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Effects of alum (*Aluminium sulphate*) on faecal quality of broiler fed low protein diets

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Abstract

A study was conducted to evaluate the effects of manipulation of dietary protein on the physico-chemical quality of broiler faeces and response of these qualities to 1.5% alum (Aluminium sulphate) treatment during storage. Chicks were allotted to corn-soy diets in a completely randomized design for forty-two days. The diets were 22 and 20% CP with methionine + lysine content balance and, 22 and 20% CP diets with 110% NRC recommendation of methionine and lysine. Faecal nitrogen decreased ($P<0.05$) with dietary protein levels and, methionine and lysine supplementation of 22 and 20% dietary protein. Faecal pH of broiler fed low protein diets were slightly acidic and ranged from 4.76-4.80. Faecal minerals were generally lower than the range of values reported for broilers in other investigations. Furthermore, treatment of broiler faeces with alum (1.5%) led to reduction in pH (4.78 to 4.58). Also, rate of reduction in faecal nitrogen and organic matter levels, and increase in pH was observed to be lowering in alum-treated compared to the untreated broiler faeces in a 7 days storage. In conclusion, feeding low level of dietary protein with or without methionine and lysine supplementation in excess of requirement is a suitable means of reducing nitrogen and mineral excretion in broiler production. During feacal storage, reduced nitrogen volatilization and consequently, nitrogenous emissions from broiler faeces can be achieved by the addition of alum treatment.

Keywords: Alum; broiler; faecal nutrient; protein; storage

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Introduction

Rapid growth and intensification of poultry production has resulted in increased concern on associated public health risks and effective waste disposal systems. Air emissions and faecal minerals emanating from intensive chicken operations could have serious environmental consequences when poorly managed. Nitrogenous compounds including ammonia (NH_3), nitrous oxide (N_2O) and other oxides of nitrogen (NO_x) as well as non-nitrogenous emissions namely methane (CH_4) and hydrogen sulphide (H_2S) are some of the air emissions of concern from broiler and layer production (NRC, 2003; Yates et al., 2011). There is abundant evidence that broiler and layers production are among the most important sources of nitrogenous and other forms of emissions from agriculture. Nitrous oxide emission from poultry waste management was higher than that from other livestock by 29.6-60.8% between 1990 and 2000 in Taiwan (Yang et al., 2003). Of the total nitrous oxide emission from Taiwan in the period under consideration, chicken accounted for about 83.5%. Similarly, in China, nitrous oxide emissions from livestock and poultry waste management increased at the rate of 7.5% per year, rising from 47.76 Gg in 1949 to 241.2 Gg in 2003 (Zhou et al., 2007). Chicken topped the chart among poultry and accounted for about 9% of the total emissions from animal production in China between 1995 and 2003. Emission of ammonia ranged from

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0.034-0.384 kg NH_3/bird/year for various layer systems (Koerkamp, 1994; Yang et al., 2000). Thus, factors such as diets, housing system, manure handling method, bird type and season of the year are among the factors affecting nitrogenous emissions from chicken production (Bussink and Oenema, 1998). In addition, available faecal nitrogen is a determinant of the extent of nitrification and denitrification (Philips et al., 1999).

Nutritional measures aimed at reducing nitrogen excretions from broiler and layer units will ultimately ensure reduction in the amount of nitrogenous emission from manure in storage. Microbial activities after excretion, during storage and land application, create odours of various noxious gases and are responsible for the release of greenhouse gases (CAST, 1996). Chao (2001) studied the effect of livestock and poultry compost on N_2O emissions from soils application and reported that compost released 0.48-0.60% of nitrogen as N_2O. Similarly, 18-41% of faecal N was lost to the atmosphere as NH_3 and other nitrogenous compounds, especially before strategic measures were taken to modify nutrient excretion (Yang et al., 2000; Patterson, 2001).

