THE INCORPORATION OF GRAIN DUST IN LIVESTOCK DIETS

by

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INTRODUCTION

One of the hazards associated with the grain industry is caused by grain dust. This fine material has been cited as a primary cause of fires and explosions. Grain dust also can be harmful to feed and grain workers' health. Regulations are now in force which eliminates venting of these airborne particles into the atmosphere. This requires collecting devices to be used to filter out the dust. Once grain dust has been collected, a problem arises concerning use or disposal. In the feed industry, the dust could be utilized in ground grain products. But in the grain elevators, the practice of adding the grain dust back into the grain when loading out, is a poor solution.

The objectives of these studies were to evaluate the feasibility of incorporating pelleted grain dust in swine and poultry diets. Little research has been conducted on these methods of grain dust utilization. This information could be valuable in creating confidence in using grain dust as a feed ingredient. This in turn could reduce some of the hazards of the grain industry.

LITERATURE REVIEW

Grain Dust Characteristics

In the grain industry, dust is the fine, dry particles of matter usually resulting from the cleaning or grinding of grain or other feedstuffs (NRC, 1971). All grain contains some dust. Amounts vary from less than 0.02% to greater than 1.0% (Miller, 1978). Martin and Stephens (1977) found that corn dustiness increased about 0.09% per handling operation.

In studies conducted by the United States Grain Marketing Research Center, some of the physical characteristics of grain dust were determined (Martin and Sauer, 1976). In that study, total weight of cyclone tailing dust collected, expressed as a percentage of the grain, was considered a measure of relative grain dustiness.

Both the kind of grain and the handling operation have an effect on the dustiness of the grain. Martin and Sauer (1976) found that corn averaged 0.119% dust collected after a bin transfer operation. When a cleaning step was done in addition to the transfer, 0.534% dust was collected. Wheat was examined during car unloading and in bin transfer for dustiness. They concluded wheat dustiness was similar for both operations and was almost inconsequential in comparison with corn dustiness.

Martin and Sauer (1976) reported the amount of fine dust (passing through a U.S. 120 mesh sieve) of corn to be three to four times that of wheat dust. Martin and Stephens (1977) found in 21 consecutive bin transfer operations, the fine dust from corn decreased slightly, but overall 70% of the dust collected was smaller than 125μm. Martin and Lai (1978) reported that although the percent dust of total grain differs between corn, sorghum and wheat, the fine fraction was nearly the same for all three grains. These two conflicting reports, Martin and Sauer (1976), and Martin and Lai (1978), show the variability found in grain dust. The lots of grain in these two reports were from different crop years.

The dust fraction smaller than 8μm includes the respirable fraction that is considered a factor in the health of workers (Martin and Sauer, 1976). It was reported by Martin and Sauer (1976) that corn dust contained a larger fraction (5-12% of the dust) of respirable dust than found in wheat dust (3-4% of the dust).

Grain Dust Hazards: Health

The harmful influence that grain can exert on health is almost entirely due to the dust that is associated with it. This dust is composed not only of disintegration products of the grain itself, but also soil, fungal spores, bacteria, insects, mites and their residues, chemicals and other contaminants that have become associated with the grain (Dennis, 1973). Many articles have been published concerning grain dust inhalation (Farant and Moore, 1978; Skoulas et al., 1964; Williams et al., 1964; Shrag, 1972). These health problems reported have generally resulted from handling moldy or heating grain and have been termed "farmers' lung disease" or "heating grain syndrome". Dennis (1973) described health records of farmers and grain elevator operators as showing a high incidence of respiratory diseases of both allergic asthmatic and farmers lung types, and of pneumonia. At an international conference on the health hazards of grain dust, farmers' lung was not considered important. The major problems discussed were chronic bronchitis and asthma-provoking allergies (doPico et al., 1977; Martin and Lai, 1978).

Grain Dust Hazards: Explosion

The explosion risk from agricultural dusts was reported in 1795 following a flour mill explosion in Italy (Eckhoff, 1978). A study by Verkade and Chiotti (1976) of dust explosions found that of all industrial dust explosions in the United States, grain dust explosions in elevators occurred more often and caused more damage and injuries. From 1900 to 1956, agricultural dusts have been involved in 54% of all industrial dust explosions in the United States. This 54% accounted for 61% of the total material losses. This suggests agricultural dust explosions are generally more severe than those caused by other material (Eckhoff, 1978). This is also shown through research by the Unites States Bureau of Mines (Jacobson et al., 1961). They found mixed grain dust to be nine times more explosive than coal dust. Data compiled by Iowa State University and Kansas State University showed that of 220 explosions during 1957-1977, 75% occurred in grain elevators, resulting in 126 deaths (85% of the total) and 91% of the total property damage (Schoeff, personal communication).

