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AARHUS UNIVERSITY

REPORT

The nutritive value of grain stored in air tight silos compared to grain sufficiently dry for storage

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Background:

Traditionally, grain is stored by drying it to moistness of approximately 14 % water content. The grain is sufficiently dry for storage with this water content and can thus stand being stored in an environment with oxygen without rotting. We expect that an air tight storage of the grain will have a favorable influence of the nutritive value of the grain as feed. An example is the enzyme phytase which may stimulate the breakdown of the complex phytate during storage. In this way the digestibility of phosphorus of air tight stored grain is expected to be larger compared to dryly stored grain. Similar effects are expected with regard to protein and other nutrients.

Objective:

The objective of the project is to test whether the nutritive value of grain is increased when stored wet in air tight silos compared to grain sufficiently dry for storage.

Experiments:

The nutritive value of the grain was examined when mixed with whole feed for pigs. A control diet and an experimental diet were produced. Grain stored dry was used for the control diet, and grain stored in air tight silos was used for the experimental diet.

Barley and wheat were harvested in August 2009 and constituted subsequently the grain part of the diets. Half of the grain was harvested and stored with a low water content, whereas the other half was harvested and stored in air tight silos with a higher water content. The barley was harvested from the same field which means no difference of strain etc. The same applies for wheat. This means that only the storage of the grain varies. The dry matter content measured at the time of harvest is shown in table 1.

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Table 1: The dry matter content at the time of harvest measured in the laboratory

	Control (dry)	Wet (experiment)
Dry matter (barley; harvest), %	89.8	85.2
Dry matter (wheat; harvest), %	88.3	82.8

The experiment was carried out as a digestibility and balance experiment involving a total of 16 pigs which in pairs originated from the same litter and were fed the control diet or the experimental diet (table 2). At the beginning of the experiment the pigs weighed approximately 45 kg. They were then fed the different diets for 12 days. After a 5 day adaption period where the pigs were getting used to the diets, the collecting started, and urine catheters were used for separate collection of urine and faeces. Faeces and urine from each pig were collected for 7 days. Then a representative faeces and urine sample was collected from each pig for analysis, and the quantities were registered. The quantity of feed consumed by each pig was also registered, and samples of the feed were collected for analysis.

Table 2: Experiment design

Treatment	**Control**	**Experiment**
Storage of the grain	**Dry grain**	**Air tight grain**
Litter 1-8	8 pigs	8 pigs

By means of the feed optimization program (standard) a basic diet was made based on table values for the content of dry grain (50 % barley and 50 % wheat) and with soy meal and rape. The composition of the diet is shown in table 3.

Based on the content of dry matter in dry and wet grain respectively, the content of grain in the experiment feed was adapted to that of the control feed so that the content of nutrients of the weighed out feed quantity for control and experiment pigs was the same.

At the start-up of the experiment the air tight silos were opened and samples for determination of dry matter were taken. These were used to calculate the quantity of feed weighed out to the various servings of the pigs. All servings were weighed out simultaneously in air tight bags which were stored in cold conditions until the time of feeding. Similarly, the content of dry matter of the dryly stored grain was established. Servings of dry grain were weighed out so that the experimental and control pigs received the exact same quantity of dry matter. At the time of

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feeding, the grain part was mixed with the weighed out quantity of the other feedstuffs, minerals etc.

Table 3: The composition of the basic diet, %

Ingredients	**Basic diet**[1)]
Barley and wheat, %	70.89
Soy meal, %	18.0
Rapeseed cake, %	9.00
Methionin	0.01
Lysine	0.07
Limestone ($CaCO_3$)	1.49
Sodium chloride	0.34
Vitamins/minerals	0.20

[1)] The feed was optimized to fulfill all nutrients according to the present Danish recommendations. However, feed phosphate was not added as one of the objectives was to establish the effect on the digestibility of phosphorus in connection with air tight storage.

The collected samples were analyzed for the following:
Feed: Dry matter, nitrogen, energy, phosphorus, calcium, phytate phosphorus, phytase.
Faeces and urine: Dry matter, nitrogen, energy, phosphorus, calcium.

Based on the registered quantities (feed, faeces, urine) and a chemical analysis, the digestibility and the utilization were calculated for protein (nitrogen), phosphorus, calcium and energy for each pig by means of standard procedures. Subsequently, a statistical analysis was made comparing the measured parameters of pigs fed the control and experimental diet, respectively.