Mineral nutrients from chicken manure are also potential environmental risk factor especially in soil and water pollution. Apart from their nitrogen content, chicken manure are also rich in other nutrients such as sodium (Na), potassium (K) phosphorous (P), magnesium (Mg), calcium (Ca) and sulpher (S) which makes it valuable for use in crop production. About 30-50% of total N in chicken manure is readily plant available (Nicholson et al., 1996). However, due to limited land availability and lack of nutrient test to determine requirements before applications, soils applied with chicken manure have been observed to have excess N and P (Moreki and Chiripasi, 2011). Risks of nutrients, organic material and pathogens contaminating water bodies are also common with increased manure spread (Smith et al., 2001). Amendments of poultry manure could be utilized to further control mineral volatilization and other forms of releases from chicken manure. Alum (aluminium sulphate), sodium bisulphate and mineral or organic acids are some of the materials that could be used for litter or manure amendments for N and NH_3 as well as other benefits, including controlled mineralization (Koelkebeck and Harrison, 2013). Alum, also referred to as filter alum $(Al_2 (SO_4)_2$ is used as a flocculating agent in the purification of drinking water and waste water treatment (Kvech and Edwards, 2002; Global Health and Education, 2007). The aim of this study was to evaluate the effect of dietary protein manipulation on broiler faecal physico-chemical quality and its response to alum treatment during storage.

Materials and Methods

One hundred and sixty eight day old (mixed sex) Abor Acre Plus broiler chicks were purchased and randomly allocated to twelve pens at a density of $0.1m^2$/bird. Birds were given water and feed *ad libitum* (Table 1) for a study that lasted for 42 days.

Dietary treatments and management of experimental birds

Twenty two and twenty percent crude protein diets were the treatments in this study. Four diets were used to study the effect of feeding low protein diets supplemented with methionine and lysine on performance, nitrogen economy and faecal quality of broilers. The four diets were

22% CP with NRC (1994) Methionine + Lysine

22% CP with 110% Methionine + Lysine of NRC (1994) recommendation

20% CP with NRC (1994) Methionine + Lysine recommended level

20% CP with 110% Methionine + Lysine of NRC (1994) recommendation

The composition of the diets on calculated basis is presented in Table 1. Birds were randomly allocated to these treatments in three units (replicates) of 14 birds each. Birds were vaccinated against Newcastle disease at 1 and 3 weeks of age and infectious Bursa Disease at 2 weeks of age. The study was conducted for 6 weeks.

Data collection

The study was carried out in the Animal Pavilion of the Department of Animal Production, University of Ilorin, Ilorin. Ilorin is located on latitude 08 29’N and longitude 004 35’E. The elevation is 305m 1001’. Annual temperature range is 22-34ºC and annual precipitation is 80-12-mm (World Climate, 2013).

At the end of the third week of the study, a nutrient retention study was conducted. Feed was weighed and given to birds and faecal samples were collected over a period of 72 hours employing total collection method. About 50 g of faecal samples were weighed in 2 places per replicate with one part treated with 1.5% alum while the other part was not treated. Portions of the faecal samples were oven dried (40ºC for 4hrs) and analyzed for N, pH, organic matter and some mineral constituents. The baseline analyses were carried out a day after treatment with alum and 7days post-treatment.

Faecal analysis

Proximate composition of faeces was carried out using the methods of AOAC (1990). The mineral content of the faeces was determined using an Atomic Absorption Spectrophotometer (AAS) model 200A.

Response criteria were subjected to analysis of variance and differences between treatment means were separated by Duncan Multiple Range Test using the Statistical Analytical System (SAS, 1985) software. Changes in physico-chemical response of broiler faeces in storage were also subject to descriptive statistical analysis.

Table 1: Composition of broiler's diets supplemented with methionine and lysine (%DM)

Ingredients	22% CP with 100% Met + Lys	22% CP with 110% Met + Lys	20% CP with 100% Met + Lys	20% CP with110% Met + Lys
Maize	52.6	52.6	58.3	58.3
SBM	31.3	31.3	25.6	25.6
WB	6.2	6.2	6.2	6.2
Fish Meal	4.0	4.0	4.0	4.0
Palm oil	2.6	2.44	2.45	2.3
Bone Meal	0.5	0.5	0.5	0.5
Lysine	0.2	0.31	0.3	0.4
Methionine	0.1	0.15	0.15	0.2
Salt	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Oyster Shell	2.0	2.0	2.0	2.0
Total	100.0	100	100	100
Composition of Diets on as calculated basis				
Crude Protein (%)	21.95	21.95	19.94	19.94
Methionine (%)	0.52	0.55	0.52	0.57
Lysine (%)	1.40	1.50	1.37	1.47
Ca (%)	1.05	1.06	1.05	1.05
P (%)	0.54	0.54	0.52	0.52
Mg (%)	0.18	0.18	0.17	0.17
K (%)	1.11	1.11	0.98	0.98
Fe (%)	0.02	0.02	0.015	0.015
Mn (mg/kg)	20.25	20.25	18.65	18.65
Zn (mg/kg)	42.43	42.43	41.10	41.10
Cu (mg/kg)	13.60	13.60	11.77	11.77