Grain Dust Control

Several federal agencies oversee dust control at grain elevators. The Environmental Protection Agency (EPA) regulates the amounts of allowable emissions to the atmosphere from grain elevators. The Occupational Safety and Health Administration (OSHA) is concerned with the exposure of workers to grain dust. EPA regulations force elevators to keep the grain dust from leaving the elevator. This can result in higher dust concentrations inside the elevator, causing a conflict with OSHA regulations. So dust must be controlled.

In the grain industry, dust becomes airborne at many transfer points throughout the elevator. The most common types of dust collection devices used in the grain industry are cyclones and fabric filters. The cyclone is a mechanical collector that uses centrifugal force to separate dust particles from an airstream. Fabric filter devices accomplish dust collection by filtering dust-laden air through fabric bags. Dual cyclones can reportedly collect up to 99% by weight of the grain dust in an airstream while fabric filters exceed cyclones in efficiency (Maness, 1978).

Another method of control reported by Cocke et al. (1978) deals with limiting dust generation instead of dust collection. They used hydrocarbon-base oil as an additive to wheat, corn and soybeans. Dust levels reportedly were reduced more than 92% with oil levels of 0.07% on wheat. But Cocke cautions using additives as they could affect storage and processing requirements.

When the grain dust is collected, disposal becomes a problem. Because of the handling characteristics of grain dust, special equipment is required in the form of pneumatic conveying systems and live bottom bins. Generally, most grain dust was separated from the grain for environmental and safety control reasons. The dust was then remixed with the grain upon shipping. But this creates more problems for the grain handlers further down the marketing system.

Grain dust has been used as a feed ingredient, but data concerning the analysis and feeding performance has not been reported. A report by Desmarchelier and Hogan (1978) reveals work with grain dust as a feed ingredient. But their work dealt with reducing insecticide residues in the grain dust.

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EFFECT OF GRAIN DUST IN PERFORMANCE OF BROILERS

INTRODUCTION

The use of grain dust in poultry diets was conducted to examine its feeding value in a high growth demand situation. There has not been animal data published as to the value of grain dust. However, Behnke (1978) describes the grain dust as having 80% of the potential nutritive value of the grain, from which the dust comes.

It has been demonstrated with broilers that the addition of fiber to the diet causes an elevated dry matter intake as the chick attempts to maintain a constant level of energy intake (Hill and Dansky, 1954; Scott and Forbes, 1958). Din *et al*. (1975) found in Leghorn-type pullets that body weight was significantly greater on a corn-soybean meal diet than those diets with wheat middlings and wheat bran.

A study was conducted to determine the effects of mixed grain dust on the voluntary feed intake and growth rate of broilers.

In addition to the broiler study, a grain dust sample survey was conducted. Midwest elevators were asked to send grain dust samples so that proximate analysis could be performed (table 1).

TABLE 1. NUTRIENT ANALYSIS OF MIXED GRAIN DUST[a]

Item	Dry Matter %	Protein %	Ash %	Fat %	Fiber %
Mean	91.8	9.7	9.9	3.2	11.7
Range	89.6-93.7	7.6-12.1	4.6-23.6	1.5-7.9	6.3-21.1
S.D.	1.1	1.4	3.8	1.4	4.3

[a]Values are from 21 samples of midwest origin, collected during 1978. All analysis according to A.O.A.C. 1975.

EXPERIMENTAL PROCEDURE

Male broiler-type day old chicks were allotted by weight to 12 cages in a completely randomized design. Each cage contained 10 birds, and all were housed in starter batteries for the first four weeks. At four weeks of age, each group of 10 birds was randomly divided in half, and moved to wire finishing cages. Crumblized grain dust was substituted on an equal weight basis for 0, 25, 50 or 75% of the cereal fraction in the corn, sorghum and soybean meal control diet. All other ingredients were held constant in the four diets (table 2). Diets were pelleted using a 25 hp Master Model California Pellet Mill[1] equipped with a 50.8 mm thick die with a 4.8 mm hole diameter. Conditioning chamber temperature was 70 C. After cooling, diets were then crumblized to prevent segregation. Chickens were allowed _ad libitum_ access to the diets and water. During the experiment, feed consumption and weight gains were measured at 14-day intervals and feed efficiency was calculated. Data was analyzed using analysis of variance and Duncan's Multiple Range Test (Barr _et al_., 1976).

