeas and better post weaning performance (29). Similarly, fluid replacement therapy of postweaning diarrhoeas showed reduced mortality and increased feed conversion efficiency (29).

MATERIALS AND METHODS

The Farm: The studies were conducted on an 800-sow breeding and production facility. The sows were Landrace, Durocs, Chester White and their crosses. A variety of antibacterials were administered to all sows and their litters at birth as a routine management practice.

<u>Study I:</u> A total of 35 litters comprising 286 piglets, of which 144 showed clinical diarrhoeas, were used in this study. A glucose-electrolyte mixture which was given as an isotonic solution contains the following :-

Dextrose	27.20 g/l
Na^+	53.60 mEg/l
K^+	9.12 mEg/l
Mg^{++}	2.64 mEg/l
HCO_3^-	32.40 mEg/l
Cl^-	30.32 mEg/l

Litters showing onset of clinical diarrhoeas were randomly assigned to one of the following treatment groups:

Group I: Antibacterials only.
Group I comprised 13 litters with a total of 118 piglets. Of these, 64 showed clinical diarrhoea. One ml. of *Trimethosulf[R] was administered daily, by intramuscular injections, until 2 days after resolution of clinical diarrhoea. Non-diarrhoeic litter mates were left untreated.

Group II: Fluid only.
This group consisted of 22 clinically diarrhoeic piglets from 7 litters of 55 piglets. Treatment of this group was solely by provision of the oral glucose-electrolyte solution ad libitum.

Group III: Fluid plus antibacterials.
Group III consisted of 30 diarrhoeic piglets from 7 litters of 51 piglets. The treatment involved daily antibacterial intramuscular injections plus provision of an oral glucose-electrolyte solution ad libitum.

Group IV: Control
This group consisted of 8 litters of 62 piglets, of which 30 showed clinical diarhoeas. No treatment was given. No purebred piglets were included in this untreated group in deference to the wishes of the farm management.

Daily weights of all piglets undergoing observation were recorded from the onset until cessation of clinical diarrhoea in the litter. All piglets involved in the study were individually identified. Clinical observations on the severity of diarrhoea, other clinical signs and any mortality were duly recorded.

*Trimethosulf [R] .Bremer-Pharma gMBH, 2850 Bremhaven, West Germany. Contains sulfamerazine 100mg/ml, sulfadiazine 600mg/ml, sulfathiazole 40mg/ml trimethoprim 40mg/ml

The body weights of 402 non-diarrhoeic piglets from 47 litters of various ages were recorded and compared to those of diarrhoeic piglets of similar ages, at the onset of diarrhoea, in order to determine the co-relation, if any, between the weight of the piglets and susceptibility to diarrhoea.

Study II: Forty One piglets from 8 litters which showed clinical evidence of diarrhoea were given 0.5ml oral Trimethosulf ^{R} daily, from the onset of diarrhoea until 2 days after resolution of clinical signs. Daily weights of piglets were recorded. This group was compared with Group I from Study I which received intramuscular Trimethosulf ^{R} .

Study III: Maximum and minimum temperatures for each day were taken with a maximum-minimum thermometer at 7.00 am daily. Hours of rain and cool, cloudy weather were recorded for the period of 7.00 am to 7.00 pm daily. All litters in the farrowing units were monitored for prevalence of clinical diarrhoeas.

RESULTS AND DISCUSSION

Study I

When diarrhoea occured at any time during the first 12 days of life, there appeared to be no significant difference between the mean body weights of the piglets at the onset of diarrhoea and those of their counterparts (at the same ages) from non-diarrhoeic litters (Table 1). There was also no apparent difference when the mean weights of piglets were compared to their non-diarrhoeic littermates at the onset of diarrhoea except for those in the 4-day age group (Table 2). However, piglets that contracted diarrhoea at ages 16 days or more were generally those with lower mean body weights when compared to their counterparts from non-diarrhoeic litters (Table 1).

