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A Study on the Reducing Pollutants in Non-Ruminant Manure by Increasing Feed Utilization

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사료이용율 증가에 따른 비반추가축의 분뇨에 의한 공해발생 감소에 관한 연구

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ABSTRACT : Localization of livestock facilities leads to concentration of livestock wastes and subsequent leakage of pollutants into the environment, resulting in public concern about their effects. Nitrogen (N) and phosphorus (P) are the most harmful components of animal manure, but odor from the manure itself and the livestock facilities is also a problem. Improving the nutrient efficiency of the livestock helps to decrease excretion of these environmental contaminants. Pigs and chickens are the main experimental models used in studies to improve nutrient efficiency. Addition of feed supplements and modifying feeding systems to improve nutrient efficiency can result in significant decrease in the N, P, odor and dry matter(DM) weight of manure. Examples of these methods include the following. 1) Addition of synthetic amino acids and reducing protein contents resulted N reductions of 10 ~ 27% in broilers, 18 ~ 35% in chicks and layers, 19 ~ 62% in pigs, and a 9 ~ 43% reduction in odor in pigs. 2) Enzyme supplementation resulted in a 12 ~15% reduction in DM weight in broiler manure. 3) Phytase supplementation resulted in P reductions of 25 ~ 35% in chickens and 20 ~ 60% in pigs. 4) Use of growth promoting substances resulted in a 5 ~ 30% reduction in N and a 53 ~ 56% reduction in odor of pigs. 5) Formulating diets closer to requirements(diet modification) reduced N and P by 10 ~ 15% each in chickens and pigs, and odor by 28 ~ 79% in pigs. 6) Phase feeding reduced N and P excretion by chicken and pigs from 10 ~ 33% and 10 ~ 13% each, as well as odor in growing and finishing pigs by 49 ~ 79%. 7) Use of highly digestible raw materials in feed reduced N and P excretion by 5% in chickens and pigs. Certain feed manufacturing techniques(grinding feed grains and proper particles size, feed uniformity in rations, or expanding and pelleting) when done properly can significantly reduce N, P and odor contents and DM weight of chicken and pig manure, but further research is needed in this area. Coordinating actual feed analytical results with production technique modifications is needed to reduce environmental contamination by animal manure by animal manure, but specialists may needed to be consulted for successful implementation of these efforts.

(Key words: enzymes; feed manufacturing; manure; nutrient efficiency; phase feeding; pollutants; protein levels)

INTRODUCTION

Public concern about environmental pollution from intensive swine and poultry production is increasing. Environmental pollution is defined as contamination with poisonous or harmful substances to human

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beings, animal production and other organisms (Williams, 1995).

The primary livestock excreta of concern in agriculture is manure. Animal manure is primarily a mixture of urine and feces, and it contains undigested dietary components, endogenous end products, and indigenous bacteria from the lower gastrointestinal tract (GIT), which contain a variety of organic compounds, complex to simple in nature, inorganic compounds, and potentially, feed additives, depending upon the make-up of the diet (Sutton et al., 1999).

Much of the concern for pollution from animal manure involves nitrogen (N) pollution of ground water and running off into surface water and phosphorus (P) pollution of ground and surface water via soil erosion and run off. Although odors are generally considered a swine problem, all livestock producers may have to address the changing public attitude toward rural air quality eventually (Hamilton and Arogo, 1999). N, P, and some metals in livestock manure are feed nutrients, while the odor from excreta is caused by feed nutrients in the manure. Nutrient excretion is a result of the inefficiencies associated with digestion and metabolism (Coffey, 1996).

Without appropriately addressing these critical eco-nutritional issues, the livestock and poultry industries will be faced with major public opinion and regulatory problems that could limit the potential for growth. There are many methods of reducing environmental pollution by reducing excreta N, P, and odor contents and dry matter weight of manure. The focus of this paper is on improving manufacturing techniques along with feed testing to improve feed nutrient efficiency and therefore reducing manure pollutants. Various feed supplements and modified feeding systems that have been developed for the same purpose are also introduced here.