WB= Wheat Bran; SBM= Soya Bean Meal; Met= Methionine; Lys= Lysine

Results and Discussion

The faecal quality of broilers fed low protein diets supplemented with methionine and lysine are presented in Table 2. Faecal N decreased (P<0.05) with dietary protein levels and with methionine and lysine supplementation in excess of requirement of broilers fed 20 and 22% protein diets. Faecal nutrients reported in this study (Table 2) were generally lower than the range of values reported for fresh and stable chicken manure in other investigations (Kogram et al., 2002; Khalil et al., 2005), which suggests that feeding low protein diets to broilers, with or without amino acid supplementation above the recommended values of NRC (1994), tended to reduce the excretion of nitrogen and minerals in broilers. Thus, low protein diets fed to broilers may be a potential means of lowering nitrogen and mineral excretion (Hassan et al., 2011). It was also observed that faecal Ca, Mg, K, P, Na, Mn, Zn, Cu, Ni and Pb decreased (P<0.05) while faecal Fe increased (P<0.05) as dietary protein level decreased from 22 to 20% in diets with NRC (1994) recommended methionine and lysine. The trend for all faecal mineral nutrients (excluding Fe) was similar to that of the mineral contents of the experimental diets, which decreased with crude protein level. This is quite understandable since the main drivers of the mineral contents of the experimental diets in this study were also the major determinant of the dietary protein level. Khalil et al. (2005) has noted that the constituent of the feed is one of the factors responsible for differences in nutrients quantity in the various forms of chicken manure.

Similarly, methionine and lysine supplementation of 22% protein diets above the broiler requirements resulted in significantly lower (P<0.05) faecal Ca, Mg, K, P, Na, Mn, Zn, Cu and Ni when compared with unsupplemented 22% protein diets. On the other hand, methionine and lysine supplementation above broiler requirements in 20% protein diets resulted in significantly higher (P<0.05) faecal Ca, Mg, P, Mn and Zn when compared with unsupplemented 20% protein diets. This result, therefore, suggests some influence of dietary protein and amino acids on faecal nutrients levels. Thus, it is suspected that at some protein levels, excessive supply of methionine and lysine may affect the excretion of some minerals in broilers, thereby leading to either reduced or increased faecal nutrients as the case may be. Hence, there may be need for further investigation of the relationship between dietary amino acids and mineral excretions in broiler.

Faecal pH for broiler fed low protein diets in the present study ranged from 4.76 – 4.80 and were within the slightly acidic range for all treatment. The implication of acidic faecal pH is that at low pH, ammonification is inhibited and therefore leads to reduction in ammonia emissions to the atmosphere (NRCS, 2007). This may also explain the efficacy of low protein diets as a mean of reducing ammonia and other nitrogenous emissions from chicken manure. Faecal organic matter content showed significant (P<0.05) treatment effect with 22% supplemented with methionine + Lysine and 20% CP diets having the lowest values; however, no consistent trend was observed.

Alum treatment and broiler faecal pH, OM and N during one week of storage

The observed trends for faecal pH, OM and N during storage of alum treated and untreated broiler manure are presented in Table 3. Addition of alum to broiler manure lowered average faecal pH from 4.78 to 4.58 within the first day of application. Although, the pH value increased and tended towards alkalinity in storage, it remained lower in alum-treated than in untreated manure (Table 3). In the same vein, there was 6.56 and 12.41% reduction in OM alum-treated and untreated stored broiler manure respectively (Fig. 1). Similarly, manure treated with alum had higher nitrogen than the untreated after one week due to lower faecal nitrogen loss as a result of alum treatment (Table 3). Thus, one of the benefits of alum-treated manure is that the nitrogen concentration tends to be elevated compared to normal manure. The elevated faecal nitrogen in alum-treated manure could be attributed to lower magnitude of nitrogen loss in treated compared