Table 1: Comparison of mean body weights of *diarrhoeic & non-diarrhoeic litters

Age in days	Mean weights of pigs in kg (No. of pigs) Diarrhoeic Litters	Non-diarrhoeic Litters
4	1.82 ± 0.35 (10)	1.93 ± 0.37 (41)
6	2.03 ± 0.39 (10)	2.19 ± 0.34 (18)
7	2.23 ± 0.41 (38)	2.32 ± 0.48 (36)
8	2.46 ± 0.37 (38)	2.49 ± 0.40 (53)
9	2.89 ± 0.70 (69)	2.58 ± 0.25 (9)
10	2.92 ± 0.46 (44)	2.84 ± 0.56 (36)
12	3.29 ± 0.58 (42)	3.27 ± 0.56 (51)
16	^{a} 3.58 ± 0.53 (24)	^{b} 4.50 ± 0.52 (8)
19	^{a} 3.72 ± 1.06 (10)	^{b} 5.16 ± 0.56 (7)

*: All weights taken at onset of clinical diarrhoea. Means in a row bearing different superscripts differ significantly ("t" test), $P<0.005$.

Table 2: Comparison of mean body weights of *diarrhoeic piglets and their non-diarrhoeic littermates

Age in days	Mean weights of pigs in kg. (No. of pigs) Diarrhoeic piglets	Non-diarrhoeic littermates
4	^{a}1.48 ± 0.43 (3)	^{b}1.96 ± 0.20 (7)
6	2.25 ± 0.21 (2)	1.97 + 0.42 (8)
7	2.38 + 0.38 (16)	2.13 ± 0.41 (22)
8	2.43 ± 0.39 (6)	2.47 + 0.37 (32)
9	2.74 ± 0.70 (21)	2.96 ± 0.70 (48)
10	2.68 ± 0.37 (7)	2.97 ± 0.46 (37)
12	3.33 ± 0.53 (2)	3.27 ± 0.60 (30)
16	3.56 ± 0.32 (12)	3.61 ± 0.70 (12)
19	3.48 ± 1.07 (3)	3.81 ± 1.12 (7)

*: All weights taken at onset of clinical diarrhoea. Means in a row bearing different superscripts differ significantly ("t" test) $P<0.05$.

These results indicate that at ages over 16 days, litters with lower mean body weights are more likely to develop diarrhoea. The lower body weights of these pigs could have resulted from small birth weights or previous episodes of illnesses, including enteric diseases, that could subsequently lead to a greater pre-disposition to develop diarrhoeas or other problems especially at times of stress.

Within a litter at four days of age, and probably younger, piglets of lower body weight are more likely to contract diarrhoea (Table 2).

Table 3: Comparison of mean number of diarrhoeic days

	Treatment Groups			
Parameters	1. Antibacterials only	2. Fluid Only	3. Fluid plus antibacterials	4. Control
Mean No. of diarrhoeic days (No. of pigs)	2.67 ± 1.62 (62)	2.73 ± 1.39 (22)	2.33 + 0.80 (30)	2.43 ± 1.17 (30)
Average age (days) at onset	13.33	13.48	12.20	11.87
Average max. diarrhoea score	2.0	2.2	2.3	2.0
Diarrhoea associated mortality in pigs	2.0	NIL	NIL	NIL

*Severity of diarrhoea as graded on a scale of 1 to 3: 1 -mild pasty diarrhoea 2 -moderate runny diarrhoea, 3 -profuse watery diarrhoea

Group III had the lowest mean number of diarrhoeic days and less variability in duration of diarrhoea (Table 3). This finding is consistent with the findings of other workers (10,14,29) who also reported more efficient control of diarrhoeas using the combination treatment of conventional antibacterials plus fluid therapy. Treatment I and II gave comparable results.

Comparisons between the treatment and control groups were not regarded as valid because the latter comprised solely of piglets from crossbred sows. These were generally shown to have a heavier body weight at any age when compared to piglets from treatment groups which were made up of litters of both purebred and crossbred sows (Table 4). The heavier lifeweights of piglets of crossbred sows - mated to purebred boars - compared to those from purebred sows is tabulated in Appendix I for both diarrhoeic and non-diarrhoeic litters. These faster growing pigs would be expected to possess greater capacity to fight against infections, hence the low mean number of diarrhoeic days (Table 3) and the relatively slight loss in weight gain during diarrhoea (Table 5).