STRATEGIES TO IMPROVE FEED NUTRIENT EFFICIENCY FOR REDUCING POLLUTANTS IN MANURE

1. Ways to Increase Feed Nutrient Efficiency

More attention should be placed on feeding diets with minimal nutrient excesses. Until recently, diets have been often formulated with relatively large excesses of nutrients with little attention being paid to the excretion patterns of non-utilized nutrients (Farrell et al., 1998; Morse et al., 1992). Provided proper attention is paid to nutrient management, animal excreta can be used as fertilizers, soil amendments and feed ingredients (Nahm, 2000). Furthermore, the contents of N, P, odor and dry matter contents in livestock manure can be reduced by paying careful attention to diet composition – for example, by applying the concept of ideal protein, supplementation with synthetic amino acids, addition of various enzymes including phytase, lowering the protein and P contents, and use of highly available sources of supplementary P and vitamin D (Nahm, 2000).

Scientists have reported the potential reduction of N, P, odor, and excreta weights in chickens and pigs (Table 1). Table 1 shows that various studies have been carried out mainly using test subjects of poultry and swine to find methods of reducing pollutants in manure. Methods have mainly involved adding supplements to the feed and modifying the feeding systems. Supplements that have been found to be beneficial include: synthetic amino acids and reduced protein levels, enzymes, phytase, and growth promoting substances. Modification to feeding system that have been studied include: formulations closer to requirements (including diet modification), phase feeding, and use of highly digestible raw materials in the ration.

When feed rations were formulated to maintain the appropriate levels of each amino acid rather that just the total protein contents, there was improved feed efficiency as well as reductions in manure pollutants. For example, in one research study (Blair et al., 1999), there was a reduction of 10 ~ 27% of the N contents of broiler manure by using synthetic amino acids and reducing protein content. A similar reduction of 18 – 35% was seen in chicks and layers (Blair et al., 1999; Farrell, 2000; Summers, 1993) and in pigs there was a reduction of 19 ~ 62% (Bridges et al., 1995; Carter et

Table1. Reducing various pollutants in animal manure though supplements and feeding systems

Factors	% reduction of pollutants in manure				Experimental animal used	References
	N	P	Odor(NH_3 emission)	Dry matter		
Supplements						
Synthetic amino acid	18 ~ 35				chick and layers	2, 9, 23
and reduced protein	10 ~ 27				broilers	2
intake	19 ~ 62		9 ~ 43		pigs	4, 7, 8, 13, 22
					pigs	1, 25
	13	2 ~ 37			chickens & pigs	10
Enzymes, Genneral	5				chickens & pigs	10
				12 ~ 15	broilers	31
				5	pigs	20
Phytases	5	25 ~ 35			chickens	10, 19
		25 ~ 60			pigs	8, 10, 14, 18, 21
		20			turkeys	16
Growth promotants	5 ~ 30	5			chickens & pigs	10, 30
or chemicals			53 ~ 56		pigs	24
Systems						
Formulation closer to requirements	10 ~ 15	10 ~ 15			chickens & pigs	10
Diet modification	41				pigs	15
			28 ~ 79		pigs	5, 6, 11, 15, 27
Phase feeding	10 ~ 33	10 ~ 13			chickens & pigs	10, 12, 17, 26
			49 ~ 79		pigs	3, 26, 28, 29
Use of highly digestible raw materials	5	5			chickens & pigs	10

