

Size Distribution and Nutritional Value of Swine Manure Separates

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THE nutrients contained in manures can be utilized to some extent in the diets of animals. All of the nutritional and safety aspects of coprophagy have not been determined, but it appears that in the future the technique will provide both a useful means of disposing of manures and a way of conserving feed nutrients. Feeding of animal manures has been done with a minimal amount of processing (usually drying or ensiling) on the manures to transform them into a convenient form for handling and storing and then feeding them with supplemental concentrates.

Bucholtz et al. (1971) have reported that animal wastes (feces and urine) contain from 12 to 40 percent protein equivalent and from 40 to 70 percent carbohydrates and that these wastes can provide useful nutrients when fed to ruminants. From 20 to 50 percent of the nitrogen in animal waste exists as nonprotein nitrogen which ruminants can utilize more efficiently than nonruminants.

The objective of the study reported here was to determine the extent that a mechanical size separation process can be used to separate the major nutritional components in swine waste. Specifically, the study was conducted to determine (a) the effect of particle size distribution of the animal's ration on the particle size distribution in the animal's feces and (b) the proximate composition of various size separates within the ration

and feces. Size separation could provide a means of concentrating one or more of the nutrients in animal waste into a particular fraction resulting from the separation. This fraction might then be either eliminated from or added to a ration containing the waste to enhance the nutritional properties of the ration.

METHOD

Three diets were prepared for each of three pens of four 60-lb hogs. Each diet contained the following percentage of ingredients and differed only in the particle size of corn portion of the ration:

Ingredient	Percent by weight
Yellow corn	78.9
Solvent soybean meal (44 percent)	18.2
Calcium carbonate	0.8
Dicalcium phosphate	1.1
Iodized salt	0.5
Trace mineral premix	0.05
Vitamin premix	0.05
Antibiotics Mix (50 g/lb)	Trace (20-50 g)

One diet consisted of whole corn fed free choice and all other ingredients fed as a free-choice supplement. A second diet consisted of cracked corn mixed with the other supplemental ingredients and fed ad libitum. The third diet consisted of finely ground corn mixed with the other supplemental ingredients and fed ad libitum.

The hogs were placed on their respective diets 10 days prior to the first collection of waste. The pens were thoroughly cleaned, and the animals were weighed to obtain an initial weight and every seven days thereafter. Two days prior to the first collection of waste, the pens were again cleaned by washing with water from a high-pressure source.

Collections were made every two days for six days. After the collection was made, the pens were cleaned with high pressure wash water. This allowed 48 hr for manure to accumulate in the pens. The manure from each pen was placed in a container and taken to the laboratory for separation, preparation, and anal-

ysis. The second week's feces accumulated for 24 hr and was treated the same as the previous week's collections. Urine was conserved only to the extent that it would mix with the manure on the concrete lot.

Each collection was separated, dried and stored for analysis at a later date. The separation consisted of washing a weighed sample (600-1000 g) of the collected waste, through a set of standard screens with opening sizes of 4.76, 3.36, 2.00, 1.19, 0.595, and 0.250 mm. A sample of feed from each pen was separated in the same manner as the waste.

The separates from each screen

were oven dried at 70 C and stored for sample preparation. The total suspended solids concentration (TSS) of the wash water was determined. The solids which washed through the final screen were allowed to settle in a collection vessel and were removed by decantation and were dried to 103 C. After drying, they were placed in a container for later preparation. The weight of solids which passed through the final screen was determined by:

$$\text{weight sludge, (g)} = \text{volume wash water, (l)} \times \text{TSS, (g/l)}.$$

The samples were prepared for analysis by grinding them through a screen with opening size of 0.250 mm (Tyler #60). The ground samples were then analyzed for ether extract, ash and crude protein using standard procedures (AOAC 1970). Nitrogen free extract was estimated by difference. Crude fiber was not determined, so the estimate of nitrogen-free extract includes the crude fiber portion of the sample. The quantity of ether extract

