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# The effect of feeding storage deteriorated and normal barley, soaked and unsoaked, on the growth and carcase quality of pigs

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Summary

The experiment was designed to determine the effect of feeding two different qualities of barley (deteriorated and normal) on the production results and quality of the lean and fat of the resultant carcases. A study was also made of the effect of soaking these two lots of barley. A total of 128 pigs (20 - 90 kg) were used in the experiment.

The normal lot of barley was grown on the college farm and compared with a lot purchased through the trade and which had deteriorated during storage. The germination percentage of this latter lot of barley was not more than 23 and it had in addition a high level of bacterial and mould infection.

No statistically significant differences were found between the lots of barley with regard to the growth or feed utilization of the pigs but there was a tendency for the deteriorated barley to give a somewhat inferior result than normal. The lean/fat ratio was not affected.

A comparison of the effect of the two lots of barley on the lean quality showed that the deteriorated barley adversely affected the brightness and chroma values of the lean, the pH value 45 minutes after slaughter, the extinction value (acc. to Hart) as well as the total pigment content. The differences were all significant. A significant difference in the "keepability" of the depot fat attributable to differences in the lots of barley was also established.

Soaking the barley had no effect on any of the characteristics studied.

Zusammenfassung

Es wurde der Einfluss von zwei Gerstenpartien (lagerungsgeschädigt und normal) auf die Produktionsresultate und die Fleisch- und Fettqualität in einem Schweineproduktionsversuch (20 - 90 kg) mit 128 Tieren untersucht. Das Futter wurde teils eingequollen und teils trocken verfüttert.

Eine im Handel und eine unter guten Bedingungen auf dem Versuchsgut angebaute und gelagerte Partie wurde untersucht. Die Keimfähigkeit betrug im ersteren Falle nur 23 %. Der Bakterien- und Schimmelgehalt war stark erhöht.

Bezüglich der Gewichtszunahmen und Futterverwertung konnten keine statistisch gesicherten Unterschiede zwischen den Gerstenpartien festgestellt werden; eine gewisse Tendenz zu Ungunsten der geschädigten Partie trat jedoch hervor. Das Fleisch-Fettverhältnis wurde nicht beeinflusst.

Der Einfluss der beiden Partien auf die Fleischqualität ergab signifikant geringere Qualitätsmasse für die geschädigte Gerste betreffs des Helligkeits- und Farbton-wertes, des pH-Wertes 45 Min. post mortem, des Extinktionswertes nach Hart sowie des Totalpigmentgehaltes. Es konnte auch ein signifikanter Zwischenpartieeffekt auf die Haltbarkeit des Depotfettes festgestellt werden.

Für die Einquellung konnte kein signifikanter Einfluss festgestellt werden.

Introduction

Periodically there arises serious problems due to pale soft exudative (PSE) muscles in the pig carcases. It was thought that this condition could be associated with storage deteriorated grain, mainly barley. It was thought that the feeding of such grain in a soaked condition further aggravated the occurrence of PSE-muscle.

Design of experiment

Four treatments were employed:

Meal containing Barley A - unsoaked
" " Barley A - soaked
" " Barley B - unsoaked
" " Barley B - soaked

The barley was from the 1963 harvest. Barley A was of normal quality whereas Barley B had undergone deterioration during storage. There were 16 pigs on each treatment and the experiment was carried out first in the summer of 1964 and replicated during the winter 1964/65. The feeding practice was the same as that employed at the Swedish Pig Progeny Testing Stations (Svinstamkontrollen, Kungl. Lantbruksstyrelsens meddelanden, Serie B, Nr. 55).

Results

Growth and feed utilization. No differences were found between treatments with regard to appetite. The growth and feed utilization of the pigs is presented in Table 1 which shows that the growth of the pigs on Barley A tended to be higher than that of the pigs on Barley B in both replications. The mean difference was approximately 20 g but it was not statistically significant. Soaking the meal did not have any effect on the growth or feed utilization with either Barley A or B. The feed utilization of the pigs on Barley B was less efficient than pigs on Barley A and this was a consequence of the lower growth rate of Barley B pigs. However, the differences were not statistically significant and must be interpreted as an indication of the poorer nutritional quality of Barley B.