RESULTS AND DISCUSSION

Analysis of the growth data (table 3) indicated no difference ($P < .05$) in average daily gain for the first 14 days, although gain was depressed in diets containing

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[1]California Pellet Mill Co., San Francisco, California.

dust. Chicks fed the control diet gained faster ($P < .05$) from day 15 to 42 than chicks fed diets containing dust. However in the final 14 days, chicks fed diets containing dust were not different ($P < .05$) from chicks fed the control diet in average daily gain. A depression in gain with diets containing dust was again shown.

The slightly lower gains in the birds receiving the grain dust diets may have been due to the grain dust nutrients not being as available to the bird as the cereal grain nutrients in the control diet. The digestibility of the poultry diets containing grain dust was not investigated, however, digestibility in swine will be discussed in the next chapter. This lower availability of energy and nutrients also is exhibited by the feed efficiency (table 3) of the experimental diets. The control diet efficiency was superior ($P < .05$) to the diets containing dust. The 75% dust replacement was less efficient in conversion rate than either of the other levels tested, probably due to the increase in fiber content (table 5). It should be noted that this trial was conducted in the summer in a non-air-conditioned cage facility. The over-all efficiencies of the diets could be affected by this fact.

SUMMARY

One hundred twenty broiler-type male chicks were used to evaluate the substitution of grain dust for a portion of the cereal fraction. Treatments used in this study were: 0% dust, 25% dust, 50% dust and 75% dust, substituted on an "as fed" weight for weight basis. All diets were fed in crumblized form. In the eight week trial, no statistical difference ($P < .05$) in average daily gain was found, although a 5% growth depression with diets containing grain dust was shown. The data for feed efficiency showed a difference ($P < .05$) between the treatments with the 0% grain dust diet superior to the diets containing dust. The 25% and 50% treatments showed improvement ($P < .05$) in feed efficiency over the 75% treatment.

TABLE 2. COMPOSITION OF BROILER DIETS CONTAINING GRAIN DUST, %

Ingredient	Internat'l Ref. No.	Treatment 1	2	3	4
Ground yellow corn	4-02-931	30.0	22.5	15.0	7.5
Ground grain sorghum	4-04-383	30.0	22.5	15.0	7.5
Crumblized grain dust	--------	----	15.0	30.0	45.0
Soybean meal (44%)	5-04-604	26.4	26.4	26.4	26.4
Alfalfa meal	1-00-023	5.0	5.0	5.0	5.0
Distillers solubles	5-02-147	2.0	2.0	2.0	2.0
Fish meal	5-01-977	3.0	3.0	3.0	3.0
Dicalcium phosphate mn 18.5% P, 15.5% Ca	6-01-080	1.0	1.0	1.0	1.0
Limestone mn 38% Ca	6-02-632	1.5	1.5	1.5	1.5
Salt	6-04-151	.5	.5	.5	.5
Premix[a]		1.0	1.0	1.0	1.0

[a]Contributed the following per kilogram of complete diet: Mn, 50 mg; Fe, 50 mg; Zn, 50 mg; Ca, 20 mg; Cu, 5 mg; I, 1.5 mg; Co, .5 mg; A, 2,200 IU; D_3, 1,650 IU; B_{12}, 2.6 mg; Riboflavin, 4 g; Choline Chloride, 20 g; d-Calcium Pantothenate, 4 g; Niacin, 6 g; Methionine, 506 mg; Amprol 25%, 506 mg; Aurofac 10, 251 mg; Baciferm 10, 251 mg.

TABLE 3. CUMULATIVE AVERAGE DAILY GAIN AND FEED EFFECIENCY OF BROILERS FED DIETS CONTAINING GRAIN DUST

	Grain Dust, %[a]			
Parameter	0	25	50	75
Avg Daily Gain (g)				
week 0-2	17.57	15.87	15.92	17.10
week 0-4	28.66[b]	25.91[c]	25.00[c]	25.59[c]
week 0-6	36.07[b]	32.97[c]	31.93[c]	32.40[c]
week 0-8	39.73	37.67	37.40	37.00
Feed/Gain				
week 0-8	2.37[b]	2.63[c]	2.63[c]	2.96[d]

[a]Substituted for cereal on an "as fed" weight for weight basis.