Table 2: Faecal quality of broilers fed low protein diets supplemented with methionine and lysine

Parameters	22% CP	22% CP with 110% Met + Lys	20% CP	20% CP with 110% Met + Lys	SEM
Nitrogen (%)	2.14[a]	2.08[a]	2.05[b]	1.99[c]	0.02
Calcium (%)	1.91[a]	1.39[b]	1.28[c]	1.40[b]	0.03
Magnesium (%)	0.33[a]	0.23[c]	0.23[c]	0.27[b]	0.02
Potassium (%)	0.47[a]	0.34[b]	0.32[b]	0.33[b]	0.01
Phosphorus (ppm)	30.89[a]	20.29[b]	18.90[c]	20.70[b]	0.27
Sodium (ppm)	25.72[a]	22.54[b]	20.16[c]	20.93[bc]	0.49
Manganese (ppm)	151.79[a]	143.30[b]	136.62[c]	148.41[a]	0.10
Iron (ppm)	186.00[c]	212.13[a]	196.70[b]	187.50[c]	0.95
Zinc (ppm)	28.55[a]	20.34[b]	18.91[c]	21.08[b]	0.44
Copper (ppm)	6.20[a]	4.42[b]	4.60[b]	4.15[b]	0.15
Nikel (ppm)	0.027[a]	0.018[c]	0.021[b]	0.017[c]	0.001
Lead (ppm)	0.059[ab]	0.064[a]	0.055[b]	0.057[b]	0.002
Organic matter (%)	8.22[a]	7.67[b]	7.78[b]	8.25[a]	0.06

Table 3: Comparison between residual nitrogen, pH and organic matter of alum treated (1.5%) and untreated broiler manure after 1 week of storage

Parameters	With alum		Without alum	
	Range	Mean	Range	Mean
Nitrogen (%)	1.92-2.11	2.02	1.74-1.98	1.87
pH	4.63 - 4.83	4.77	4.93 - 5.17	5.05
Organic matter (%)	7.11-7.70	7.46	6.20-7.45	6.20

with untreated manure. The implication of the above observations is that treating broiler manure with alum during storage does not completely stop the processes that result in gaseous nitrogenous emissions (that is, denitrification and ammonification) but may slow it down. This corroborated reports that addition of alum to litter has been described as an effective method of reducing nitrogen lost due to ammonia volatilization (Moore et al., 1995 & 1996). Similarly, Patterson (2001) indicated that trapping faecal nitrogen in the faeces is an improved means of managing faecal nitrogen and ensuring environmental integrity.

Conclusion

The results of this study suggest that feeding of broilers with amino acids supplemented lower (20%) protein diets improved efficiency of protein utilization. Similarly, further reduction of nitrogenous loss during storage can be achieved through amendments of broiler manure with alum. The overall effect of this manipulation is the potential mitigation of environmental challenges related to air and water pollution.

References

Association of Official Analytical Chemists. 1990. *Official methods of analysis* (15th ed.), Washington DC.

Bussink, D.W. and Oenema, O. 1998. Ammonia volatilization from dairy farming system from nitric acid-treated cattle slurry surface applied grassland. *Netherlands Journal of Agricultural Science*, 42: 293-309.

CAST. 1996. Integrated animal waste management. In: Task Force Report No. 128, Council for Agricultural Science and Technology, Ames, IOWA. P:87.

Chao, C.C. 2001. Emission and mitigation of nitrous oxide flux from the composting and application of livestock wastes. In: Yang, S.S. (Ed.), Flux and Mitigation of Greenhouse Gases (III). Global Change Research Center, Department of Agricultural Chemistry and Agriculture Exhibition Hall, National Taiwan University, Taipei, Taiwan, Pp: 115-127.

Global Health and education Foundation. 2007. Conventional coagulation-flocculation-sedimentation. safe drinking water is essential. National Academy of Science. Retrieved 26/08/2013.

Hassan, K., Ziaei, N. and Pilevar, M. 2011. Effects of dietary crude protein fluctuation on performance, blood parameters and nutrient retention in broiler chicken during starter period. *Global Veterinaria*, 6: 162-167.