In the first replication of the experiment (summer 1964) one pig from each of Barley A and B had to be emergency slaughtered and in the winter replication one pig from Barley B was eliminated. The causes of elimination were not found to be associated with the treatments.

Carcase quality. Carcase quality was assessed on the basis of backfat measurements and an assessment of leanness based on the method employed by the Swedish Pig Progeny Testing Stations. The following model was used for the statistical analyses.

| Source of variation | Degrees of freedom |
|---|---|
| Replications | 1 |
| Treatments | 3 |
| Barley A v. Barley B | 1 |
| Soaked v. unsoaked | 1 |
| Interaction | 1 |
| Error | 120 |
| Total | 124 |

The significance level of the differences are shown in Tables 2 - 4 and follow normal statistical practice.

It will be seen from Table 2 that there was no significant difference in backfat thickness due to the sources of variation. There was, however, a significant difference in belly thickness between replications and also a significant difference between replications with respect to leanness in the side. The area of the longissimus dorsi tended to be somewhat greater in Replication I than II which may be explained by the variation in the experimental animals obtained for each replication.

It was interesting to observe that there was a significant difference ($P<0,05$) in the loss at slaughter between soaked and unsoaked meal. The soaked meal resulted in a lower loss at slaughter (27,9 %) than unsoaked (28,5 %).

Lean quality. It was presumed that soaking the meal would favour the formation of fat break down products which would in turn influence normal tissue functions. This was measured by determining the GOT-value before transport to the abbattoir and after slaughter. The results (Table 3) show that there was a significant difference between replications with blood taken before slaughter. There was also a significant difference between the GOT-values before and after slaughter. The increase was significantly greater in Replication I than in Replication II.

A satisfactory expression of lean quality is obtained by measuring the brightness value of the lean by means of a remission photometer and then expressing the results according to the CIE-system (Thomke et al. 1965). Significant differences ($P<0,05$) between Barley A and B's effect on the brightness value of the lean was established in this experiment. The B Barley gave rise to clearly lighter coloured lean than the A grain. It will also be seen from Table 3 that there were significant differences in the colour (chroma) of the lean between replications as well as between Barley A and B.

Other measures of lean quality such as the pH, the extinction value acc. to Hart and the total pigment content showed highly significant differences in some cases between replications and significant between Barley A and B.

Fat quality. Table 4 shows that there were significant differences between replications with respect to the quality of the depot fat. Significant differences between Barley A and B for the "keepability" of the depot fat were also established.

Discussion

Several reports in the literature indicate that the feeding of storage and harvest deteriorated grain adversely affects the growth rate, feed utilization and general health of the pigs. In other reports however, no negative effects have been observed. In this present experiment a slightly negative, though not significant, effect on the growth rate and feed utilization was noticeable between Barley A and B. There were, however, significant differences between Barley A and B with regard to the quality of the lean and fat.

The causes of the differences must obviously be attributed to the barley, but these differences were not apparent from the crude analysis of the barley lots. However, as described earlier, Barley B differed from normal grain in several respects and the changes which occurred due to unsatisfactory storage has presumably given rise to the differences observed. In order to be able to state this with a greater degree of certainty it would have been more satisfactory if adequate quantities of Barley A had been made available and subjected to a clearly defined deterioration process. Regardless of this, however, it is interesting to observe the pronounced differences between the barley lots in their effect on the quality of the meat produced.

Since the energy supplied by the feed was the same for all the treatments and the growth of the pigs on the normal barley tended to be somewhat higher than the pigs on the B barley it is most probable that the differences which occurred were due to the fact that the B Barley was utilized less efficiently. Possibly this was a result of the latter barley having undergone some process of deterioration which blocked the utilization on one or several nutrients or essential constituents or, that some inhibiting factor originated during the process of deterioration. It will be seen from Table 1 that the differences between the lots of barley tended to be greater in Replication I than in Replication II. That some changes took place in the barley between the replications is supported by the fact that there were significant differences between replications with respect to some lean and fat quality measurements. It is probable that this is connected with the fact that the moisture content of

the barley was not sufficiently low (14 %) for storage at relatively high temperatures and also that the barley was stored in paper sacks.

