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Conference paper

INFLUENCE OF THE WATER HOLDING CAPACITY OF THE DIET ON THE INCIDENCE OF DIARRHOEA AND THE COLONISATION OF THE SMALL INTESTINE IN STRESSED PIGS

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Summary

Present experiment was a part of an extensive study on the effects of the water holding capacity (WHC) on the digestive physiology in pigs. In previous experiments there were strong indications that a high WHC increased the bacterial counts and the flow of bacterial N in the ileum. This could be caused by a slower absorption of nutrients, which are trapped in the water-fiber matrix, favouring the development of the bacterial flora.

Stress also can alter the digestive physiology. A frequent observed phenomenon thereby in stasis in the stomach and small intestine which can result in bacterial overgrowth.

The present experiment was set up to study the combined effect of the WHC, stress and an experimental infectin with an enterophathogenic E. coli in pigs at the age they enter the fattening units, when they are known to be very prone to digestive upsets.

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Material and methods

Animals and housing

20 pigs of mixed origin and weighing 20 kg (10 BL and 10 BL x P) were purchased. They were divided according to sex and weight in 2 comparable groups. One group received the diet with a high WHC (H), the other group received the diet with a low WHC (L). The difference in the WHC was obtained by mixing different fibre-rich feedstuffs with a highly digestible, fibre-poor basis-feed in a proportion of 30/70. The composition and the proximate analysis of the diets is given in table 1.

During the first week the animals were adapted to the diets. They were housed per 5 on flat deck cages in a temperature controlled room (21 °C). Feeding was dry ad libitum.

Table 1. - COMPOSITION AND PROXIMATE ANALYSIS OF THE DIETS USED

	L	H
Composition (%)		
Soybean hulls	-	12.5
Oat husk meal	10.0	1.9
Alfalfameal	-	12.6
Palmkernel meal	4.6	-
Citrus pulp	1.4	3.0
Rice bran	14.0	-
Basis-feed	70.0	70.0
Proximate analysis (determined, % of feed)		
Dry matter	88.8	88.9
Ash	7.0	6.3
Crude fat	2.1	2.3
Crude protein (N x 6.25)	13.6	14.5
Total dietary fibre	20.0	21.6
WHC (g water/g feed)	2.7	3.5

During the second week several stress factors were introduced. The pigs were regrouped per 2 and housed on concrete in a cold stable where the T was fluctuating (12-17 °C). Feed was restricted to 85% of ad lib. and given in 2 meals (8 and 16.30 h). At the first feeding on day 1 and 3 of the seconed week 10^8 E. coli O149 K88ac (a common cause of weanling diarrhoea) was top dressed on the feed (= 1 ml of a 16 h incubated nutrient broth).

During the second week the health status of the pigs was recorded twice daily. The faeces was inspected and scored visually: 1 = watery 2 = liquid, 3 = pasty, 4 = soft, and 5 = normal.

Slaughter

After the stress-week the pigs were slaughtered for studying the gastro-intestinal (gi) contents. Therefore they were fasted overnight. In the morning they were allowed to eat during 1 h. 3h later they were anaesthesized with an overdose of Nembutal (I.C.; Sanofi, Libourne, F.) and bled. The gi tract was removed.The stomach, small intestine and large intestine were dissected and weighed (tissue + contents). A sample was taken from the stomach contents, the contents of 6 equal parts of the small intestine, and of the rectal contents.

Analyses

The feed was analysed using the EC methods (Anonymous, 1971, 1972). The total dietary fibre was determined with the method of Prosky et al. (1984). For the WHC the centrifugation-method was used (AACC method 88-04, 1995).

On the gi-contents the pH, DM% and WH was measured. Bacteriological counts were done on gastric contents and in the 3th (jejunum) and 5th (jejunum-ileum) segment of the small intestine. The method of Van Der Heyde (1967) was used with the selective media and culture conditions specified in table 2.

Table 2. - SELECTIVE MEDIA AND CULTURE CONDITIONS USED FOR THE BACTERIOLOGICAL COUNTS.

Total count	Reinforced clostridium agar with 0.001 % hemine, 72 h, anaerobic, 37°C, total count of colonies
Lactobacilli	Rogosa agar, 48 h, anaerobic, 37°C, white colonies
Streptococci (faecal)	Slanetz and Bartley agar, 48 h, aerobic, 37°C, pink to brown colonies
E. coli	Eosin methylene blue agar, 18 h, aerobic, 37°C, greenish metallic colonies

Results and discussion

There were no problems during the first week. the feed intake/pig/d was 0.99 0.1 kg for diet H and 1.14 0.1 kg for diet L. respectively.

During the second week, and after dosing the E. coli, there were no health problems, neither feed refusals. The occurrence of diarrhoea was highly variable but there was a significant ($p<0.05$, Wilcoxon test) difference between the diets, as can be see in table 3 which gives the procentual distribution of the faecal scores. The incidence of diarrhoea was much higher on the L. diet.