[b,c,d]Different superscripts in same row indicates significant difference ($P < .05$).

TABLE 4. BROILERS FED DIETS CONTAINING GRAIN DUST FINAL BIRD WEIGHTS, 56 DAY

	Grain Dust, %[a]			
Item	0	25	50	75
Mean bird wt (g)	2262	2148	2132	2108

[a]Substituted for cereal on an "as fed" weight for weight basis.

TABLE 5. PROXIMATE ANALYSIS OF BROILER DIETS

	Grain Dust, %[a]			
Fraction, %[b]	0	25	50	75
Dry Matter	89.0	88.4	88.4	89.6
Protein	21.1	18.2	20.4	20.8
Fiber	4.1	4.6	5.3	5.9
Fat	2.7	3.2	3.6	4.1
Ash	6.6	7.9	8.6	9.9

[a]Substituted for cereal on an "as fed" weight for weight basis.

[b]A.O.A.C. 1975. Official Methods of Analysis.

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FEEDING VALUE AND DIGESTIBILITY OF GRAIN DUST FOR SWINE

INTRODUCTION

Grain dust is the fine, dry particles resulting from the cleaning or grinding of grain (NRC, 1971). In a feed mill these fine particles can be added into a ground product. However, grain elevators are being required to separate grain dust from the parent grain. Because of the explosion and health hazards associated with grain dust, collection and disposal of this grain by-product is necessary.

Although mill dust and elevator dust have often been used in livestock diets, there is no information in the literature regarding its feeding value for swine. Generally millfeeds have reduced availability of nutrients when compared to high quality feedstuffs (Patience et al., 1977). Young and Forshaw (1974) combined wheat shorts with corn in varied ratios and supplemented the mixture with different levels of soybean meal. At the lower protein levels, shorts promoted more efficient feed conversion, although corn was associated with faster gains.

It has been established that crude fiber depresses the digestibility of swine diets. Troelsen and Bell (1963) found that crude fiber from different sources had different digestibilities and the source of crude fiber may also be a factor in energy utilization.

The present study was conducted to evaluate the performance of swine fed a diet containing crumblized grain dust. A second study was also conducted to determine the digestibility of diets containing crumblized grain dust. Crumblized grain dust has improved handling characteristics and readily mixes with other ingredients without the need for grinding. The results from this study could be valuable in providing feeding values of grain dust in swine diets.

EXPERIMENTAL PROCEDURE

Feeding Trial. Thirty-six crossbred pigs were used to compare crumblized grain dust to yellow dent corn on a weight basis. Pigs averaging 30.5 kg were randomly allotted to three treatments, based on sex, litter and weight. Each experimental treatment had four replications, each containing three pigs. Equal numbers of barrows and gilts were used. The pigs were housed and pen fed in open-front finishing units with concrete floors. Each pen contained a self-feeder, automatic waterer and sprinkler system. Body weights and feed consumption were recorded at 14-day intervals. Pigs were removed from the experiment when individual pens reached an average weight of 97.7 kg.

Compositions of the grain dust and corn are presented in tables 6 - 8. Proximate analysis and mineral analysis of the grain dust was determined by methods outlined by A.O.A.C. (1975). Amino acid determinations of the grain dust were conducted using a Beckman Model 120 C Amino Acid Analyzer[1] using the procedure reported by Liu and Chang (1971).

Composition of the experimental grower diets fed in a pelleted form are shown in table 9. The control was a 16% protein, corn-soybean meal based diet. In diets 2 and 3, 25% and 50% of the cereal fraction, or corn, was replaced with crumblized grain dust on an equal weight basis.

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[1]Beckman Instrument, Inc., Palo Alto, California.

Table 10 shows the proximate analysis of the three experimental grower diets. The finishing diet was reformulated (tables 11 and 12) according to NRC (1973) requirements and replaced the growing diets when average pen weight reached about 70 kg.

Digestion Trial. A digestion trial using 12 crossbred barrows, averaging 29.1 kg initially, was conducted to investigate apparent nutrient digestibility of diets containing grain dust. The three dietary treatments were the same as those used in the previous growing phase of the swine growth study (table 9). Pigs were randomly assigned to dietary treatments in period 1. In period 2, the assignment of a pig to one of the two remaining diets was also random.