The experiment has been carried out at Aarhus University, Faculty of Agricultural Sciences.

Results:
The analyzed chemical results of the two diets are shown in table 4.

The results show that the dry matter percentage was approximately 3 per cent units lower when using the feed stored in air tight silos. The content of protein, energy, ash, phosphorus and calcium of the two diets was identical per kg dry matter.

Table 4: Analysis results of the feed

Treatment	**Control**	**Experiment**
Storage of the grain part	**Dry grain**	**Air tight grain**
Dry matter, %	89.2	86.5
Protein, g/kg dry matter	199	202
Gross energy, joule, KJ/kg dry matter	18.0	18.0
Phosphorus, g/kg dry matter	4.8	4.8
Calcium, g/kg dry matter	7.2	7.1
Phytate phosphorus, g/kg dry matter	2.7	2.6
Phytase, FTU/kg dry matter	870	990
Gross energy, Joule/g ash	343	349

The content of phytate bound phosphorus of the grain stored air tight or dry was determined at harvest and before mixing of the feed. The analyses show that the quantity of phytate bound phosphorus fell with approximately 7 % during the half year when the grain was stored wet in the air tight silos. This means that during the air tight storage phosphorus was liberated from phytate. The analysis also showed that the phytase activity of the grain stored dry was lower. This suggests that air tight storage of grain is gentle and maintains the activity of phytase. The gross energy was measured in the grain, and the content was similar for both storage forms measured per kg dry matter and per kg ash.

The differences of the dry matter content of the dryly stored grain and the air tight stored grain were taken into consideration when the diet was weighed out into daily servings. This means that the pigs being served the two feed diets (control and experimental) were given the same daily quantity dry matter and thus nutrients.

The main results of the digestibility and balance experiment are shown in table 5. The results show that the digestibility of protein rose with 2.5 per centage points (from 78.2 to 80.7). This difference tended to be significant (p=0.10). The experiment also showed that the digestibility of plant phosphorus was significantly increased in air tight stored grain as the digestibility increased by 12 % from 41 to 46 %. The digestibility of dry matter, however, was not significantly affected by air tight storage of grain. The digestibility of energy was only a little higher after air tight storage even though the difference was not significant.

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Table 5: The main results of the digestibility experiment with diets where the grain part had been stored dry or air tight.

	Control (dry)	**Air tight (experiment)**	
Digestibility of:			
Dry matter, %	82.9	83.5	NS
Protein, %	78.2	80.7	p = 0.10
Phosphorus, %	41.4	46.0	p < 0.01
Calcium, %	38.9	40.3	NS
Energy, %	81.7	82.3	NS
FEs/kg dry matter	1.13	1.14	NS

NS – non significant (p > 0.05)

The results show that air tight storage of grain has a positive effect on the digestibility of the nutrients protein and phosphorus, while the digestibility of dry matter and calcium was only increased to a less degree. The mentioned effects mean that air tight stored grain had a higher content of digestible phosphorus corresponding to approximately 0.2 g and of digestible protein of approximately 5 g. The experiment also showed that the energy digestibility increased a little causing the energy content per kg dry matter to increase a little.

Conclusion:

The experiment with air tight stored grain showed that the digestibility of protein increased by 2.5 per cent units (from 78.2 to 80.7). This difference tended to be significant (p=0.10). Air tight storage of the grain had, however, a significant effect on the digestibility of phosphorus which increased by 12 % compared to grain stored dry. The experiment also showed that during the storage period phosphorus was liberated from phytate which contributed to the increased digestibility of phosphorus. Further, air tight storage had a positive impact upon the stability of phytase, as the activity was 14 % higher in the air tight stored grain. The energy digestibility was also a little higher in air tight stored grain.

In general, the results show that air tight storage of grain after harvest and until feeding approximately half a year later will increase the utilization of protein and phosphorus when the grain is used in feed for finishing pigs. Thus, one of the perspectives of air tight storage of the grain is that the excretion of nitrogen and phosphorus will be reduced if the increased digestibility is included in diet optimization programs. Air tight storage seems to be gentle to the activity of the enzyme phytase. The energy content of the diet containing grain stored air tight was a little higher than of the feed stored dry.

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