RESEARCH REPORT
ANIMAL SCIENCE

Title: Carbohydrate and Bacterial Non-antibiotic Production Enhancers **- NPB 04-143**

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Institution: Purdue University

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Abstract
The objective of this project was to conduct a review of the literature on carbohydrate and bacterial non-antibiotic production enhancers for swine.

Introduction
There is increasing public and government concern about the use of growth promotant antibiotics in livestock production. Thus, there is increasing interest in non-antibiotic production enhancers, such as probiotics (direct fed microbials) and prebiotics (carbohydrates). Throughout history people have consumed “probiotic” microorganisms in fermented foods and there have been numerous testimonials that these probiotics enhance health. Prebiotic compounds (inulin) occurs naturally in plants. Because of the recent increase in interest in prebiotics and probiotics, many think that this is a new field, however Metchnikoff (1907) suggested that there are “bad” bacteria in the intestine that shorten an individuals life, but that the use of fermented foods increased health in individuals. However, as Rettgeri and Chaplin (1921) indicated, research with probiotic bacillus and lactobacillus (including Bifidobacteria) and the prebiotic “lactose” in the late 1800’s. Although there is increasing interest in these approaches, there is also concern about how effective they are, compared to growth promotant antibiotics and whether there is increased variability in efficacy with these alternatives to antibiotics.

Objective
The Objective of this project was to review the literature and conduct a meta-analysis on the available data to determine efficacy of these compounds on enhancing pig performance.

Materials and Methods:
Exhaustive data searches were conducted on the most important literature databases (Pubmed, Chem Abstracts, Biological Abstracts and Agricola). Extensive analysis of the results and identification of how each database handled searches further increased the extensiveness and focus of the literature. Data was extracted from the publications and entered into Microsoft access and subsequently analyzed for performance criteria using SAS.

We limited our data on peer reviewed articles and also rated the articles as to whether the data was poor, fair or good. The evaluation was based on the quality of data, not quantity of data. The primary criteria were replication of experimental treatments and the STD or SEM of Control values for ADG, when possible. We did not include data from abstracts or reviews, where the data had not been published in a peer reviewed process because of concerns about the quality of data if it is not peer reviewed. However, we are planning on including information from these sources in the future and weighting the data. We separated research data into maternal, suckling, nursery, grow and finish phases. We limited the search to bacterial probiotics, or products that primarily contained bacterial probiotic organisms. We also limited our search on prebiotics to the predominant prebiotics (fructooligosaccharides and transgalactooligosaccharides) that have been used in swine. We also collected data on microbial populations and volatile fatty acid fermentation products.

Results

We have over 1,300 citations of work related to probiotics or prebiotics (including abstracts, book chapters, etc.). From this data pool, we entered data from 59 peer reviewed articles, 42 contained data on probiotics, 12 contained data on prebiotics and 5 contained data on synbiotics (combinations pf probiotics and prebiotics). Thirty two of the articles contained performance data, 19 articles contained data on microbial populations and 11 articles contained data on VFA. For bacterial and VFA data we separated the data provided for different sections of the intestinal tract. For example the different sections where microbial data was provided include: stomach, small intestine, cecum, colon (proximal, middle and distal) as well as feces. We also separated the performance data based on production phase (maternal, suckling, nursery, grow, finish and grow/finish, based on age and or initial weight. Thus, when we separated the data into logical comparison units, there was relatively little data that could be used for each statistical analysis of the data. There was also a lot of variation in the types of probiotics (and validation of live microorganisms) and prebiotics. Some were used as single probiotics, whereas others were composed of a mixture of probiotic organisms. For example there were 11 articles using various bacill (there were 8 bacilli were specifically identified to the strain level, others only to the genus or species level. There were 5 different strains of Bifidobacteria, 7 Enterococcus (of which 5 were identified to the strain level), one E. coli, 5 Streptococcus (none identified to the strain level) and 26 articles with lactobacilli (5 were identified to the strain level). Twenty eight articles used single bacterial species and 34 data sets where mixtures of probiotic bacteria were used.