Barrows were adapted to metabolism crates prior to the study. The experimental diets were fed for 3-day adjustment periods before the 5-day collection periods were begun. Fecal matter was collected using a marker-to-marker technique. Urine was not collected. Feed was provided twice daily in equal portions, with water being given at each meal. Daily intake was 1 kg during the first period, and 1.25 kg in the second period. Representative feed and fecal samples were analyzed in duplicate for dry matter, nitrogen, fiber and gross energy (A.O.A.C., 1975).

Results of both animal experiments were statistically analyzed using analysis of variance and Duncan's multiple range test (Barr et al., 1976).

RESULTS AND DISCUSSION

Feeding Trial. In the swine growing-finishing trial no statistical differences ($P < .05$) were found for average daily gain or feed efficiency between treatments (table 13). However, feed per gain ratios tended to be highest for pigs fed the highest level of grain dust. Pigs consumed more of the diets containing grain dust as compared to the control diet ($P < .05$).

It has been reported (Baird et al., 1975; Cole et al., 1967) that pigs can tolerate ranges of crude fiber in the diet, provided energy density is adequate. These reports suggest that unless prevented by bulk or palatability of the diet, the pig tends to eat until energy requirements are satisfied. Increased feed intake associated with reduced energy has been reported (Merkel et al., 1958; Troelsen and Bell, 1962; Cole et al., 1967). The results of this study are in general agreement with the above reports. Although the gross energy of all the treatments (tables 10 and 12) are similar, it was presumed the energy was less available in diets containing dust. A concurrent digestion trial was conducted using the same diets to determine this.

Digestion Trial. Apparent digestibility for the following proximate and energy components were depressed (P < .05) as grain dust was substituted for the cereal fraction of the control diet (table 14): dry matter, digestible energy, crude protein, crude fiber and ash.

Protein digestibility was decreased (P < .05) 5-8% by the addition of grain dust to the diets compared to the diet without dust. But due to the higher protein content of the grain dust (table 2), compared to corn, the percent digestible protein in the three diets is similar.

Digestible energy for the 0%, 25%, and 50% grain dust replacement levels was 3.45, 3.21 and 3.05 kcal/gm respectively. This showed that, from the digestible energies determined, only the 0% dust replacement diet met the pig's requirement as stated by NRC (1973). This was in agreement with the previous information concerning feed intake to meet energy requirements. However, these lower digestibilities for diets containing grain dust did not decrease pig performance in the feeding trial. This study has shown that for growing-finishing swine, growth requirements can be met without changing performance.

SUMMARY

Forty-eight grower-finisher (30 kg) pigs were used to evaluate grain dust in swine diets. Grain dust was substituted on an equal weight basis for 25% and 50% of the cereal fraction of a conventional swine diet. A 16% protein diet was fed to 70 kg, and a 13% protein diet for the remainder of the trial. The grain dust used analyzed (percent on a dry matter basis): crude protein, 10.8; crude fiber, 11.3; ether extract, 3.0; ash, 9.2; NFE, 65.7. Gross energy of the grain dust was 4204 kcal/kg. There were no differences ($P < .05$) between treatments in average daily gain or feed efficiency. Feed intake increased linearly as level of dust increased.

The same three diets were used to determine digestibility. As grain dust was substituted for the cereal, digestibility of dry matter, energy, crude protein, crude fiber, ether extract and ash decreased ($P < .05$).

TABLE 6. GROSS ENERGY AND PROXIMATE ANALYSIS OF GRAIN DUST vs. CORN

Analysis	Mixed Grain Dust[a]	Corn[b]
Dry Matter, %	89.25	89.00
Crude Protein, %	9.65	8.90
Crude Fiber, %	10.05	2.00
Ether Extract, %	2.65	3.90
Ash, %	8.20	1.10
Gross Energy, cal/g	4204	3918

[a]A.O.A.C. 1975. Official Methods of Analysis.

[b]NRC-No. 2 yellow, Ref. No. 4-02-931.

TABLE 7. MINERAL PROFILE[a]---GRAIN DUST vs. CORN[b]

Mineral	Mixed Grain Dust	Corn
Phosphorous, %	.16	.27
Calcium, %	.24	.03
Magnesium, %	.15	.15
Manganese, mg/kg	34.0	4.1
Zinc, mg/kg	38.0	10.4

[a]On an "as fed" basis.