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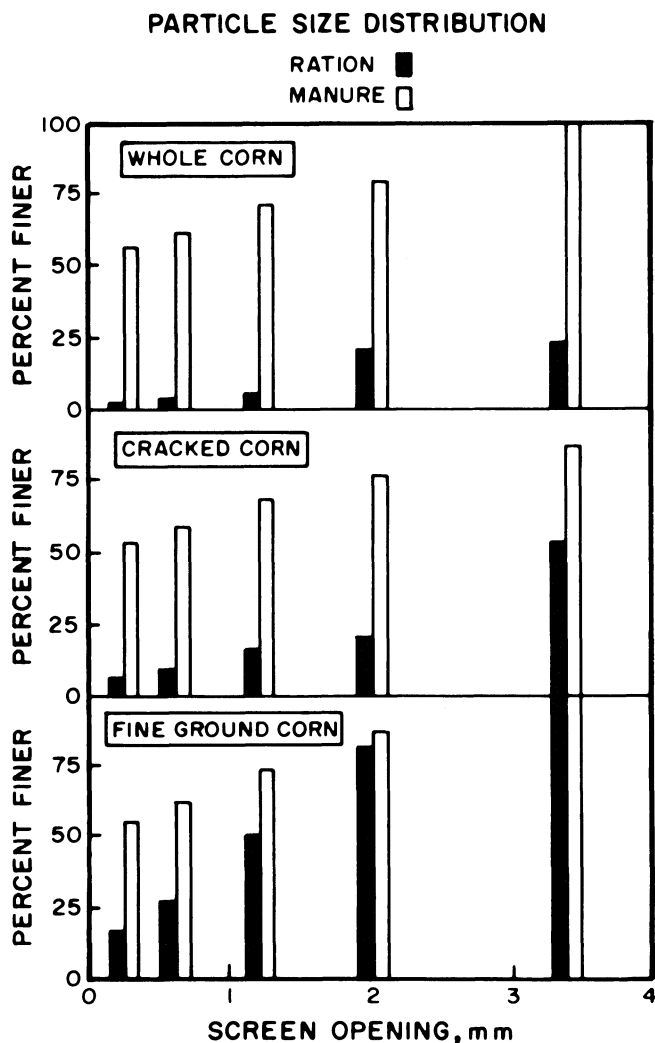


FIG. 1 Particle size distribution in swine manures and rations.

in a feed is generally considered as a measure of its "fat" content. However, other fat-like substances of vital importance to animal nutrition may be removed in the extraction process and included as ether extract. These include sterols, carotenes,

phospholipids, chlorophyll, waxes, and essential oils. The ash content of a feed is a measure of its mineral content. Minerals are essential to good animal nutrition as evidenced by the special importance of calcium and phosphorus in stock feeding. The term

crude protein is commonly used to include all of the nitrogenous compounds in feeds. True proteins which consist of combinations of amino acids make-up only a part of the crude protein fraction of animal manure. The remaining part consist of simpler nitrogenous compounds such as ammonia, urea, and uric acid. The nitrogen-free extract includes the carbohydrates such as starch, sugars, and pentosans. The fiber in a feed includes the cellulose lignin and hemicellulose and other complex carbohydrates. Fiber is relatively indigestible and has little nutritional value in feeds for nonruminants. Swine diets normally contain very little fiber. (Morrison 1950).

The results of the tests are presented as bar graphs in Figs. 1 and 2 as Percent Finer as a function of Screen Opening. Percent Finer in interpreted as the percent of the total dry weight contained in the part of the sample which passed through the screen of the size indicated. For example, as shown in Fig. 1, for the whole corn diet, 79 percent of the particles in the manure passed through the screen with the 2.00 mm opening, while only 20 percent of the particles in the diet passed through this same screen. Also as shown in Fig. 2, for the whole corn diet, 92 percent of the crude protein in the manure was contained in the particles which passed the screen with the 2.00 mm openings, while 56 percent of the crude protein was contained in the particles in the diet passing the same size screen.

Only small differences were found between the various analyses made on the 24- and 48-hr collections as