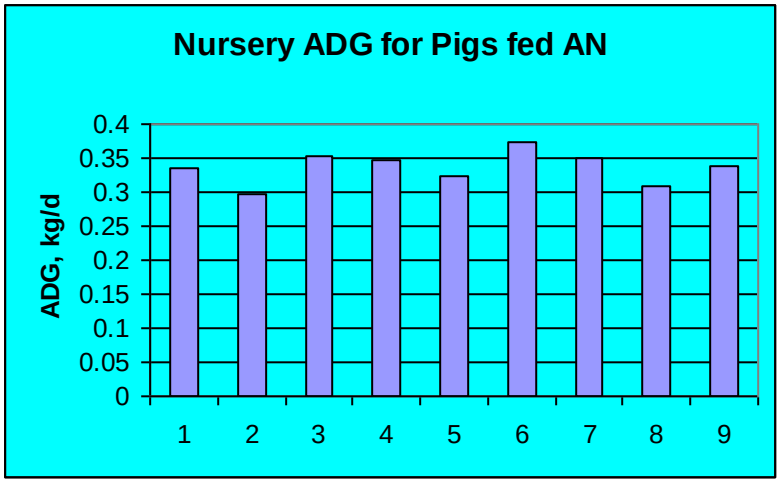
Thus, with the variety of probiotic organisms used and the variety of animal phases and intestinal sections make it difficult to do a statistical analysis and as one would expect, there were very few cases where there was a significant effect on performance by probiotics, prebiotics and antibiotics. Because of the variability within performance parameters, we also transformed the data looked at % difference from the control. Graphs of this data are attached. There are more data points for probiotic treatments than for antibiotic treated animals. The data shows that there is a lot of variation for probiotic and prebiotic treatments, whether one looks at ADG, FI,G/F or the % difference graphs, however there is also a lot of variation with the antibiotic treatments.

Discussion

There is a lot of variation within all data sets and because there are relatively few data points for specific probiotic or prebiotic treatments, it is difficult to determine if the variation is due to differences in efficacy of specific organisms or to differences in viability of the different organisms administered. At present, the data shows that there is variation of response with all treatments and depending upon the parameter being assessed, the probiotic and prebiotic treatments may be more or less variable than antibiotics. The primary limitation is having a good data set with enough experiments to statistically analyze the data.

Lay Interpretation

Although there is a relatively small data set on specific probiotic or prebiotic treatments, especially when the experiments also have an antibiotic treatment as a positive control, there is an increase in data being published and we should have a large enough data set to statistically analyze for treatment effects. In the meantime, probiotics and prebiotics show promise as alternatives to growth promotant antibiotics.