It must however, be pointed out that there were differences between the experimental animals between the replications and this may have had a deciding influence. Thomke et al. (1965) showed that there were pronounced differences between progeny groups with regard to lean and fat characteristics. In this present experiment the differences between the experimental animals has probably been a contributing cause to the differences between replicates.

Surprisingly a consistently higher average pH value was obtained in Replication II in spite of the fact that the extinction values were clearly lower in this replication than in Replication I. This is contrary to general experience and earlier results.

Of more interest from an experimental point of view, however, are the differences attributable to the two lots of barley. A pronouncedely paler lean which had a poor juice retaining capacity resulted from the feeding of deteriorated barley, i.e. it was qualitatively inferior to lean obtained from the feeding of normal barley. Since no difference was established between the GOT-values of the deteriorated versus normal barley groups it can be assumed that there was no tissue break-down (muscular dystrophy) attributable to the barley lots. No histological examination of possible tissue changes was undertaken since in the planning of the experiment it was decided that possible differences would be characterised by the GOT test.

In the calculation of the differences in GOT-values prior to transport and after slaughter it was found that there were significant differences ($P < 0,05$) firstly between the replications (mean differences = 13 GOT units) and secondly between normal and deteriorated barley (mean difference = 10 GOT units). Insofar as the former difference was not occasioned by the differences in experimental animals (between replications) it may possibly be explained by the fact that the experiment was performed during the summer half of the year when the animals were probably exposed to greater stress factors in connection with slaughter. The differences between the barley lots indicate that the D Darley had an aggravating effect with respect to the differences in the GOT-values brought about by the transportation to the slaughterhouse.

The significant difference in the "keepability" of the depot fat between pigs fed on normal and deteriorated barley is most probably explained by the low tocopherol content of the latter barley (28 mg compared with normally about 40 mg per kg).

A general observation made in other experiments and which was confirmed in these experiments was that after the oxidation of the antioxidants the formation of peroxides in connection with the "keepability" test (expressed as regression values) is more rapid in fat samples with a long than with a short "keepability". This is no doubt associated with the amount of anti-oxidant substances and the differences in the distribution of fatty acids in these fats.

Soaking of meal containing deteriorated or normal barley did not influence the production results or the quality of the carcasses. It was, however, interesting to note that the loss at slaughter was somewhat higher for pigs fed unsoaked than for pigs fed soaked meal but it is doubtful whether this differences is in fact real. The overall result may thus be summarized by concluding that soaking of deteriorated or normal barley did not have any influence on either the production results or the quality of the lean or fat in the carcasses.

Table 1. Treatment means at the start and finish of the experiment together with mean growth rates and feed utilization

| | No. of pigs | Start wt. kg | Final wt. kg | Growth rate g/day | Feed units/ kg gain |
|---|---|---|---|---|---|
| Replicate I | | | | | |
| Barley A, unsoaked | 15 | 22,9 | 91,3 | 710 | 3,15 |
| Barley A, soaked | 16 | 23,1 | 91,9 | 702 | 3,17 |
| Barley B, unsoaked | 16 | 22,6 | 92,5 | 697 | 3,20 |
| Barley B, soaked | 15 | 21,8 | 91,6 | 700 | 3,22 |
| Replicate II | | | | | |
| Barley A, unsoaked | 15 | 23,6 | 91,5 | 736 | 3,15 |
| Barley A, soaked | 16 | 23,7 | 91,3 | 698 | 3,26 |
| Barley B, unsoaked | 16 | 23,5 | 91,2 | 682 | 3,38 |
| Barley B, soaked | 16 | 23,5 | 91,3 | 682 | 3,40 |