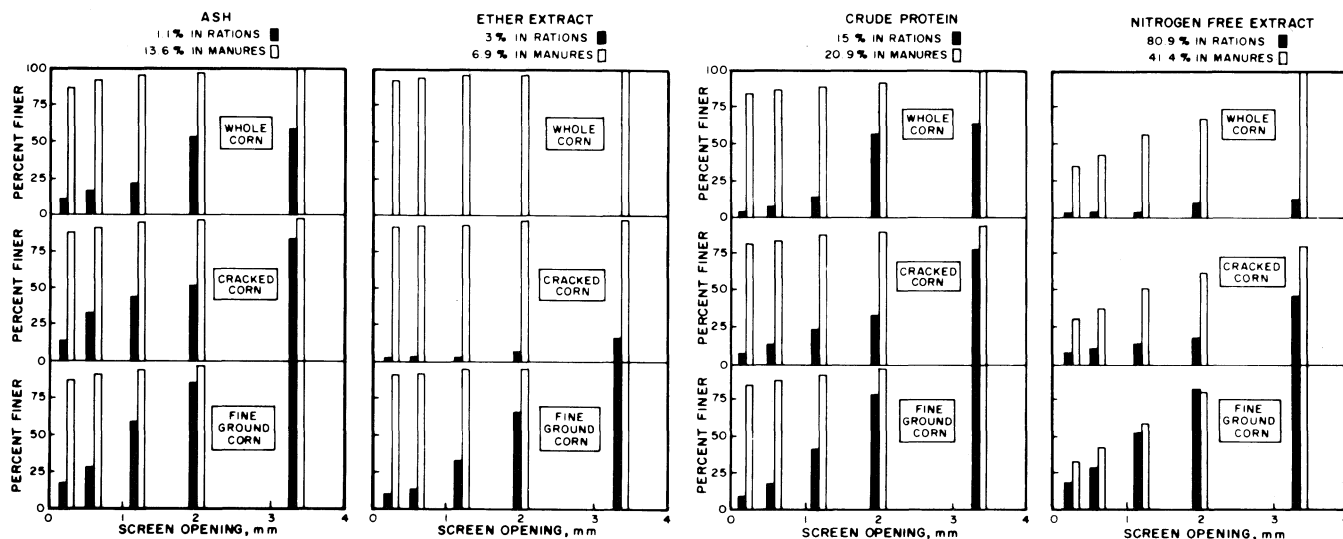


FIG. 2 Percentage of the proximate components contained in the size separates of swine manures and rations.

previously described. For this reason the data presented here is the average of the analyses for the two collection periods. Therefore, the value represented by each bar on the graphs is the average of six samples. In addition, the chemical analysis made for each of the proximate components for each size separate was duplicated. An estimate of the percentage of each proximate component contained in the manure and the diet is given at the top of each graph in Fig. 2.

RESULTS

The fineness of grind of the shelled corn portion of the rations had a marked effect on the rate of gain. This effect is shown below:

Ration	Average weekly gain in pounds
Whole corn	10.2
Cracked corn	7.2
Finely Ground Corn	10.6

The rate of gain was increased by 4 percent by finely grinding the grain but was decreased by 29 percent by cracking the grain. Hays (1967) has found similar results. He reported an increase in the rate of gain of swine of 5.6 percent by finely grinding the ration and an increase in conversion efficiency of 5 percent.

The results shown in Fig. 1 show that swine can effectively grind (by chewing) whole corn, as indicated by the similar size distribution of the particles contained in their manure for the whole corn and finely ground rations. Apparently, swine do not grind the cracked ration as well since 12.5 percent of the manure from animals on this ration did not pass the 3.37 mm screen whereas 100 percent of the manure from the whole and fine ground rations passed this size screen. This could account in part for the decrease in average weekly gain found for the cracked grain ration. With this exception, the particle size distribution in the manures of the animals on the three rations are remarkably similar regardless of the size

distribution of the feed.

Crude Protein

Approximately 83 percent of the crude protein in the manure samples was contained in the material which passed the 0.250 mm screen for all rations as shown in Fig. 2. This was true regardless of the distribution of the protein in the ration.

Ash

Approximately 87 percent of the ash in the manures was contained in the particles which passed the 0.250 mm screen, as shown in Fig. 2. This value varied less than one percentage point between the manures produced from the animals on the various rations.

Ether Extract (EE)

Some difficulty was experienced in measuring the EE in the samples. Several negative values were measured particularly for the manures collected after a 24-hr accumulation. However, in each case the negative values were near zero and were recorded as zero for the purpose of averaging the various replications. Errors in measuring EE will also be reflected in the values of NFE since NFE was estimated by differences as follows:

Percent NFE = 100 - Percent Crude Protein - Percent Ash - Percent EE

However, since the total EE was less than 1.5 percent it will not reflect a large error in the NFE.

The data presented in Fig. 2 show that most of the EE was contained in particles in the manure that did not pass the 3.36 mm screen for swine eating the whole grain and cracked grain rations. It was relatively evenly distributed between the various particle sizes in the manure from animals consuming the fine ground corn ration.

Nitrogen Free Extract (NFE)

Approximately 68 percent of the

NFE in the manures was in particles that did not pass (of greater size) the 0.250 mm screen as shown in Fig. 2. It was relatively evenly distributed within the size ranges above this screen. This was true regardless of the distribution of the NFE in the diet which varied widely between the whole corn and fine ground corn diets.

CONCLUSIONS

The distribution of the particle sizes and the four proximate components (crude protein, ether extract, nitrogen-free extract and ash) within the size range tested (0.250 mm to 3.36 mm) was remarkably consistent for the manure samples tested. Considering the manure from the swine on all three rations, more than 83 percent of the crude protein, 93 percent of the ether extract and 87 percent of the ash were contained in the portion of the manures that passed through the 0.250 mm screen during wet screening. More than 68 percent of the nitrogen-free extract was contained in the portion of the manure that did not pass through the 0.250 mm screen. Wet screening can be used to separate effectively the nitrogen-free extract from the other proximate components. This separation could be useful in the formulation of rations containing swine manure if it were desirable to concentrate for example either the crude protein or the nitrogen-free extract portions of the manure.

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