[b]NRC-No. 2 yellow, Ref. No. 4-02-935.

TABLE 8. AMINO ACID PROFILE[a]--GRAIN DUST vs. CORN[b]

	% (gm/100 gm) sample	
	Mixed Grain	
Amino Acid	Dust	Corn
Lysine	.34	.20
Methionine	.11	.10
Threonine	.35	.40
Arginine	.23	.50
Isoleucine	.20	.50
Leucine	.63	1.11
Phenylalanine	.30	.50

[a]On "moisture free" basis.

[b]NRC-No. 2 yellow, Ref. No. 4-02-931.

TABLE 9. SWINE GROWER DIETS CONTAINING GRAIN DUST

Ingredient, %	Internat'l Ref. No.	Treatment (Control)	(25%)	(50%)
Ground yellow corn	4-02-931	75.9	56.9	38.0
Crumblized grain dust	--------	----	19.0	37.9
Soybean meal (44%)	5-04-604	21.0	21.0	21.0
Dicalcium phosphate mn 18.5% P, 15.5% Ca	6-01-080	.7	.7	.7
Limestone, mn 38% Ca	6-01-632	1.1	1.1	1.1
Salt	6-04-151	.3	.3	.3
Premix[a]		1.0	1.0	1.0

[a]Contributed the following per kilogram of complete diet: A, 4,400 IU; D_3, 330 IU; E, 22 IU; B_{12}, 24.2 μg; Riboflavin, 4.9 mg; Pantothenic acid, 13.2 mg; Niacin, 27.5 mg; Choline Cl, 507 mg; Menadione sodium bisulfate 3.5 mg; ASP-250, 2.5 g; Mn, 50 mg; Fe, 50 mg; Zn, 50 mg; Ca, 20 mg; Cu, 5 mg; I, 1.5 mg; Co, .5 mg.

TABLE 10. GROSS ENERGY AND PROXIMATE ANALYSIS OF SWINE GROWER DIETS CONTAINING MIXED GRAIN DUST[a]

Analysis[b]	Diet 1 (Control)	Diet 2 (25% Dust)	Diet 3 (50% Dust)
Dry Matter, %	88.20	87.31	87.38
Crude Protein, %	15.58	16.23	16.60
Crude Fiber, %	2.76	3.50	4.48
Ether Extract, %	3.02	3.58	3.61
Ash, %	5.65	6.69	7.69
Gross Energy, cal/g	3860	3890	3927

[a]On an "as fed" basis.

[b]A.O.A.C. 1975. Official Methods of Analysis.

TABLE 11. SWINE FINISHING RATIONS CONTAINING GRAIN DUST

	Internat'l	Treatments		
Ingredient, %	Ref. No.	(Control)	(25%)	(50%)
Ground yellow corn	4-02-931	85.1	63.8	42.5
Crumblized grain dust	--------	----	21.3	42.6
Soybean meal (44%)	5-04-604	12.2	12.2	12.2
Dicalcium phosphate mn 18.5% P, 15.5% Ca	6-01-080	.3	.3	.3
Limestone, mn 38% Ca	6-01-632	1.1	1.1	1.1
Salt	6-04-151	.3	.3	.3
Premix[a]		1.0	1.0	1.0

[a]Contributed the following per kilogram of complete diet: A, 4,400 IU; D_3, 330 IU; E, 22 IU; B_{12}, 24.2 µg; Riboflavin, 4.9 mg; Pantothenic acid, 13.2 mg; Niacin, 27.5 mg; Choline Cl; 507 mg; Menadione sodium bisulfate, 3.5 mg; Tylan-10, 2 g; Lysine HCl-98%, 2 g; Mn, 50 mg; Fe, 50 mg; Zn, 50 mg; Ca, 20 mg; Cu, 5 mg; I, 1.5 mg; Co, .5 mg.

TABLE 12. GROSS ENERGY AND PROXIMATE ANALYSIS OF SWINE FINISHER DIETS CONTAINING MIXED GRAIN DUST[a]

	Diet 1	Diet 2	Diet 3
Analysis[b]	(Control)	(25% Dust)	(50% Dust)
Dry Matter, %	83.92	84.67	85.34
Crude Protein, %	13.82	13.74	13.98
Crude Fiber, %	2.15	3.50	4.70
Ether Extract, %	2.47	3.62	3.08
Ash, %	3.88	5.95	6.95
Gross Energy, cal/g	3873	3888	3927

[a]On an "as fed" basis.