1. Aamick et al.(1993); 2. Blair et al.(1999); 3. Boisen et al.(1995); 4. Bridges et al.(1995); 5. Cahn et al.(1998a); 6. Cahn et al.(1998b);
7. Carter et al.(1996); 8. Crumwell and Coffey(1995); 9. Farrell(2000); 10. FZTANA(1992); 11. Hankins et al.(2000);
12. Henry and Doumad(1993); 13. Hobbs et al.(1996); 14. Jongbloed et al.(1992); 15. Kay and Lee(1997); 16. Khan(2000);
17. Koch(1990); 18. Kornegay and Harper(1997); 19. Lobo(1999); 20. Lobo(2000); 21. Michel and Frosoth(1999);
22. Pierce et al.(1994); 23. Summers(1993); 24. Sutton et al.(1992); 25. Sutton et al.(1996); 26. Sutton et al.(1997); 27. Sutton et al.(1999);
28. Turner et al.(1996); 29. Vander Peet – Schwering and Voermans(1996); 30. Williams et al.(1987); 31. Wyatt and Harker(1995).

al., 1996; Crumwell and Coffey, 1995; Hobbes et al., 1996; Pierce et al., 1994).

By supplementing rations with enzymes, a reduction in manure dry matter contents of 12 ~ 15 % (broiler) could be expected (Wyatt and Harker, 1995). Phytase supplementation reduced P contents of manure up to 25 ~ 35% in chicken (Federation Europeenne des Fabricants d'Adjuvants pour la Nutrition Animale - FEFANA, 1992; Lobo, 1999) and up to 25 ~ 60% in pigs (Crumwell and Coffey, 1995; FEFANA, 1992; Jongbloed et al., 1992; Kornegay and Harper, 1997; Michel and Frosoth, 1999). When somatotrophin was used as a growth promotant, N content of pig manure was reduced 5 ~ 30% (FEFANA, 1992; Williams et al., 1987). Odor (ammonia emission) of pig manure was reduced by 53 ~ 56% when sarsaponin extract was used as a growth promotant (Sutton et al., 1992).

When feeding systems were adopted to provide formulations that were closer to the nutrient requirements, a 10 ~ 15% reduction of N and P contents of chicken manure resulted (FEFANA, 1992).

Recent research into dietary modification has resulted in odor reduction (NH_3emission) of 28 ~ 79% in pig manure (Cahn et al., 1998a; Cahn et al., 1998b; Hankins et al., 2000; Kay and Lee, 1997; Sutton et al., 1999).

Phase feeding in chicks and pigs reduced N content 10 ~ 33% (FEFANA, 1992; Henry and Dourmad, 1993; Koch, 1990; Sutton et al., 1997) and odor content(NH_3 emission) in growing and finishing pig manure by 49 ~ 79% (Boisen et al., 1995; Sutton, 1997; Turner et al., 1996; VanderPeet-Schwering and Voermans, 1996). According to scientists (FEFANA, 1992; Henry and Dourmad, 1993; Koch, 1990; Sutton et al., 1997), phase feeding also resulted in a 10 ~ 13% reduction in P of pig manure. Use of highly digestible raw materials in chicken and pig formulations has resulted in an 5% reduction each in manure N and P contents (FEFANA, 1992)

2. Odor in Animal Agriculture and Diet Manipulation

Odor has been described as the number one problem associated with animal pollution (Lyons, 1995). And odor and N pollution are closely related since both are mainly produced by crude protein (CP) (Coelho, 1994). Offensive odors from livestock facilities consist of many (ranging from 30 to more than 200) volatile odorous compounds including hydrogen sulfide and ammonia (Hobbs et al., 1995; O'Nell and Phillips, 1992; Shurson et al., 1999; Spoelstra, 1980). Sutton et al. (1999) reported that primary odor-causing compounds evolve from excess degradable protein and lack of specific fermentable carbohydrates during microbial fermentation.