Table 3. - PROCENTUAL DISTRIBUTION OF THE FAECAL SCORES (140 OBSERVATIONS PER DIET)

diet	H	L
1 = watery	0	5
2 = liquid	7	17
3 = pasty	9	19
4 = soft	26	20
5 = normal	58	39

At slaughter the different parts of the gi-tract were weighed. The weight, in % of body weight at slaugter, is given in table 4.

Table 4. - WEIGHT OF THE DIFFERENT PARTS OF THE GI-TRACT IN % OF BODY WEIGHT (MEAN S.D.)

diet	H	L
Stomach	3.5 (0.6)	3.4 (0.8)
Small intestine	6.4 (0.7)	6.6 (0.8)
Large intestine	4.3 (0.7)	3.0 (0.3)**

The weight of the large intestine was much greater in the pigs receiving the H diet ($p<0.01$, t-test). Taking into account the difference in DM% (see below) the difference is nearly totally due to the higher water content.

There were no differences for the pH and the DM% in the stomach and the different parts of the small intestine between the 2 diets. The pH was 3.7 (0.6) in the stomach and gradually increased from 5.6 (0.6) in segment 1 to 6.5 (0.3) in segment 6 of the small intestine. The values for the DM% were 21% (3) in the gastric contents and 13 (4) to 17% (2) in the upper and lower parts of the small intestine. The DM% of the rectal contents however differed markedly

between the 2 diets ($p<0.001$, t-test): H = 27.1 (2.1) versus L = 36.3 (2.7). The faecal score on the morning before slaughter was H = 4.5 versus L = 3.5. Those results clearly indicate that there is no relationship between the visual appearence of the faeces and the DM%.

The difference of the WHC of the diets was reflected in the WHC of the gi-contents, which differed significantly at each location ($p<0.001$, t-test). There was a gradual increase in the WHC towards the end of the small intestine with both diets, the increase being most pronounced with diet H. This increase most probably is due to an enrishment in the undigestible fibre-fraction in the contents. Results are given in table 5.

Table 5. - WHC (G/G) OF THE GASTRO-INTESTINAL CONTENTS (MEAN S.D.)

Diet	H	L
Stomach	22.2 (0.2)	1.6 (0.2)
Smal intestine: segment		
1	-	2.3 (0.1)
2	3.2 (0.7)	2.4 (0.3)
3	2.9 (0.3)	2.3 (0.3)
4	3.0 (0.3)	2.6 (0.4)
5	3.2 (0.4)	2.5 (0.4)
6	3.6 (0.3)	2.7 (0.3)

Table 6. - BACTERIOLOGICAL COUNTS IN THE STOMACH AND SMALL INTESTINAL CONTENTS (LOG/ML, MEAN S.D.)

		Stomach	Small intestine: segment	
	Diet		3	5
Total count	H	7.1 (0.4)	7.3 (0.8)	8.1 (0.5)
	L	6.7 (0.5)	7.0 (0.5)	7.6 (0.4)*
Lactobac.	H	7.0 (0.5)	7.0 (0.6)	7.0 (0.4)
	L	6.6 (0.5)	6.6 (0.6)	6.9 (0.5)
Streptoc.	H	6.8 (0.6)	7.5 (0.9)	7.8 (0.4)
	L	6.5 (0.4)*	7.0 (0.6)	8.0 (0.3)
E. coli	H	5.3 (0.7)	5.5 (0.6)	6.1 (0.5)
	L	4.9 (0.5)	5.5 (0.5)	6.5 (0.5)*

The results of the bacterological counts are given in table 6. There is a cleare trend that the number of all bacterial species counted in the stomach and

upper small intestine was higher with the H diet, although significant differences were only occasionally obtained. This seems to confirm the previous results obtained. The number of E. coli on the other hand was highest ($p<0.5$, t-test on log values) in the lower parts of the small intestine in the pigs receiving the L. diet. The reason therefore is not very clear, but it may be that fibre with a high WHC hinders the attachment and development of pathogenic E. coli in the same way as pectin and other water binding substances (e.g. kaolin) do.

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UTJECAJ SPOSOBNOSTI ZADRŽAVANJA VODE U OBROKU NA POJAVU PROLJEVA I KOLONIZACIJE TANKOG CRIJEVA U SVINJA POD STRESOM

Sažetak

Ovaj je pokus dio opsežnog proučavanja djelovanja sposobnosti zadržavanja vode (WHC) na fiziologiju probave u svinja. U prijašnjim pokusima (Decuypere i sur. 1994) postojali su jaki pokazatelji da visoki WHC povećava broj bakterija i kolanje bakteriskog N u ileumu. Uzrok tome može biti sporija apsorpcija hranjivih tvari zaglavljenih u vodeno-vlaknatoj matrici, što pogoduje razvoju bakterijske flore.

Stres može isto tako izmijeniti fiziologiju probave. Često zapažena pojava je stoga stasis u želucu i tankom crijevu što može prouzročiti prebrz rast bakterija.

Ovaj je pokus obavljen zato da bi se ispitalo zajedničko djelovanje WHC-a, stresa i eksperimentalne infekcije enteropatogene E. coli u svinja u dobi ulaska u tov, kad je poznato da su vrlo sklone probavnim poremećajima.

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