EFFECT OF GRAIN PARTICLE SIZE AND PELLETS ON DEVELOPMENT OF GASTRIC ULCERS IN SWINE

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GASTRIC ulcers in swine obviously have many causes. Among these, the physical structure of the diet has been a subject of much interest. Oat hulls are reported to prevent gastric ulcers, but the effect was reduced when the hulls were finely ground (Maxwell et al., 1967). The positive association of fine structure on gastric ulcer frequency has also been described by other investigators (Mahan et al., 1966; Reimann et al., 1968).

The pelleting process has been discussed as another cause of the increasing incidence of gastric ulcers. Reese et al. (1966) found no detrimental effect, while other workers indicate an increasing incidence caused by feeding pelleted diets (Pocock et al., 1969; Chamberlain et al., 1967).

On examination of 1,000 stomachs from a Norwegian slaughterhouse in 1966, a rather high frequency (55%), of epithelial alterations and ulcers was found (Teige, 1967). The frequency of ulcers is thought to have increased during the last 10 years. In the same period the pelleting process has become more common. It was, therefore, of interest to study the influence of particle size and the pelleting process on gastric ulcer frequency, and at the same time record differences between genetically divergent groups.

Materials and Methods

Three hundred and forty-one pigs of the Norwegian Landrace were used. The pigs, weighing about 20 kg live weight at the start of the experiment, were born and reared under the same conditions of management at Arteid Research Station. They were divided into four equal lots according to litter, sex and weight. In all, the pigs were the progeny of 33 boars. The experiment lasted for 1½ years and included 10 replications, a total of 40 groups. The floor space per pig was about 0.7 to 0.8 m². Wood shavings were used for bedding.

The pigs were fed twice daily according to Norwegian feeding standard. The composition of the diet is shown in table 1. The diet was given in the following structural forms: Lot 1, finely ground; Lot 2, pellets made of finely ground meal; Lot 3, coarsely ground; Lot 4, pellets made of coarsely ground meal.

The difference between fine and coarse grinding refers to barley and oats. These components were prepared by grinding through either a 2.5 mm or a 6.0 mm screen in a hammermill.

The pellets were made in a Floating Die 100 HF machine. The food passed through a conditioning chamber into which steam under a pressure of 7 to 8.5 kg/cm² was injected. The steam-heated meal having a temperature of nearly 80°C was then extruded through 4.8 mm dies. The temperature was immediately reduced to about 30°C with a draft of cold air. After passing over a sieve it was brought directly to a sacking machine. No type of agglutinant was used.

The module of uniformity was determined in the manner described by Henderson and Perry (1955). For the fine feed it was found to be 0.4:6. The corresponding data for the coarse feed was 0:6:4. The module of fineness was determined to 1.60 for the finely ground and 1.80 for the coarse. The average crude protein contents were 16.4 and 16.9% for the finely and coarsely ground diets, respectively. Corresponding data for the fiber contents were 5.5 and 5.3%.

The last feed was given about 3 hr. prior to slaughter. The animals were weighed weekly and slaughtered at first deliverance after having achieved 90 kg live weight. Average carcass weight and average length of feeding period are given in table 2.

The stomachs were emptied immediately and the content classified as (1) dry, (2) semifluid or (3) fluid (Reimann et al., 1968). The stomachs were frozen for later determination of the ulcer index. This was done by the method described by Baustad and Nafstad (1969). The scale of scoring ranged from one to nine, the lowest indicating normal stomachs, and the highest, deaths due to penetrating ulcers.

1 Appreciation is expressed to Dr. med. vet. Inger Nafstad for assistance with classification of the gastric ulcers.

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**TABLE 1. THE COMPOSITION OF THE DIET**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herring meal, extra</td>
<td>5.0</td>
</tr>
<tr>
<td>Soybean meal, extracted</td>
<td>9.0</td>
</tr>
<tr>
<td>Barley meal</td>
<td>55.0</td>
</tr>
<tr>
<td>Oat meal</td>
<td>20.0</td>
</tr>
<tr>
<td>Wheat bran</td>
<td>8.9</td>
</tr>
<tr>
<td>Ground limestone</td>
<td>2.0</td>
</tr>
<tr>
<td>Vitamin Premix III E</td>
<td>0.1</td>
</tr>
</tbody>
</table>

*Vitamin Premix III E provided per kilogram of diet: Vitamin A, 2,000 IU; vitamin D₃, 250 IU; vitamin E, 4 mg; riboflavin, 2 milligrams. No salt was included in the diet.

**Results and Discussion**

The results are shown in table 2. The data show a low frequency of severe alterations. Only eight of 341 pigs developed erosions and ulcers of the stomach epithelium. No pig died due to ulcers. The physical form of the diet had a significant (P < .001) effect on the incidence of gastric defects. This is in agreement with earlier reports by Mahal et al. (1966); Reimann et al. (1968); Chamberlain et al. (1967) and Pocock et al. (1969).

Comparing finely and coarsely ground meal, the first resulted in a significantly (P < .001) higher frequency both when the feed was given as meal and as pellets. The same result was obtained when only meal and pellets were compared (P < .001).

The highest frequency of all types of alterations was observed in treatment groups receiving pellets made from finely ground meal. Of 86 stomachs, only 14 were normal. A good protection thus seems to have been obtained by using coarsely ground barley and oats. Between groups fed finely ground meal and those given pelleted coarse meal no real difference existed.

The stomach content score was highest when pigs received pelleted diets of finely ground meal and lowest when the coarse meal diet was fed. A highly significant (P < .001) association was found between the ulcer index and the content scores, indicating that alterations in gastric epithelium were associated with a more fluid content.

Starvation apparently increases the incidence of gastric lesions (Pocock, Bayley and Roe, 1968). The low frequency in this experiment may have been influenced by the short time between the last feeding and slaughter.

The use of wood shavings is reported to increase the number of normal stomachs found on examination (Pocock et al., 1969). In this experiment, the pigs ate wood shavings used...
for bedding. This may have given an extra supply of coarse material which may provide an explanation for the low frequency of severe defects.

In a Swedish experiment, the incidence of ulcers was much higher when the feed was ground through a 1.25 mm screen, than when using a 2.25 mm screen (Björklund, Crabo and Simonsen, 1970).

In a recent paper, Maxwell et al., (1970), studied the effect of particle size on lesion development. They found a lower pH and a higher pepsin activity in the oesophageal region when a fine diet was fed. Earlier, most of the biochemical components had been measured in samples from the whole gastric content. It seems that more reliable data can only be obtained by measuring the concentration in different regions.

Pigs fed pellets made of finely ground meal made more rapid and efficient gains (P<.01) than pigs fed the nonpelleted diet. Comparing pigs fed the coarse diet as meal or pellets, the latter had a significantly (P<.01) better daily gain. No significant difference was observed in feed consumption.

The mean ulcer index of the 13 boars with more than 10 offspring ranged from 1.1 to 2.0. A significant difference was found between sire groups (P<.01). This may indicate genetic differences. No differences were related to sex. Mahan et al. (1966) found neither a genetic relationship nor relation to sex.

**Summary**

The effect of physical structure of the diet on the development of gastric ulcers was studied in an experiment involving 341 pigs. A total of 115 pigs developed alterations of the stomach wall. In 107 of these the lesions were classified as epithelial changes. Small particle size of the diet and use of pellets appeared to be the most consistent factors related to lesions. Diets of an identical composition produced fewer alterations of the gastric epithelium when fed in a coarse form. No pigs died due to ulcers. A significant (P<.01) difference was found between sire groups in the incidence of ulcers, but no influence of sex was observed.

**Literature Cited**