Solutions to odor control have been studied in masking agents, enzyme and bacterial preparations, feed additives, chemicals, oxidation processes, air scrubbers, biofilters and new ventilation systems, but research relating the effects of the swine diet on manure odors has been scarce (Sutton, 1999). However, dietary manipulation is an opportunity for improvement to reduce nutrient excretion as well as to improve odor control (Coffey, 1992)

A large part of the N losses is associated with inefficiencies of digestion and absorption, so providing diets with highly digestible amino acids may reduce the amount of N excretion. In one study, when dietary CP was lowered from 17 to 13% for 24-week-old laying hens, fecal N excretion was reduced as much as 34% without affecting egg production (Summers, 1993). Hobbs et al. (1996) demonstrated that reducing dietary protein concentration reduced several of the odor producing compounds. When nutritionally adequate, low sulfur starter diets are fed, total sulfur and sulfate excretion can be reduced approximately 30% without compromising energy and N digestibility or pig performance (Shurson et al., 199).

Furthermore, this study shows that a reduction in total sulfur consumption and excretion can lead to a reduction in hydrogen sulfide gas and odor, but not affect ammonia levels in nursery facilities. Sutton et al. (1999) reported that ammonia emissions were reduced by 28 to 79% through diet modification and limited research on reduction of other odorous volatile organic compounds through diet modification is promising.

They added that continued nutritional and microbial research to incorporate protein degradation products, especially sulfur-containing organics, with fermentable carbohydrates in the lower gastrointestinal tract of pigs will further control odors from manure.

IMPROVING NUTRIENT EFFICIENCY THROUGH MANUFACTURING STRATEGIES TO REDUCE POLLUTANTS

Decreasing the excretion of excess nutrients may be achieved by determining the content of nutrients in feedstuffs and improving manufacturing techniques. Determining the nutrient content in feedstuffs will be discussed in the section on testing of the complete feed. Feed processing increases the surface area of the feed that is exposed to the animal digestive system. Processing is also known to facilitate fixing, improve feed density, reduce dustiness, improve palatability, extend"shelf life"and alter nutrient makeup (Jensen et al., 1965; Nahm et al., 1998; Peisker, 1994; Wilson and Beyer, 1997).

1. Effect of Grinding and Particle Size on Feed Efficiencies

Prior to mixing, grain is ground to increase the surface area and subsequently improve the digestion rate, to decrease segregation and mixing problems, and to assist in processes such as extrusion or pelleting (Nir, 1996). And grinding to the proper size can improve a herd's feed efficiency and be more cost efficient (Nprton, 1999).

Reducing particle size from 1000 to 400 microns improved nutrient digestibility and lowered average daily feed intake which resulted in a 26% decrease in daily dry matter excretion and a 27% decrease in daily N excretion in the manure of finishing pigs (Wondra et al., 1995c). While in another study, a particle size less than 600 microns was suitable for corn used for meal and pelleted diets. It has also been shown that uniform particle sizes provide improved nutrient (dry matter, N and gross energy) digestibilities (Wondra et al., 1995a; 1995b). In poultry, particle size preference has been shown to vary with age, the preference for larger particles increases as the bird become older, and it may be related to beak dimensions (Bartov, 2000).

In broiler, the positive effects of mesh coarseness on performance is seen even after the feed was subsequently pelleted and phytate P utilization by broilers improved by increasing the particle size (Kasin and Edwards, 1998). The effects of corn or hard and soft grain sorghum particle size on growth performance and nutrient utilization in broiler chicks has been investigated (Healy et al., 1994). The reduced particle size improved growth performance with the optimum particle size being 700 microns. for corn, 500 microns for hard grain sorghum and 300 microns for soft sorghum. When properly processed, the grain sorghum had a nutritional value similar to corn.