Nursery ADG for Pigs fed AN
ADG, kg/d
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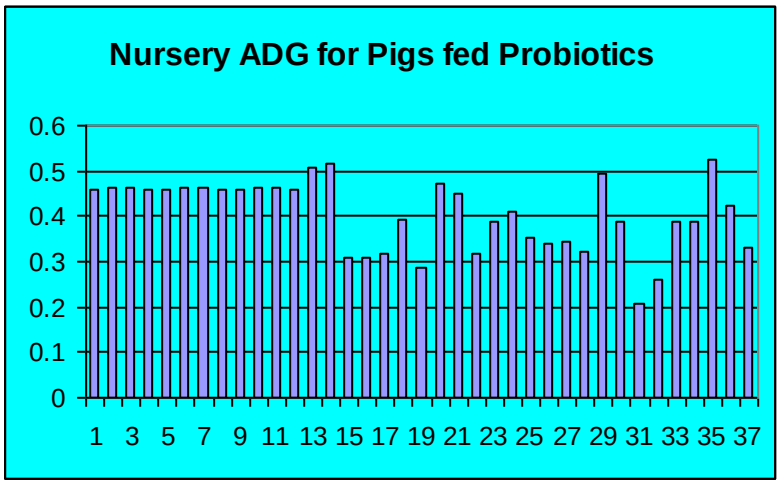
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1 2 3 4 5 6 7 8 9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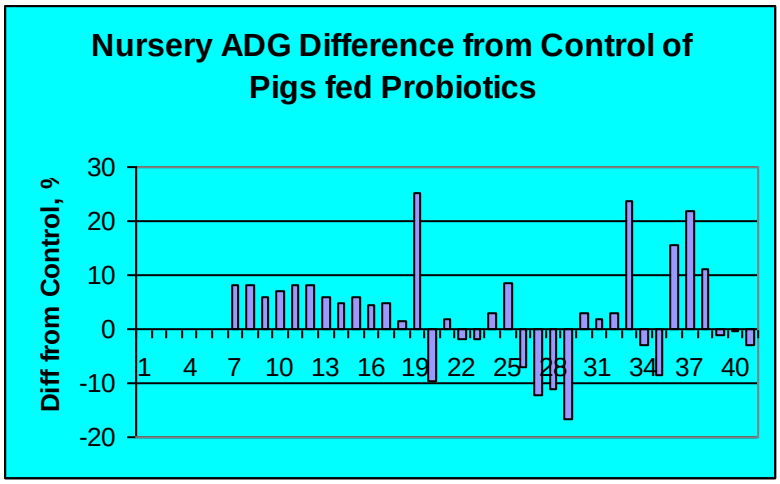