[b]A.O.A.C. 1975. Official Methods of Analysis.

TABLE 13. RESULTS OF SWINE GROWING-FINISHING TRIAL WITH DIETS CONTAINING GRAIN DUST

Parameter	Diet 1 (Control)	Diet 2 (25% Dust)	Diet 3 (50% Dust)
Average daily gain (kg/day)	.74	.79	.77
Feed intake (kg/hd/day)	2.06[a]	2.25[ab]	2.35[b]
Feed efficiency (feed/gain)	2.81	2.86	3.05

[ab]Different superscripts in the same row indicate significant difference ($P < .05$).

TABLE 14. APPARENT DIGESTIBILITIES OF DIETS CONTAINING GRAIN DUST[a]

Item, %	Diet 1 (Control)	Diet 2 (25% Dust)	Diet 3 (50% Dust)
Dry matter[b]	87.86	81.84	76.72
Crude protein[b]	86.94	82.49	80.30
Crude fiber[b]	55.31	39.65	26.79
Ash[b]	59.89	50.12	42.33
Energy[b]	89.37	82.46	77.74

[a]Values are averages of 8 observations using 12 barrows during two collection periods (initial wt 29.1 kg).

[b]All values are significantly different ($P < .05$).

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Appendix A

TABLE 15. BROILER CHICK STUDY USING DIETS CONTAINING GRAIN DUST---INDIVIDUAL PEN DATA

Treatments	ADG g	Avg wt 56 day g	Total feed per pen, kg	Bird days[a]	Feed/gain[b]
Rep 1					
Control	41.1	2340	55.2	557	2.41
25% Dust	37.8	2155	54.8	560	2.59
50% Dust	36.3	2071	41.6	434	2.64
75% Dust	36.4	2076	62.1	560	3.05
Rep 2					
Control	39.0	2218	52.1	557	2.40
25% Dust	38.3	2184	50.7	513	2.58
50% Dust	35.8	2042	55.6	548	2.83
75% Dust	37.0	2110	58.6	546	2.90
Rep 3					
Control	39.1	2229	46.5	518	2.30
25% Dust	36.9.	2105	56.0	560	2.71
50% Dust	40.1	2284	52.3	539	2.42
75% Dust	37.6	2140	56.5	510	2.95

[a]Calculated by sum of days each bird in lot on trial.

[b]Calculated by total feed divided by product of, number bird days times average daily gain.

Appendix B

TABLE 16. SWINE STUDY USING DIETS CONTAINING GRAIN DUST---INDIVIDUAL PEN DATA

Treatment	ADG kg	ADF kg	Feed/ gain
Rep 1			
Control	.83	2.22	2.67
25% Dust	.82	2.29	2.79
50% Dust	.80	2.52	3.15
Rep 2			
Control	.72	1.90	2.64
25% Dust	.80	2.39	2.99
50% Dust	.70	2.30	3.29
Rep 3			
Control	.60	1.75	2.92
25% Dust	.68	1.90	2.79
50% Dust	.69	1.79	2.59
Rep 4			
Control	.80	2.37	2.96
25% Dust	.85	2.42	2.85
50% Dust	.87	2.78	3.20

Appendix B

TABLE 17. SWINE STUDY USING DIETS CONTAINING GRAIN DUST---INDIVIDUAL PIG AVERAGE DAILY GAIN

Treatment	Pig 1	Pig 2	Pig 3	Avg
Rep 1: barrows				
Control	.85	.77	.85	.83
25% Dust	.83	.81	.82	.82
50% Dust	.94	.87	.61	.80
Rep 2: gilts				
Control	.85	.60	.69	.72
25% Dust	.80	.80	.82	.80
50% Dust	.70	.69	.71	.70
Rep 3: gilts				
Control	.48	.66	.65	.60
25% Dust	.75	.70	.58	.68
50% Dust	.72	.68	.67	.69
Rep 4: barrows				
Control	.75	.90	.74	.80
25% Dust	.83	.80	.90	.85
50% Dust	.83	.80	.90	.85