The effects of grain particle size on nutrient digestibility have been studied(Owsley et al., 1981). In ileal cannulated pigs, as the particle size was reduced, the upper gastrointestinal digestibility of N, DM, gross energy (GE), starch and most amino acids was increased. When the particle size of barley was reduced by 14%(789 microns vs. 676 microns) for starter pigs, their average daily gain (ADG) and gain to feed (G/F) improved by 5% (Goodband and Hines, 1988). Improved G/F and DM, GE and N digestibility were noted when the particle size of corn and grain sorghum was reduced (Ohh et al., 1983). Extensive particle size reduction may not improve the performance of pigs fed wheat. In starter pigs fed diets with wheat ground to 860 microns or 1710 microns average particle size, the average daily gain and G/F were similar (Seerley et al., 1988)

The development of esophageal ulcers, stomach lesions and keratinization in pigs has been correlated to fine grinding of feeds (Hedde et al., 1985). Fine grinding(less than 600 microns) of corn and two grain sorghum genotypes negatively affected stomach morphology, but the improved performance in these animals may make fine grinding acceptable (Cabrera et al., 1993). This study also showed that smaller grain particle size dramatically reduced DM and N excretion.

The influence of mill type (hammer mill vs. roller mill) on finishing pig performance and stomach morphology has been investigated by Wondra et al. (1993). Growth performance was not affected by mill type, but when corn was ground by a roller mill, pigs showed greater digestibilities of DM, N, and GE, while they also excreted 18% less DM and 13% less N than pigs fed hammer mill ground corn.

2. Feed(nutrient) Uniformity and Its Effect on Nutrient Excretion and Animal Performance

Improper mixing of feeds results in reduced uniformity of the diet, leading to poor animal performance and increased nutrient excretion into the environment. Analytical results from 26 sow feed samples and 17 finishing feed samples were summarized by Spears(1996). Single samples were taken from each farm and analyzed by the North Carolina Feed Testing Laboratory. The mineral concentrations in the different feeds varied substantially. The mineral contents of the feeds were in excess of the requirements suggested by the National Research Council (NRC, 1988). Use of excess nutrients in order to avoid nutrient deficiencies when formulating diets accounts for variability in ingredient composition and accuracy of diet mixing, but it also increases nutrient excretion and diet cost. Nahm et al. (1998) said that the livestock and poultry industries must be aware that if micro-ingredients of feed such as vitamins, amino acid, trace elements, enzymes, growth promotants and drugs are not properly distributed in the feed, there is a resultant adverse effect on animal performance. There is a greater importance for feed uniformity in very young animals and animals with a short digestive tract, as compared to older or larger animals that consume larger amounts of feed less often (Nahm and Carlson, 1998). Even though the importance of diet uniformity is intritive, there is very little credible research that relates diet uniformity to animal performance (Behnke, 1996).

In a survey of commercial feed mixers, over 50% did not meet the industry standard of a coefficient of variation (CV) of less than 10% when methionine or lysine was used as a tracer (Wicker and Poole, 1991). The results were similar when farm feed mixers were surveyed (Stark et al., 1991). That survey indicated that 42% of participants had CV's of less than 10% (67% were between 10 and 20% and 11% had CV's greater than 20%). The tracer in this study was salt.

Although the accepted industry standard for mix uniformity of a complete diet is a CV of 10% or less, it has been shown that broiler chicks had maximum growth performance with a diet that had a CV of 12 ~ 23%, depending on the method of analysis (McCoy et al., 1994). Nursery pigs have been reported to require feed mixed to a CV of at least 12% to maximize performance (Trayor, 1997). In both of these studies, P excretion was decreased when phytase was added to the chicken and pig diets.

Johnson and Southern (2000) determined the effect of varying mix uniformity of phytase on growth performance, mineral retention and bone mineralization. They found that P excretion increased linearly as phytase CV increased and P excretion tended to be higher for chicks fed the CV 103 (calcium - Ca 0.9% + aP 0.35% + 0 or 1200 FTU phytase units) treatment than those fed the CV0 (Ca 0.9% + aP 0.35% + 600 FTU phytase units). Ca and P excretion was numerically higher for the CV 69 (Ca 0.9% + aP 0.35% + 200 or 1000 FTU phytase units) treatment than for the CV 103 treatment.