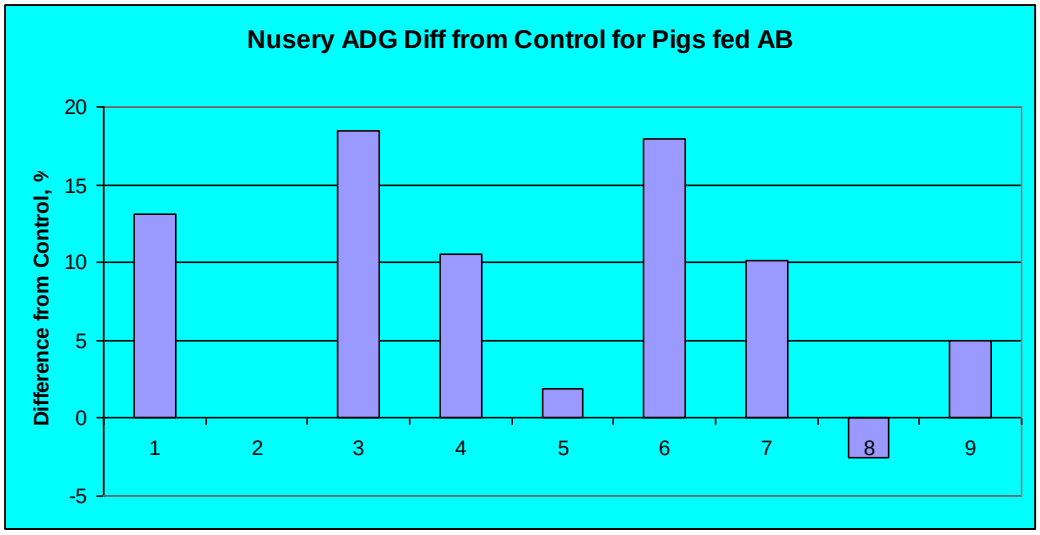
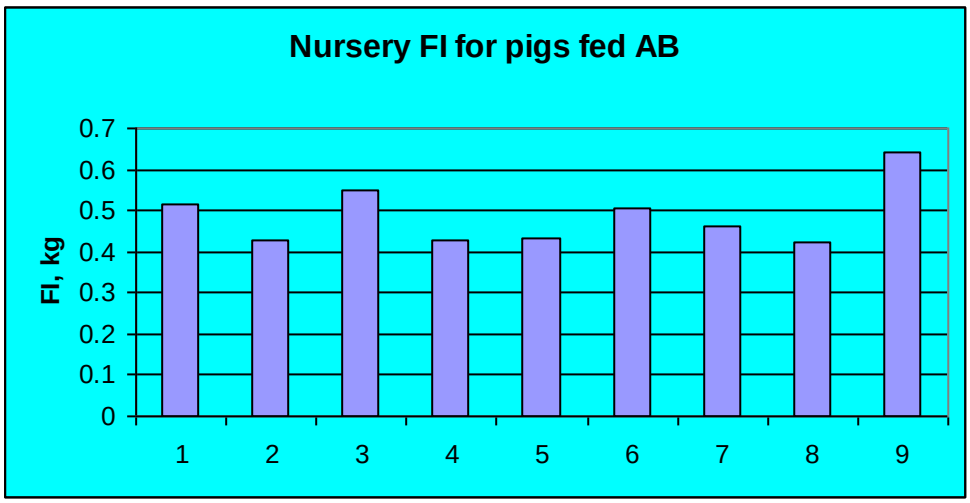
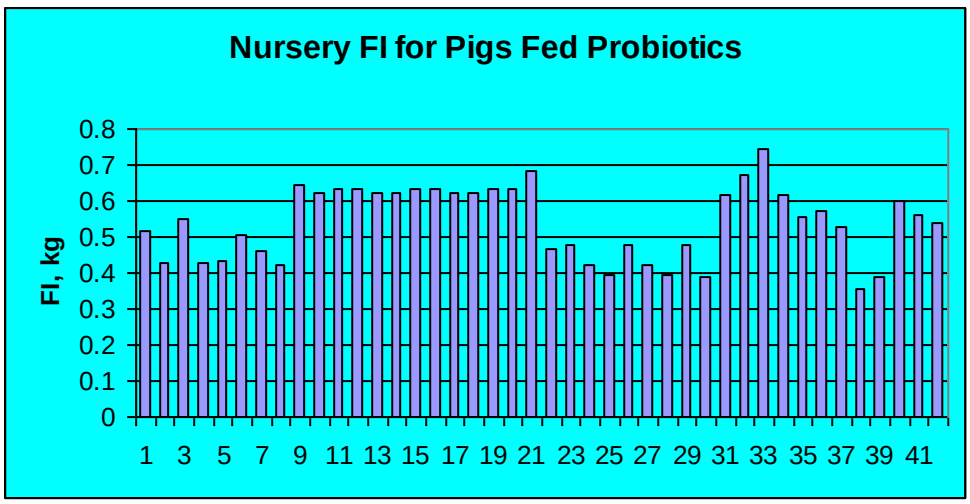
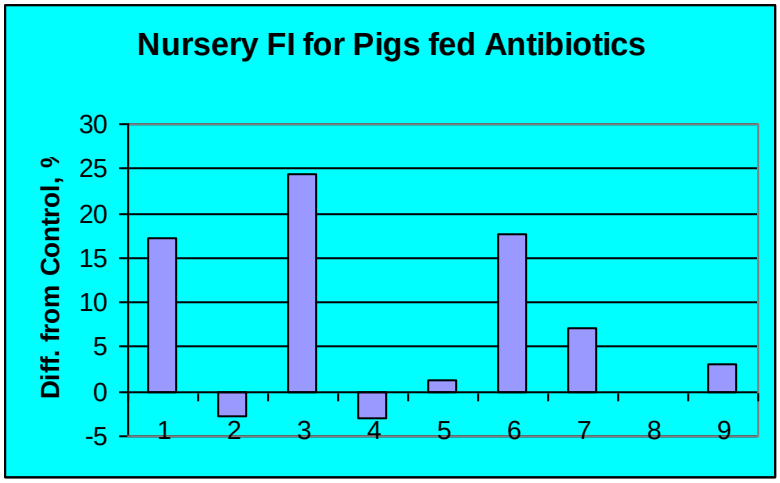
0.5
0.4
0.3
0.2
0.1
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37