Table 4: Comparison of mean body weights of piglets, at onset of diarrhoea, between control and treatment groups

Age in days	Mean Body Weight in kg (No. of pigs) Control group	Treatment groups
5	2.65 ± 0.28 (3)	2.28 ± 0.34 (7)
8	2.71 ± 0.32 (7)	2.37 ± 0.45 (3)
9	3.09 + 1.88 (5)	2.63 ± 0.71 (14)
10	2.48 ± 0.18 (2)	2.88 ± 0.53 (2)
12	3.55 ± 0.60 (12)	3.02 ± 0.18 (3)

Table 5: Daily weight gain of piglets during diarrhoea

Treatment Groups	Mean daily weight gain in grammes (No. of pigs) Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
I: Anti-bacterials Only	14.8 (64)	76.7 (45)	50.0 (29)	125.0 (12)	125.0 (6)	75.0 (4)	16.7 (3)	100.0 (1)
II: Fluid Only	100.0 (22)	97.2 (18)	122.7 (11)	50.0 (5)	133.3 (3)	100.0 (1)	- -	- -
III: Anti-bacterials plus fluid	71.7 (30)	109.7 (26)	158.3 (12)	75.0 (2)	- -	- -	- -	- -
IV: Control	48.3 (30)	130.0 (25)	109.1 (11)	50.0 (4)	175.00 (2)	200.0 (1)	- -	- -

On Day I of diarrhoea, Group II and Group III have the highest weight gains, followed by the control and lastly Group I (Table 5). The findings suggest that fluid replacement is of value in combating losses in weight gains due to diarrhoea. The greatest loss in weight gain occurred on Day I. This is in agreement with the findings of other workers (46). On Day 2 and Day 3, Groups II and III still maintained higher weight gains as compared to Group I. On Day 2 and 3, the control group showed a weight gain of 130g and 109g respectively, probably reflecting their superior genetic growth potential. Comparisons between the groups beyond Day 3 of diarrhoea are probably invalid due to the small number of animals involved.

Table 6: Daily Weight gains of piglets in the post-diarrhoeic period

Treatment Groups	Mean Daily Weight Gain in grammes (No. of pigs) Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
I: Anti-bacterials only	160 (52)	161 (36)	160 (25)	161 (19)	171 (12)	159 (11)	150 (5)	133 (3)
II: Fluid Only	140 (5)	225 (2)	- -	- -	- -	- -	- -	- -
III: Anti-bacterials plus Fluid	163 (8)	140 (5)	150 (2)	200 (2)	100 (2)	125 (2)	-	-
II & III	154 (13)	164 (7)	- -	- -	- -	- -	- -	- -
IV: Control	193 (28)	198 (23)	203 (17)	188 (8)	203 (5)	200 (3)	217 (3)	225 (2)

The Control Group had the highest daily weight gain among the study groups for Day 1 and Day 2 post-diarrhoea (Table 6), consistent with earlier observations that they had relatively higher body weights at any age as compared to the piglets in the other groups (Table 4).

The daily weight gains for the other treatment groups for Day 1 and Day 2 in the post-diarrhoeic period are essentially the same, indicating that fluid therapy beyond the diarrhoeic period did not have any beneficial effect on the daily weight gain. This finding appears to be at variance with a previous study (29) (Appendix IV) where improved weight gain was seen with supportive fluid therapy in early weaned pigs. However, in this report (29), the diarrhoea was more severe and prolonged with mortality rates of up to 11% at 45 days of life. In the present study, the effects of fluid therapy in the post diarrhoeic period are probably negligible due to the mild diarrhoeas encountered.

These findings also indicate that the enteric diseases of piglets on this farm during the period of study had no severe residual effect on the gastrointestinal tract functions as evidenced by the daily weight gains in the post-diarrhoeic period.