The nutrient availability in animal feedstuffs may be increased through the use of enzymes. The actions of feed enzymes include any or all of the following: 1) supplement to the endogenous enzyme production of the host; 2) nutrient availability in the feed may be improved; 3) digestibility of the indigestible fiber materials may be improved; 4) the anti-nutritional factors in feed ingredients may be decreased (Scott, 1991).

The CV's of the enzyme application improves with in creased mixing of the liquid enzyme in the finished feed. Improvements in CV's have been seen during the transfer of the feed from the mixing screw, to the bin on the farm and to the feed hopper in the poultry house. It is recommended that finished feed be sampled immediately after blending/mixing to determine how well the feed mill is applying the enzyme.

The quantity of enzyme is as important as the consistency of application. Although adequate field performance has been noted with CV's of 15 ~ 20% (Classen, 2000), there is a variable seen with the use of enzymes since there are many factors that influence them. The effectiveness of feed enzymes is significantly affected by the type of ingredients, cultivars, types of soils, diet ingredients, types of feed processing, age of animal, etc. (Duncan, 1973).

There is a specific assay and mode of action for every enzyme. Uniformity of these assays is an industry problem since there are a variety of reasons for this. The complete enzymes levels in feed are suspect because of the small quantity of enzyme in feed as well as the possibilities of soluble inhibitors and enzyme binding to substrate (Classen, 2000). The primary method of determining the quality of an enzyme product is biological testing under commercial feed manufacturing and animal production conditions (Nahm, 1992; Classen, 2000).

3. Expanding/Pelleting Processes

The process of expanding is a typical High-Intensive-Short Term (HIST) process involving an expander which is a simplified and low cost extruder having its own technical specification. The expander is used in industrial manufacturing of a compound as a pressure conditioner before the pellet mill in order to improve the pellet quality.

Multiple beneficial effects can be obtained through expanding. Nutrient digestibility is in creased by expanders, resulting in increased N digestibility and reduced N excretion. They also are responsible for inactivation of anti-nutritional factors like protease inhibitors, renaturation of the tertiary protein structure, removal of resistance to proteolytic enzymes which decreases hydrolysis time in the gastrointestinal tract (Coelho, 1994). Expanders are also involved with improving the hydrolysis, gelatinization and melting of starch and polysaccharides, which includes the decrease in crystallinity and depolymerization of starch molecules, resulting in improved digestability. Fat-splitting enzymes are inactivated by expanders and this reduces the potential for fat oxidation. Expanders inactivate several pathogenic organism such as Salmonella and E.coli (Delort-Laval, 1993).

Because of the correlation between starch modification and pellet quality, the nutritional importance of the starch modification by expanding can be used as benefit too in comparison to the conventional pelleting. Fancher et al. (1996) reported improved growth and feed conversion in male turkeys fed expanded diets compared to diets that were only pelleted. Beyer (2000) found that these parameters are improved by 5 ~ 10% when expanded diets are compared to conventionally pelleted rations in broiler trials. Edwards et al. (1999) demonstrated steam pelleting of corn, soybean meal or diets containing these ingredients, as well as extrusion of this did not increase phytate phosphorus utilization by broiler chicks. Moreover, extrusion of the diet decreased Ca, P and phytate P retention, and its ME value.

Pelleting of feeds has the potential to improve feed efficiency and reduce nutrient excretion. Wondra et al. (1995) reported that dry matter and N excretion were decreased 23 and 22%, respectively, by pelleting. Feed efficiency was improved 6.6% in that study. Summarizing eight trials on pelleting diets for swine, Hancock et al .(1996) concluded that pelleting improved average daily gain (ADG) 6% and feed efficiency 6 ~ 7%. A 2% reduction in feed wastage can reduce the N and P in manure approximately 3% (based on a N and P retention of 35%) (Heugten and Kempen, 1999).