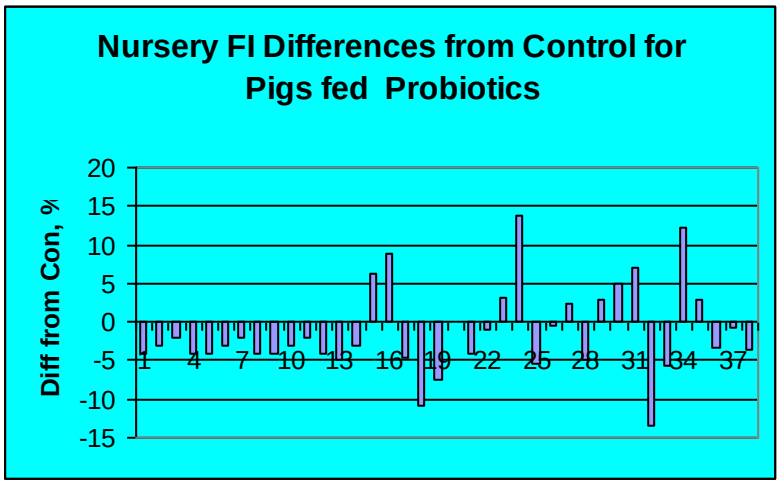

Nursery ADG Difference from Control of Pigs fed Probiotics
Diff from Control, %
30
20
10
0
-10
-20
1 4 7 10 13 16 19 22 25 28 31 34 37 40

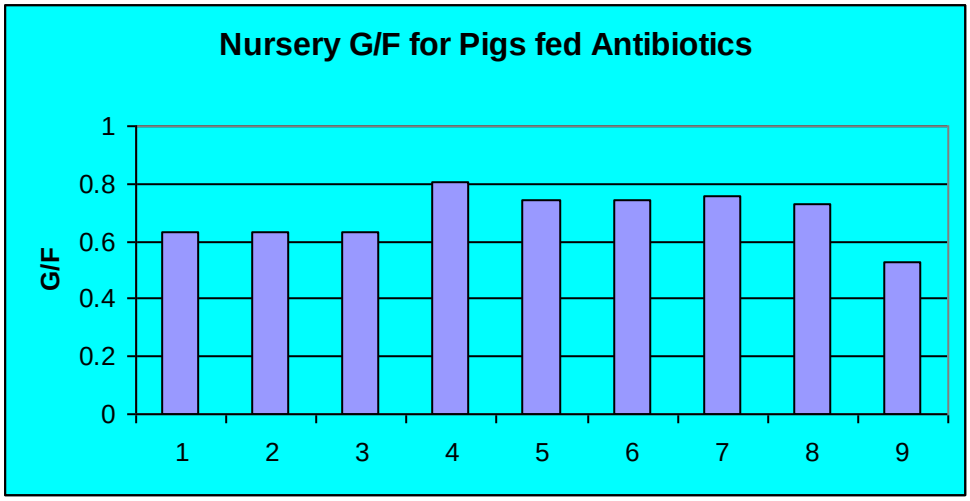

Nusery ADG Diff from Control for Pigs fed AB
Difference from Control, %
20
15
10
5
0
-5
1
2
3
4
5
6
7
8
9

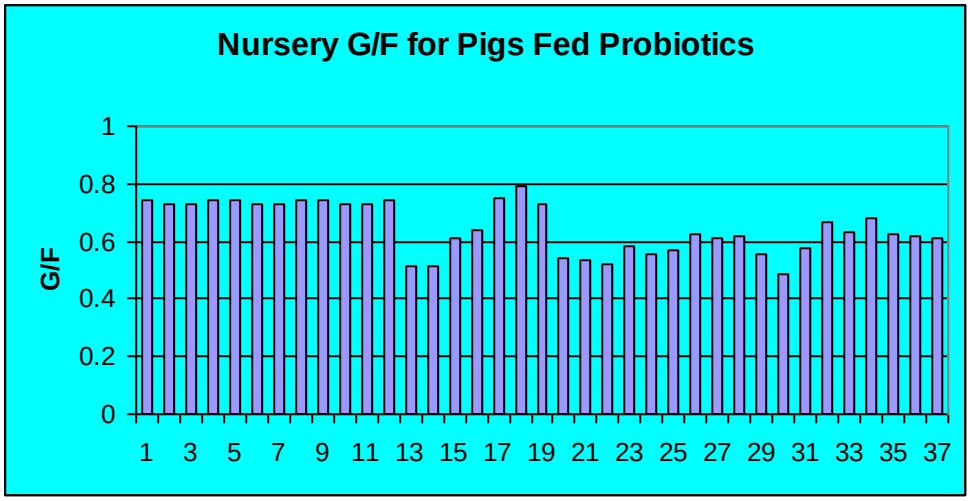

Nursery FI for pigs fed AB
FI, kg
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
2
3
4
5
6
7
8
9

