

La Trobe University

BUNDOORA / VICTORIA / AUSTRALIA 3083
TELEGRAMS AND CABLES: LATROBE MELBOURNE



SCHOOL OF AGRICULTURE

TELEPHONE: 478 3122

8th September, 1971.

The Chief Librarian,
Massey University,
Palmerston North,
NEW ZEALAND.

Dear Sir,

I have referred to my thesis "Studies on the faecal micro-flora and micro-fauna of the young pig as influenced by diet, age and time of weaning". (1962) in the enclosed paper and also in a paper I have submitted to the Australian Society for Animal Production for presentation at the 9th Biennial Conference in Canberra during February 1972.

I hereby give authority to the Massey University Library to have the thesis microfilmed for interloan purposes.

MASSEY UNIVERSITY OF MANAWATU
PALMERSTON NORTH, N.Z.

Yours faithfully,

P.D. Cranwell

P.D. CRANWELL

Lecturer in Agriculture.

Encl.
PDC/JS.

P.S. If the reprint is not required in the library please send it to Mr SC Newhook with my compliments.

PDC.

STUDIES ON THE FAECAL MICRO-FLORA AND
MICRO-FAUNA OF THE YOUNG PIG AS INFLUENCED
BY DIET, AGE AND TIME OF WEANING

A thesis presented to the Massey University
College of Manawatu in partial
fulfilment of the requirements
of the Degree of Master
of Agricultural
Science

P. D. CRANWELL

MASSEY UNIVERSITY COLLEGE OF MANAWATU

November, 1963.

the creatures outside looked from
pig to man, and from man to pig,
and from pig to man again; but
already it was impossible to say
which was which

..... George Orwell

ACKNOWLEDGMENTS

The author wishes to record his sincere appreciation and thanks for the guidance and continuous interest of Mr. B. A. Reynolds throughout this project.

Acknowledgment is due to Mr. A. C. Glenday and Mr. D. A. Evans for statistical advice; Dr. R. Clark and Miss Margaret Soulsby for preparation of the photographs; Mr. J. C. Newhook for helpful discussion; Miss M. G. Campbell and Miss Pamela Forsyth, for assistance in obtaining literature; Mr. T. Rogers of the Research Piggery (at the time of the trial) for his assistance and Mr. P. R. Hockey for help in preparation of the graphs and proof reading.

This work was carried out while the author was assisted by Farmers' Union and Pig Industry Scholarships.

Special thanks are due to Miss Jule Barber for typing this thesis.

Finally, the author wishes to express his appreciation to his wife Cecile, for her unfaltering patience and continued assistance.

TABLE OF CONTENTS

Page

INTRODUCTION 1

PART I

ENUMERATION OF THE FACIAL MICRO -FLORA OF THE PIG BY THE DROP TECHNIQUE

Chapter

I	REVIEW OF LITERATURE	4
II	MATERIALS AND METHODS	6
	A. Animals and Sampling	6
	B. The Drop Technique	6
	1. Apparatus used	6
	2. Procedure	8
III	RESULTS	12
IV	DISCUSSION	14
V	SUMMARY AND CONCLUSIONS	17

Literature Cited

TABLE OF CONTENTS (contd.)

PART II

STUDIES ON THE FAECAL MICRO-FLORA AND MICRO-FAUNA
OF NEW BORN PIG AS INFLUENCED BY DIET, AGE AND
TIME OF WEANING.

Chapter		Page
I	REVIEW OF LITERATURE	18
A.	Introduction	18
B.	The Faecal Micro-flora of the Pig	20
	1. The influence of age	20
	2. The influence of diet	24
	3. The influence of management	31
	4. The influence of chemotherapeutics as dietary supplements.	34
C.	The Micro-Flora of the Alimentary Tract of the Pig as estimated immediately after slaughter.	38
	1. The stomach	38
	2. The small intestine	39
	3. The large intestine	39
D.	The Faecal and Intestinal Micro-fauna of the pig.	47
II	THE EXPERIMENTAL DESIGN	50
III	MATERIALS AND METHODS	52
A.	Animals and Sampling	52
	1. Animals selected for the trial	52
	2. Management and Housing	52
	3. Diet	54
	4. Sampling procedure	60

TABLE OF CONTENTS (Contd.)

Chapter		Page
B.	Laboratory Techniques	60
	1. Fresh material	60
	1.1 Enumeration	60
	1.2 Characterisation	64
	1.3 pH measurements	67
	2. Preserved material	68
	2.1 Preservation	68
	2.2 Mixing and staining	68
	2.3 Enumeration	69
	2.4 Photomicrography	70
IV	RESULTS	71
	1. Animal performance	71
	2. Characterisation	73
	3. Enumeration of faecal bacteria by cultural methods	79
	3.1 Faecal organisms of the piglets	79
	3.2 Faecal organisms of the sows	85
	4. pH	86
	4.1 pH levels of the faecal samples from the piglets	86
	4.2 Relationship between levels of pH and counts of organisms	87
	5. Enumeration of undigested starch granules clones of iodophilic bacteria and <u>Balantidium coli</u> by microscopy	87
	5.1 Undigested starch granules	88
	5.2 Clones of iodophilic bacteria	89
	5.3 <u>Balantidium coli</u>	91
V	DISCUSSION	96
	1. The Use of two media for the enumeration of enterococci	96
	2. Factors which influenced the faecal populations of total anaerobes, lactobacilli enterococci and <u>Escherichia coli</u>	100
	3. <u>Clostridium welchii</u>	108
	4. Undigested starch, iodophilic bacteria and <u>Balantidium coli</u>	109
VI	SUMMARY	120
	Literature Cited	
	Appendix	