Broiler performance is affected more by addition of a beta-glucanase to a barley based diet when the feed is pelleted rather than a mash (Belyavin, 1994). Regardless of how phytase is added to the diet, inactivation of the enzyme is still a concern. Exogenous phytase addition can be done after expansion and/or pelleting (Aicher, 1998), which avoids heat inactivation of the enzyme. When properly stablized enzymes are used, heat and pelleting trials show good enzyme recovery even at high temperatures (Classen et al., 1991). A large number of commercial trials have shown that enzyme supplemented feeds pelleted at temperatures of 71 ~ 90℃(160 ~ 195°F) improved animal performance, indicating the survival and presence of added enzyme activities.

Heat stable enzyme products are available, but methods to assay the enzyme stability remaining after the pelleting process has not been agreed upon(Bedford, 1993). Enzyme stabilization through improved production technology has allowed some dry enzyme products to be pelleted after conditioning at up to 88 (190°F) and liquid enzyme to be stored in the feed mill up to four months prior to feeding (Graham, 1994).

Some improvement seen with the extrusion process include improved digestibility of nutrients by rupturing cell walls, changing the chemical and physical properties of carbohydrates and proteins, and reductions in the protein and fat contents of corn, but there were no changes seen in the concentrations of various amino acids. Use of extruded corn in the diets of young pigs improved energy utilization but there was no effect on lysine or nitrogen utilization (Herkelman et al., 1990). The trypsin inhibitor content of soybean meal is reduced by extrusion, but urease activity and utilization of lysine by young pigs were not affected (Rodhouse et al., 1992). Steam pelleting or extrusion of corn, soybean meal or diets containing these ingredients did not increase phytate P utilization by broiler chicks (Edwards et al., 1999).

Certain heat sensitive nutrients may be destroyed by expanders, but Coelho (1994) indicated that research showed this to be an significant concern. However, McEllhiney (1989) reported that feed formulations need to account for decreases in vitamin A potency of 29.3% due to grinding (regrinding), and a 12.9% decrease when reground mash is pelleted. A 17.9% loss of vitamin A was seen when feed was pelleted alone, without regrinding, but when it was reground, the loss increased to 38.4%. Pelleting of feed has been shown to increase the lysine requirement in growing turkeys compared to turkey feed similar diets in mash form, especially when lysine levels were marginal in the formulations (Jensen et al., 1965). If pelleting increases the feed conversion by 10%, then the theoretical requirement for lysine in growing turkeys, for example, would be 1.43% compared to mash at 1.3% (NRC, 1994). Further research is still needed on the effect of feed form on the nutrient content of feed. Most feed manufacturing research needs to be based on feed that has been processed by the most modern methods or the results may not be trusted.

IMPROVING NUTRIENT EFFICIENCY BY TESTING THE COMPLETE FEED

Successful quality control programs must include sending finished rations for laboratory analysis. It is important for verifying that the steps to improve efficiency have been accurate and whether or not the feed will do its job in the livestock herd. First, a representative feed sample is needed. A grain probe could be used in a stable feed mass to obtain a cross-section. Get about six to ten samples from different locations and pour those into a bucket. Then, combine to make up a sample. This sample can be reduced to a volume of about 500g by coning and quartering (Nahm, 1992). A sample should be kept back, labeled with the date, and stored in an air tight container for at least one year. This retesting sample is an insurance policy if a problem with the analysis occurs.

A reliable laboratory should be chosen to send the sample to. Results should be reported within three days and should include contents of nutrients such as protein, fat, and fiber. Sometimes the limited number of amino acids, vitamins, trace minerals and others are included along with specialist's advice for farmers on how best to apply the analytical data (Nahm, 2000). There is an acceptable analytical variation for each nutrient.