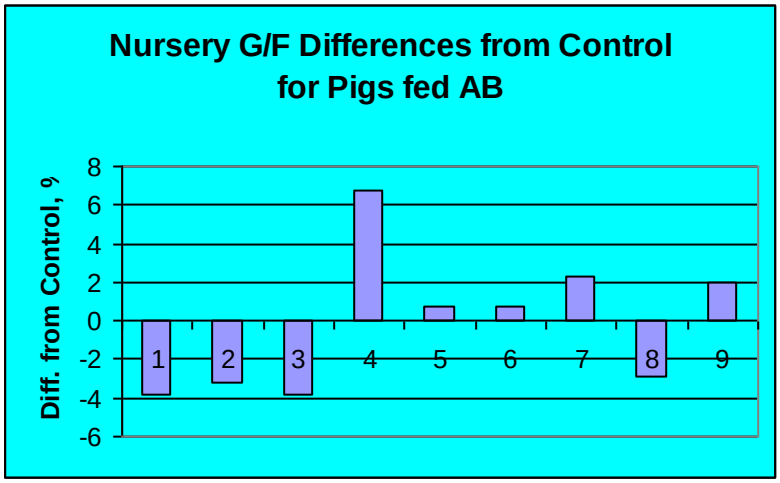

Nursery FI for Pigs Fed Probiotics
FI, kg
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41

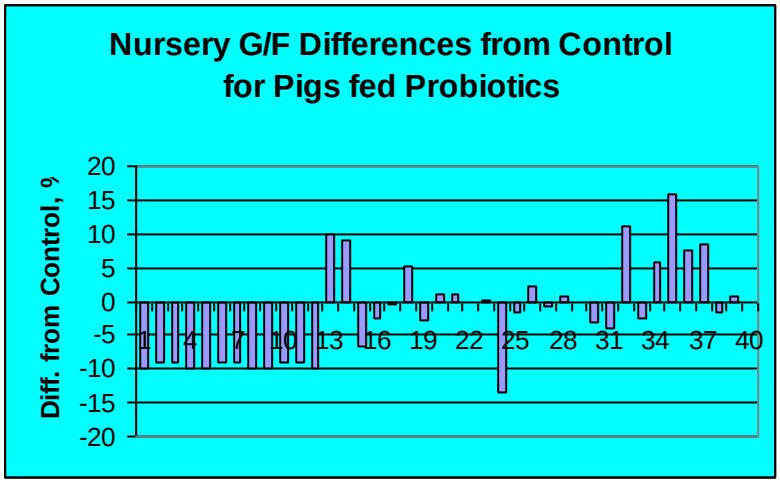

Nursery FI for Pigs fed Antibiotics
Diff. from Control, %
30
25
20
15
10
5
0
-5
1
2
3
4
5
6
7
8
9


Nursery FI Differences from Control for Pigs fed Probiotics
Diff from Con, %
20
15
10
5
0
-5
-10
-15
1
4
7
10
13
16
19
22
25
28
31
34
37


Nursery G/F for Pigs fed Antibiotics
G/F
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
8
9


Nursery G/F for Pigs Fed Probiotics
G/F
1
0.8
0.6
0.4
0.2
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37


Nursery G/F Differences from Control for Pigs fed AB
Diff. from Control, %
8
6
4
2
0
-2
-4
-6
1 2 3 4 5 6 7 8 9


Nursery G/F Differences from Control for Pigs fed Probiotics
Diff. from Control, %
20
15
10
5
0
-5
-10
-15
-20
1 4 7 10 13 16 19 22 25 28 31 34 37 40