Although the clinical diarrhoeas seen on this farm were not severe, a combination of glucose-electrolyte fluid plus antibacterial therapy is superior to antibacterial therapy alone. The obvious corollary to this observation is that in more severe diarrhoeas with greater loss of water and electrolytes, the effect of such supportive electrolyte-fluid therapy would be more pronounced.

Study II

Table 7: Comparison of mean number of diarrhoeic days between oral and intramuscular routes of administration

Treatment Groups	Mean No. of Diarrhoeic Days + Standard Deviation	No. of Piglets
I: Intramuscular antibacterials	[a] 2.66 + 1.17	62
II: Oral antibacterials	[b] 1.83 + 1.00	41

a,b: Means with different superscripts significantly different at $p < 0.00005$ ("Z" test)

The duration of diarrhoea is significantly reduced in response to oral administration when compared to intramuscular administration of antibacterials (Table 7). The Standard Deviation in oral antibacterial group is also lower than that of the intramuscular route of administration (Table 7), indicating a more uniform response to the oral route. Hence the oral route is the route of choice in the treatment of diarrrhoeas.

The significant difference in the values obtained by the two different routes also suggests that the diarrhoeas being treated are probably bacterial in origin as there is a response to treatment. It also indicates that microbial resistance to the antibacterial

minimal

Study III

The prevalence of piglet diarrhoeas appear to be lower on the days either without or with a minimal amount of rain or cool cloudy weather. Where such weather conditions prevailed for several consecutive days, an initially high prevalence of diarrhoea rapidly declined (Table 1 and Appendix II).

Wet, cold and cloudy days were followed by an increased prevalence of diarrhoea. Where such conditions were prolonged over a period of several days, the prevalence of diarrhoea tend to remain high (Table 1).

Days with high maximum temperatures were followed by a decrease in the prevalence of diarrhoea by the same evening. However, this is only true if the day was one with little or no wet, cool and cloudy weather conditions.

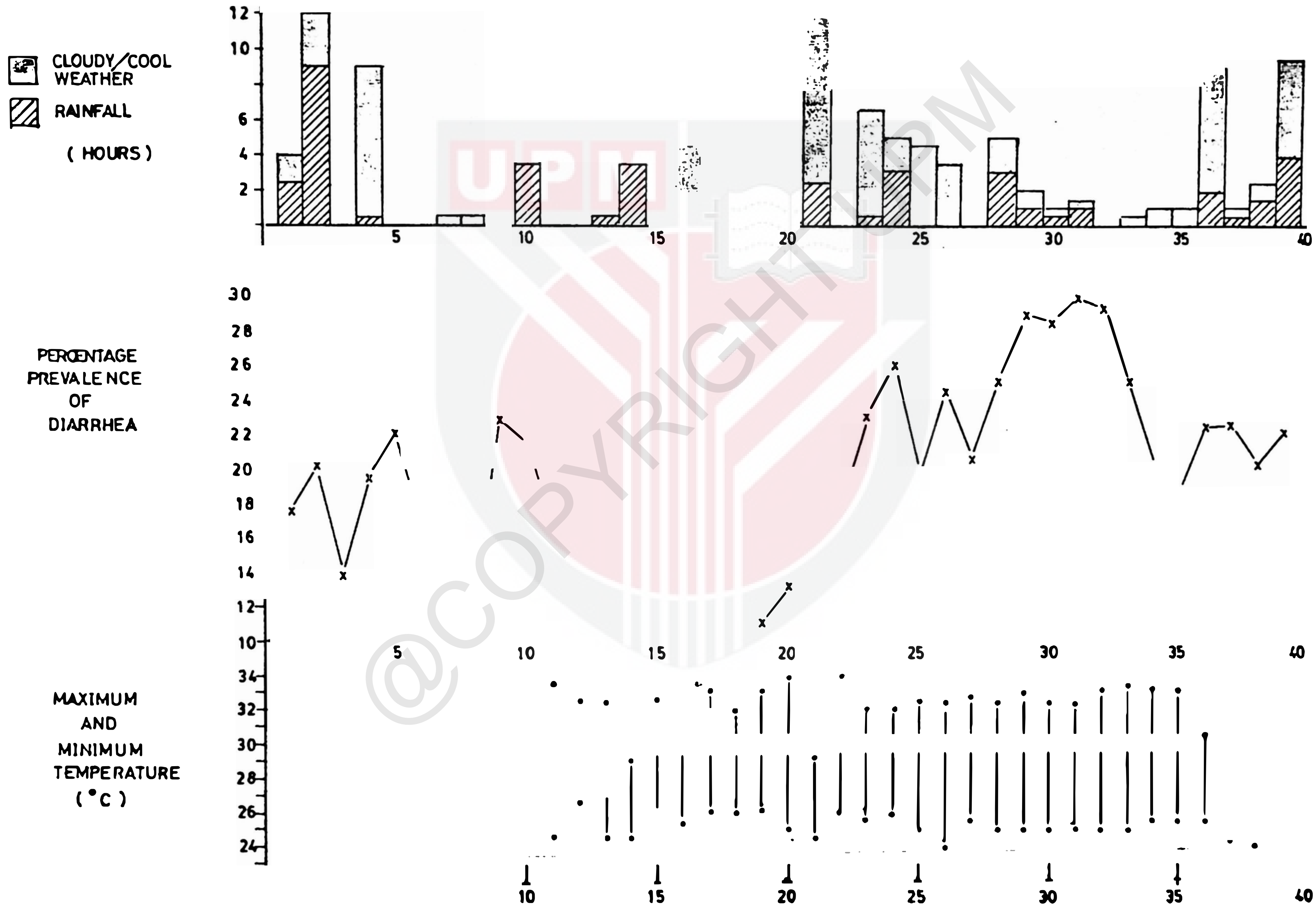
Low maximum temperatures were always associated with rainy, cool or cloudy days during the entire period of observation (Figure 1). Low maximum temperatures indicates a cool day and the prevalence tends to be higher on these days.