The analytical results can be compared to acceptable levels for each nutrient, or specialist can be consulted about the results and proper recommendations can be made. If the results show values that are not acceptable, the analytical processes and dietary formulations need re-evaluation

CONCLUSION

Recently, the reduction of pollutants in animal manure has been approached throughresearch into improving nutrient efficiency, mainly with pig and chicken test subjects. Nutrient efficiency has been improved through supplements(extended use of amino acids and related compound, use of enzymes, and use of growth promotants) and modifying feeding systems(formulations closer to requirements, phase feeding, and increased use of highly digestible raw materials). These mothods lead to reduce N, P, and metal contents as well as decreased odor and dry matter content of animal manure.

Feed manufacturing techniques including grinding methods to provide proper particle sizes and feed uniformity or expanding and pelleting techniques must be studied to improve feed efficiency and reduce manure pollutants. Specialists also need to provide improved feed formulations based on analytical results of samples taken from the farms, which will result in reduced manure pollutants of poultry and swine.

적 요

가축사육이 집단화되면서 가축배설물의 축적은 집중화 현상을 초래하게 되었고 또 계속적인 분뇨 분비물의 유출은 환경공해의 요인이 되고 있으며 이는 공공의 걱정거리로 대두되고 있다. 가축분뇨 중에서 질소와 인이 환경공해 요인이 되는 가장 중요한 영양소이지만 가축이나 축산시설물에서 발생되는 냄새 역시 공해의 요인이 되고 있다. 급여되는 사료의 영양소효율을 높이는 길이 환경공해를 감소시키는 방법이다. 가장 많은 실험은 닭과 돼지를 대상으로 하여 이루어졌다. 사료첨가제의 이용, 사양방법의 수정 등으로 사료중의 영양소 이용성을 높임으로서 질소와 인의 배출감소는 물론 냄새와 분의 건물함량을 줄일 수 있었다.

1) 합성아미노산 제제를 사료 중에 첨가하고 단백질 수준을 감소시켰을 때 육계의 경우 10 ~ 27%의 질소배출을 기대 할 수 있었으며 산란계의 경우 18 ~ 35%, 돼지의 경우 62%, 돼지에서 생성되는 냄새를 9 ~ 43%까지 감소시키는 효과를 기대 할 수 있었다. 2) 사료 중에 효소제를 첨가하였을 때 육계 분의 건물함량을 12 ~ 15% 감소시킬 수 있었다. 3) phytase를 첨가할 경우 분으로 배설되는 인의 함량은 양계의 경우 25 ~ 35%, 돼지의 경우 9 ~ 43%까지 감소가 가능했다. 4) 성장촉진제를 이용할 경우 돼지에서 질소의 배설 양을 5 ~ 30% 감소시킬 수 있었으며 냄새는 53 ~ 56%까지 감소가 가능했다. 5) 사료배합을 요구량에 가깝게 하여 급여하였을 때 양계나 양돈의 경우 질소와 인은 각각 10 ~ 15% 감소를 기대 할 수 있었으며 돼지의 냄새는 28 ~ 79%까지 감소가 가능했다. 6) 기별 사양을 철저히 실시함으로서 양계와 양돈의 경우 질소는 10 ~ 33%, 인산은 10 ~ 13%, 그리고 성장 비육돈의 경우 49 ~ 79% 감소를 기대 할 수 있다. 7) 닭이나 돼지의 사료를 배합시 소화율이 높은 곡류를 이용하면 질소와 인의 배설을 5% 감소시킬 수 있다. 사료 제조시 기술력(사료곡물의 분쇄, 입자크기의 조절, 사료배합시 일정도 그리고 배합사료의 펠렛팅이나 익스펜딩 등)은 닭과 돼지의 배설물 중 냄새 그리고 분의 건물감소에 기여할 수 있지만 이에 대한 연구는 더 계속되어야 한다. 이상적인 사료분석기술도 가축분뇨에 의한 환경공해를 예방하는데 기여한다. 또 실험실에는 전문가를 배치하여 환경공해 감소를 위한 방안들을 자문해줄 필요가 있다.

(색인어 : 효소, 사료업, 비료, 영양소효율, 배합사료, 공해, 단백질수준)

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