*Table 2. Mean backfat and lean measurements and the significance level of differences*

| | Replicate | | Significance | Barley | | Significance | Treatment | | Significance |
|---|---|---|---|---|---|---|---|---|---|
| | I | II | | A | B | | Unsoaked | Soaked | |
| Backfat mm. | | | | | | | | | |
| Midback | 20,7 | 20,2 | | 20,5 | 20,3 | | 20,4 | 20,4 | |
| Mean | 29,7 | 28,8 | | 29,3 | 29,2 | | 29,3 | 29,2 | |
| Slight of lean | 26,5 | 26,1 | | 26,1 | 26,5 | | 26,3 | 26,3 | |
| Inside fat | 27,6 | 28,2 | | 27,8 | 28,0 | | 27,6 | 28,2 | |
| Belly thickness | 34,8 | 32,3 | xxx | 33,4 | 33,7 | | 33,4 | 33,6 | |
| Leanness | | | | | | | | | |
| Area of l. dorsi, $cm^2$ | 29,0 | 28,0 | | 28,6 | 28,5 | | 28,5 | 28,5 | |
| Lean in side, mm. | 40,6 | 37,4 | xxx | 39,6 | 38,5 | | 38,6 | 39,5 | |
| Leanness score, min. 8; max. 15 | 12,7 | 12,4 | | 12,6 | 12,5 | | 12,5 | 12,5 | |
| Loss at slaughter | | | | | | | | | |
| Loss at slaughter, % | 28,2 | 28,2 | | 28,1 | 28,4 | | 28,5 | 27,9 | x |

*Table 3. Means of lean quality measurements and the significance level of differences*

| | Replicate | | Significance | Barley | | Significance | Treatment | | Significance |
|---|---|---|---|---|---|---|---|---|---|
| | I | II | | A | B | | Unsoaked | Soaked | |
| Lean quality | | | | | | | | | |
| Brightness value | 18,9 | 19,7 | | 18,5 | 20,1 | x | 19,0 | 19,6 | |
| Chroma 0,3... | 80 | 90 | xxx | 87 | 82 | xx | 83 | 86 | |
| Hue 0,3... | 52 | 52 | | 51 | 53 | | 52 | 51 | |
| pH, 45 min. after sl. | 6,00 | 6,46 | xxx | 6,33 | 6,13 | x | 6,24 | 6,22 | |
| Water, % | 73,6 | 74,7 | xxx | 74,2 | 74,2 | | 74,3 | 74,0 | |
| Crude protein, % | 22,2 | 22,1 | | 22,2 | 22,1 | | 22,2 | 22,2 | |
| Ext. value, acc. Hart | 0,91 | 0,63 | xxx | 0,85 | 0,69 | xxx | 0,76 | 0,78 | |
| Total pigment | 0,56 | 0,51 | x | 0,57 | 0,50 | xxx | 0,54 | 0,53 | |
| GOT before transport | 48,6 | 69,0 | xxx | 60,6 | 57,1 | | 60,6 | 57,1 | |
| GOT after slaughter | 71,8 | 79,8 | | 72,7 | 78,9 | | 77,5 | 74,1 | |

*Table 4. Means of depot fat characteristics and the significance level of differences*

| | Replicate | | Significance | Barley | | Significance | Treatment | | Significance |
|---|---|---|---|---|---|---|---|---|---|
| | I | II | | A | B | | Unsoaked | Soaked | |
| Fat quality | | | | | | | | | |
| Iodine No. | 55,3 | 57,2 | xxx | 56,2 | 56,5 | | 56,5 | 56,1 | |
| Redr.index, 1,45... | 889 | 906 | xxx | 896 | 899 | | 899 | 895 | |
| "Keepability", days | 3,58 | 4,55 | xxx | 5,60 | 4,53 | xxx | 4,87 | 5,25 | |
| Regression value | 1,90 | 1,60 | xxx | 1,85 | 1,64 | xx | 1,73 | 1,77 | |