Low minimum temperatures, presumably occuring in the night, tend to be associated with an increased prevalence the following day. If these temperatures occur in combination with rainy, cool cloudy days the prevalence of diarrhoea remained high.

These findings are consistent with the observations of most farmers that the prevalence of diarrrhoeas increases during cold and wet days. Conversely, warm and dry days tend to be associated with lower prevalence of diarrhoéas even, presumably, with fluctuations of temperatures during the nights. Dry pigs are less easily chilled (21,24) and the duration of chilling (if it occurs) is shorter on such days.

FIGURE

ON A DAY—TO—DAY BASIS



CONCLUSIONS

From these studies, it is concluded that:

Oral electrolyte-glucose fluid therapy is beneficial in acute diaarhoeas.

The oral route of administration of antibacterials is the route of choice in the treatment of diarrhoeas.

3. Malaysian weather conditions have a bearing on the prevalence of diarrhoeas; wet and chilly weather tends to increase the prevalence of diarrhoeas while warm and dry weather tends to lower it.

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APPENDIX I

A COMPARISON OF THE MEAN WEIGHTS AT DIFFERENT AGES OF
(1) PUREBRED AND CROSBRED LITTERS AT ONSET OF DIARRHOEA AND
(2) PUREBRED AND CROSSBRED NON-DIARRHOEIC LITTERS

Age in days	Mean weight in kilogrammes			
	*Diarrhoeic Litters		Non-diarrhoeic Litters	
	Purebred	Crossbred	Purebred	Crossbred
1	ND	ND	1.48 (19)	1.85 (8)
3	ND	ND	1.33 (3)	1.59 (35)
7	2.14 (12)	2.28 (26)	ND	ND
8	2.51 (8)	2.45 (30)	2.12 (16)	2.65 (37)
9	2.59 (26)	3.07 (43)	ND	ND
10	2.87 (19)	2.96 (25)	2.80 (10)	2.86 (26)
11	ND	ND	2.87 (11)	3.14 (22)
12	ND	ND	3.35 (18)	3.22 (33)
16	3.58 (8)	3.58 (16)	ND	ND
17	3.12 (6)	3.63 (8)	ND	ND
21	ND	ND	4.14 (8)	5.35 (30)

* Weights taken at onset of diarrhoea.