Appendix B

TABLE 18. GROWER PIG DIGESTION STUDY USING DIETS CONTAINING GRAIN DUST INDIVIDUAL PIG[a] APPARENT DIGESTIBILITIES

Treatment	Period 1				Period 2				AVG
	Dry matter digestibility %								
Control	88.7	86.4	87.9	90.0	87.5	87.5	87.3	87.7	87.9
25% Dust	83.9	83.2	82.6	81.5	80.9	80.1	81.1	81.5	81.1
50% Dust	76.7	75.8	80.1	77.8	75.4	75.7	76.6	75.5	76.7
	Protein digestibility %								
Control	87.6	84.0	87.3	88.3	86.5	87.4	88.1	86.5	86.9
25% Dust	85.4	84.4	83.4	81.4	80.6	78.9	81.9	84.0	82.5
50% Dust	80.0	77.6	82.1	80.9	80.5	81.2	80.2	79.8	80.3
	Energy digestibility %								
Control	90.1	87.8	89.7	90.9	89.0	89.1	89.2	89.2	89.4
25% Dust	84.9	81.6	83.2	82.2	81.8	80.8	82.3	82.9	82.5
50% Dust	77.9	76.9	80.6	78.6	76.9	77.5	77.0	76.5	77.7

[a]Pigs assigned to treatment randomly with only restriction that a pig could not have the same diet in both periods.

Appendix B

TABLE 18. (con't) GROWER PIG DIGESTION STUDY USING DIETS CONTAINING GRAIN DUST---INDIVIDUAL PIG[a] APPARENT DIGESTIBILITIES

Treatment	Period 1				Period 2				AVG
	Fiber digestibility %								
Control	60.2	50.3	47.2	64.7	55.6	51.0	51.9	61.7	55.3
25% Dust	49.4	47.1	41.3	30.5	31.0	28.2	37.5	52.1	39.7
50% Dust	23.3	31.9	32.2	29.9	18.4	28.6	26.9	23.3	26.8
	Ether Extract digestibility %								
Control	80.6	78.1	81.8	83.1	81.3	80.5	83.0	81.3	81.2
25% Dust	66.5	62.5	59.8	58.6	61.1	55.3	57.6	58.7	60.0
50% Dust	52.0	43.5	53.4	45.4	42.0	44.3	48.8	42.3	46.5
	Ash digestibility %								
Control	62.4	55.5	61.1	69.3	57.4	59.5	56.0	57.8	59.9
25% Dust	54.0	55.5	54.9	51.3	48.4	47.8	45.1	44.0	50.1
50% Dust	44.7	39.1	50.8	47.1	37.4	36.6	44.2	38.7	42.3

[a]Pigs assigned to treatment randomly with only restriction that a pig could not have the same diet in both periods.

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THE INCORPORATION OF GRAIN DUST IN LIVESTOCK DIETS

by

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AN ABSTRACT OF A MASTER'S THESIS

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Experiments were conducted to evaluate the performance of broilers and swine fed a diet containing grain dust. Various levels of grain dust were substituted on an equal weight basis for the cereal fraction in conventional diets.

One hundred twenty broiler-type male chicks were used to study the effect of grain dust in avian diets. Treatments used included: 0% dust, 25% dust, 50% dust and 75% dust, substituted on an "as fed" weight for weight basis for the cereal fraction. All diets were fed in crumblized form. In the eight week trial, no statistical differences ($P < .05$) in average daily gain were found, although a trend of gain depression was observed with diets containing grain dust. Feed efficiency showed a difference ($P < .05$) between treatments with the 0% grain dust diet superior to the diets containing dust. The 25% and 50% treatments showed improvement ($P < .05$) in feed efficiency over the 75% treatment.

Forty-eight grower-finisher (30 kg) pigs were used to evaluate grain dust in swine diets. Levels of grain dust substituted for the cereal fraction were, 0%, 25% and 50%. Grain dust analyzed (on a dry matter basis): crude protein, 10.8%; crude fiber, 11.3%; ether extract, 3.0%; ash, 9.2%; NFE, 65.7%. Gross energy of the grain dust was 4204 kcal/kg. There were no differences ($P < .05$) between treatments in average daily gain or feed efficiency. Feed intake increased linearly as level of dust was increased.

The same three diets were used to determine digesti-

bility. As grain dust was substituted for the cereal, digestibility of all fractions analyzed (dry matter, energy, protein, fiber, and ash) decreased ($P < .05$). The digestible energy values for the 0%, 25% and 50% dust replacement swine diets were 3.45, 3.21 and 3.05 kcal/g respectively. The digestible protein coefficients for the same three treatments were 86.94%, 82.49% and 80.30% respectively.