Khalil, M.I. Schmidhalter, U. and Gutser, R. 2005. Turnover of chicken manure in some upland soils of Asia: Agricultural and environmental perspective. In CHIMATRA-Chicken Manure Treatment and Application; Proceedings of the International Workshop, Hamburg. Pp: 275-292.

Koerkamp, P.W.G. 1994. Review of emission of ammonia from housing systems for laying hens in relation to sources, processes, building design and manure handling. *Journal of Agricultural Engineering Research*, 59: 73-87.

Kogram, C., Mannekao, S. and Poosri, B. 2002. Influence of chicken manure on cassava yield and soil properties. In: Proceedings of the 17th World Congress of Soil Science, August 14-21, Thailand, 723: 1-7.

Koelkebeck, K.W. and Harrison, P.C. 2013. Evaluation of aluminum sulfate manure treatment application on ammonia generation rate and manure properties of laying hen manure. University of Illinois, Urbana, IL.

Kvech, S. and Edwards M. 2002. Solubility control of Aluminium in drinking water at relatively low and high pH. *Water Research*, 36: 4356-4368.

Moore, P.A., Jr., Daniel, T.C., Edwards, D.R. and Miller, D.M. 1995. Effects of chemical amendments on ammonia volatilization from poultry litter. *Journal of Environmental Quality*, 24:293-300.

Moore, P.A., Jr., Daniel, T.C. Edwards, D.R. and Miller, D.M. 1996. Evaluation of chemical amendments to reduce ammonia volatilization from poultry litter. *Poultry Science*, 75:315-320.

Moreki, J.C. and Chiripasi, S.C. 2011. Poultry waste management in Botswana: A review. *Online Journal of Animal and Food Research,* 1: 285-292.

Nicholson, F.A., Chambers, B.J. and Smith, K.A. 1996. Nutrient composition of poultry manures in England and Wales. *Bioresource Technology*, 58: 279-284.

National Research Council (NRC), 1994. *Nutrient requirements of poultry* (9th ed.). Washington, D.C: National Academy Press.

NRC, 2003. Air emissions from animal feeding operations: Current knowledge, future needs. The National Research Council of the National Academies. The National Academies Press, Washington, D.C.

National Resources Conservation Service (NRCS), 2007. Manure Chemistry-Nitrogen, Phosphorus, and Carbon. Manure Management Information Sheet, 7: 1-4.

Patterson, P. 2001. Using dietary and management strategies to reduce the nutrient excretion of poultry. Livestock and Poultry Environmental Stewardship (LPES) Curriculum, Lesson. Pp:11, 32.

Philips, V.R., Cowell, D.A., Sneath, R.W., Cumby, T.R., Williams, A.G., Demmers, T.G.M. and Sanders, D.L. 1999. An assessment of ways to abate Ammonia emissions from UK Livestock buildings and waste stores. 1. Ranking Exercise. *Bioresource Technology*, 70: 143-155.

SAS Institute. 1985. SAS users guide statistics. Carry, NC. SAS Institute 1985.

Smith, D.R., Moore, P.A. Jr, Griffis, C.L., Daniel, T.C., Edwards, D.R. and Boothe, D.L. 2001. Effects of alum and aluminum chloride on phosphorus runoff from swine manure. *Journal of Environmental Quality*, 30: 992-8.

Yang, P., Lorimor, J.C. and Lin, H. 2000. Nitrogen losses from laying hen manure in commercial high-rise layer facilities. *American Society of Agricultural Engineering*, 43: 1771-1780.

Yang, S.S., Liu, C.M. and Liu, Y.L. 2003. Estimation of methane and nitrous oxide emission from animal production sector in Taiwan during 1990-2000. *Chemosphere,* 52: 1381-1388.

Yates, S.R., McConnell, L.L. Hapeman, C.J. Papiernik, S.K. Gao, S. and Trabue, S.L. 2011. Managing agricultural emissions to the atmosphere: state of the science, fate and mitigation, and identifying research gaps. *Journal of Environmental Quality,* 40: 1347-1352.

World Climate, 2013. http://www.climate-charts.com/Locations/n/NI65101.php. Retrieved 10/09/2013

Zhou, J.B., Jiang, M.M. and Chen, G.Q. 2007. Estimation of methane and nitrous oxide emission from livestock and poultry in China during 1949-2003. *Energy Policy*, 35: 3759-3767.