APPENDIX II

RECORD OF WEATHER CHANGES AND PREVALENCE OF DIARRHOEA
ON A DAY TO DAY BASIS

Day	Prevalence of diarrhoea (percentage)	Max. T° in °C	Min. T° in °C	Rain in hours	Cool/Cloudy weather in hours
1	15/85 (17.65)	ND	ND	2.3	3.7
2	18/89 (20.22)	ND	ND	9.0	12.0
3	13/94 (13.83)	ND	ND	0.0	0.0
4	19/98 (19.4)	ND	ND	0.3	9.0
5	23/104 (23.1)	ND	ND	0.0	0.0
6*	17/102 (16.7)	ND	ND	0.0	0.0
7*	16/99 (16.2)	ND	ND	0.0	4.0
8*	12/95 (12.6)	ND	ND	0.0	4.0
9*	22/96 (22.9)	ND	ND	0.0	0.0
10*	18/84 (21.4)	ND	ND	3.4	5.3
11	14/86 (16.3)	33.3	24.5	0.0	0.0
12	17/92 (18.5)	32.5	26.7	0.0	0.0
13	18/97 (18.6)	32.4	24.5	0.3	0.3
14	12/97 (12.4)	29.0	24.5	3.3	3.3
15	13/98 (13.3)	32.5	25.5	0.0	0.0
16	12/88 (13.6)	31.1	25.3	0.1	4.5
17	18/90 (20.0)	33.0	26.1	0.0	0.0
18	18/97 (18.6)	32.0	26.0	0.1	0.1
19	11/98 (11.2)	33.0	26.1	0.0	0.0
20*	12/91 (13.2)	33.9	25.0	0.2	0.2
21	18/94 (19.2)	29.2	24.5	2.3	12.0
22	18/99 (18.2)	34.0	26.1	0.0	0.0
23	24/104 (23.1)	32.2	25.6	0.3	6.3
24*	24/92 (26.1)	32.2	26.0	3.0	5.0
25	19/98 (19.4)	32.5	25.0	0.0	4.3
26	25/102 (24.5)	32.5	24.0	0.0	3.5
27	22/108 (20.4)	32.8	25.6	0.0	0.0
28	28/112 (25.0)	32.5	25.0	2.7	5.0
29*	30/104 (28.9)	33.0	25.0	0.8	2.0
30	31/109 (28.4)	32.5	25.0	0.5	0.8
31	33/110 (30.0)	32.5	25.0	1.0	1.5
32	34/116 (29.3)	33.3	25.0	0.0	0.0
33	30/120 (25.0)	33.5	25.0	0.0	0.5
34*	22/110 (20.0)	33.3	25.6	0.0	0.8
35*	20/107 (18.7)	33.3	25.6	0.1	0.6
36*	23/103 (22.3)	30.6	25.5	2.1	9.0
37	24/107 (22.4)	32.5	24.4	0.2	0.8
38	22/109 (20.2)	31.7	24.0	1.4	2.5
39	25/113 (22.1)	29.4	24.0	3.8	9.5

Record for period 4/6/84 to 12/7/84.
*Weaning was done on this day.

APPENDIX III

NET MOVEMENT OF FLUID (ml/loop per hour) DURING PERFUSION WITH VARIOUS SOLUTIONS IN SWINE INTESTINAL LOOPS INFECTED WITH ESCHERICHIA COLI 263 (ENTEROPATHOGENIC)

Pig No.	Perfusion Sequence			
	Electrolyte	Glucose	Glycine	Electrolyte
8	- 2.1	1.6	- 0.3	- 1.9
9	- 6.6	2.3	- 0.3	- 0.4
10	- 8.6	3.6	ND	ND

Note: Negative values denote enterosorption.
ND = Not determined
Source: Whipp & Moon (1973), Ref.No. 51

Plate I: Piglet drinking glucose-electrolyte solution readily.