LIST OF TABLES

PART I

Table	Facing Page
I	The log number of coliforms per g. of faeces on each of the two sampling days as determined in quadruplet from a number of sub-samples. Analysis and components of variance
	12
II	Formulae used for estimating standard errors. Estimates of components of variance and their percentage contribution. Estimated standard errors of a mean for D, drops per sub-sample, and S, sub-samples per pig
	13

PART II

Table	Page
I	Feed Mixtures used for Piglets
	55
II	Dates of farrowing and weaning of the sows in these experiments
	56
III	Daily Ration of each sow in Experiment I
	57
IV	Daily Ration of the sow with the three week nursing period in Experiment II
	58
V	Daily Ration of the sow with the six week nursing period in Experiment II
	59
VI	Liveweight Records (lbs.) for piglets. (Litter, Group and 1962 Season averages)
	72
	Facing Page
VII	Colony Types found on plates of Mitis Salivarius Agar, growth on agar stroke of isolates of these colony types on two media, and reaction to Gram Stain of smears from the isolates or streaks
	75
VIII	Results of the physiological tolerance tests performed on isolates from some of the colony types found on Mitis Salivarius Agar and M-Enterococcus Agar
	75
	Page
IX	Colony types found on plates of M-Enterococcus Agar, growth on agar stroke of isolates of these colony types on two media, and reaction to Gram Stain of smears from the isolates or streaks
	76A

LIST OF TABLES (contd.)

Table	Page
X	78
Growth on agar stroke of colonial isolates from the selective and/or differential media used on four media	
	Facing Page
XI	80
Analysis of variance for total anaerobes	
XII	80
Analysis of variance for <u>Escherichia coli</u>	
XIII	80
Analysis of variance for enterococci	
XIV	80
Analysis of variance for lactobacilli	
XV	80
Components of variance and their estimates for the pooled data for the four organisms studied.	
	Page
XVI	82
Means and their Standard Errors for these experiments.	
XVII	84
Log counts of <u>Clostridium welchii</u> for the piglets in Experiment II (Means of 12 observations).	
XVIII	Facing page
Analysis of variance for the log count per g. of faeces (Duplicates) of enterococci on two media for litter LW2	
	85
XIX	85
Analysis of variance for the log count per g. of faeces (Duplicates) of enterococci on the two media for litter LW2.	
XX	Page
The means of the log count of each organism studied for the four sows in these experiments.	
	86
XXI	Facing page
Analysis of variance for pH data	
	86
	Page
XXII	88
Analysis of variance for undigested starch granules	
XXIII	90
Number of piglets of each litter with iodophilic bacteria in their faeces and the range of counts for the four weeks.	

LIST OF TABLES (contd.)

Table		Page
XXIV	The log number of clones of iodophilic bacteria per g. of faeces for the sow of litter LW2.	90
		Facing page
XXV	The number of piglets per litter with <u>Balantidium coli</u> in their faeces and the range of counts over the experimental period.	91
XXVI	The log number per g. of faeces of <u>Balantidium coli</u> for the four sows and the means during the nursing period.	91

LIST OF FIGURES

Figure		Facing Page
1.	Apparatus	6
2.	Typical red and maroon surface colonies of enterococci on M-Enterococcus Agar	76
3.	The lower right group of the above at a magnification of 2.5x.	76
4.	Typical rough and smooth surface colonies of lactobacilli on Rogosa S.L. Agar	77
5.	The lower right group of the above at a magnification of 2.5x.	77
6.	Graph of total anaerobes (AxLWM interaction)	83
7.	Graph of <u>Escherichia coli</u> (AxLWM interaction)	83
8.	Graph of enterococci, Mitis-Salivarius Agar (AxLWM interaction)	83
9.	Graph of lactobacilli (AxLWM interaction)	83
10.	Graph of enterococci, M-Enterococcus Agar.	85
11.	Graph of pH (AxLWM interaction)	87
12.	Graph of pH v lactobacilli	87
		Following Page
13.	A starch granule surrounded by iodophilic bacteria; early phase of breakdown	93
14.	A starch granule covered with iodophilic bacteria (rods), showing dissolution of the blue reacting component (amylose) with temporary persistence of the non-reacting (amylopectin) residue.	93
15.	Centre top: Chain of small iodophilic bacteria. Left centre: Isolated rods of large iodophilic bacteria. Centre bottom: Starch granule surrounded by iodophilic bacteria.	93

LIST OF FIGURES (contd.)

Figure		Following Pages
16.	Part of a large clone of iodophilic bacteria	93
17.	A chain of large iodophilic bacteria on the surface of a plant cell	93
18.	A plant cell covered with large iodophilic bacteria	93
19.	A cyst of <u>Balantidium coli</u> showing the presence of small starch granules. As found in the faeces of an experimental piglet	94
20.	An ovoid trophozoite of <u>Balantidium coli</u>	95
21.	An elongate trophozoite of <u>Balantidium coli (suis)</u> .	95
22.	A large ovoid trophozoite of <u>Balantidium coli</u>	95