Bulletin of Animal Science, Supplement Edition, 1998 *ISSN 0126-4400*

THE EFFECT OF INCORPORATING ZEOLITE IN LAYER DIETS AND SPREADING ON TO MANURE ON HOUSE FLY LARVAE POPULATION, FAECAL AMMONIA AND LAYER PERFORMANCE

Kassim Hamid[1] and Wihandoyo[2]

ABSTRACT

This experiment was conducted to study the effect of incorporating zeolite in the diet and spreading on to manure on the population growth of house flies, manure ammonia production and layer performances. 486 Hysex-brown layers, 7 month of age, were divided into 3 treatments and fed with 0, 6 and 12% levels of zeolite in the diets, and spreading of zeolite on to manure at 0, 6 and 12% of total daily feed intake every 4 days. The result of this experiment showed increasing levels of zeolite in the diets and levels of zeolite spreading on to manure significantly (P<.05) decreased the larvae population of the house flies, ammonia production and water content of manure respectively. Incorporation of high level of zeolite in the layer diets affected significantly (P<.05) the feed conversion ratio, hen day production and shell thickness but not significantly on feed consumption, egg weight, shell weight, length and weight of tibia, respectively.

Key words: Zeolite, Diets, Spreading, Manure, Ammonia, House flies, Population, Performance

INTRODUCTION

Accumulation of chicken manure from layer production becomes a nuisance and a source of environmental pollution if not handled judiciously. Odor and flies are produced in and by the waste products that are being generated by the poultry.

Animal waste attracts flies in large numbers. One of the major attractants appears to be the ammonia emanating from the manure, and high moisture content is also desirable for fly reproduction in manure (Seltzer *et al*, 1969). Three species of filth flies are common in poultry production systems. These are the house fly, *Musca domestica* L., the little house fly, *Funnia canicularis* (L) and "black garbage flies," which are difficult to distinguish (Lysyk and Axtell, 1986). Putz (1989) also showed that the life cycle of these flies from egg to adult can be completed within 8-10 days and up 5000 maggots have been found in one kg of faeces.

The largest part of the gases arising from animal husbandry derives from the animals' excreta. In houses, the gases are produced from freshly deposited or stored faeces and urine (Hartung and Phillips, 1994). Ammonia is one of the chemical pollutant from the poultry industry, resulted from microbial activities in which uric acid and undigested proteins are degraded (Huton, 1987) and also carbon dioxide is produced in this process (Middelkoop, 1995). Ammonia is a colorless gas with a very pungent and characteristic odor, it is produced from animal wastes by bacterial action and most people can recognize its presence in the air at about 25 or more p.p.m (Seltzer *et al*, 1969). Ammonia and sulfide are widely used for this application due to their ease of measurement and known odorous characteristics (Miner, 1980), Adding odor control chemicals to manure storage tanks or animal feeds will be able to prevent the release of odorous compounds, inhibiting their formation, or masking their odor and is the most effective in odor control. Ammonia originates from faeces, both the quantity and the composition of the faeces are of interest when studying ammonia emission (Koerkamp, 1994).

[1] Faculty of Medicine and Health Sciences UPM Malaysia
[2] Faculty of Animal Husbandry GMU Yogyakarta Indonesia

Zeolite (Clipnoptilolite) are crystalline, hydrated aluminosilicates of alkali and alkaline earth cations, having infinite 3-dimensional structures, the approximate chemical formula for the clipnoptilolite is $Na_6 [(AlO_2)_6] (SiO_2)_{30}$ 24 H_20 (Mumpton and Fishman, 1977). Koelliker *et al* (1980) used clipnoptilolite from Double Eagle Petroleum and Mining Company Casoer, Wyoming in his experiment, reported that clipnoptilolite has especially good selectivity for the ammonium ion, the ammonium capacity as reported by supplier is 2.0 milli-equivalents per gram (meq/g) or 3.4 percent by weight of NH_3. According to Mumpton and Fishman (1977), zeolite can be used to extract ammonia (NH_4^+) by ion exchange.

Significant treatment effects were found for egg production, daily feed per layer, feed conversion and fecal moisture when fed rations containing 0, 2.5, 5 and 10% clipnoptilolite (Nakaue and Koelliker, 1981). The addition of sodium zeolite A enhanced tibia ash, density and shearing force when dietary Ca was low, however, when added to diets containing 1.2% Ca, sodium zeolite A reduced many bone mineralization indices with the exception of tibia Ca (Watkins and Southern, 1992). Olver (1980) reported that the hens fed on the clipnoptilolite diet laid an average of 12 eggs per hen more than those fed on control diet and the moisture content of droppings from the three strain of hens was lower for those fed on the diet with clipnoptilolite than for those fed on the diet without clipnoptilolite.

This study was undertaken to evaluate control techniques of ammonia production and house flies population in the manure by using natural product (zeolite) through the diet and spreading on to manure directly.

MATERIALS AND METHODS

Four hundred and eighty six Hysex-brown layers, 7 month of age, were arranged in a 3 x 3 factorial consisting of three levels of zeolite in the diets (0, 6 and 12%) (Table 1) and three levels of zeolite spreading on to manure (0, 6 and 12% of total daily feed intake). Diets and water were available *ad-libitum* throughout the experiment. The composition of the layer diets is given in Table 1.

Parameters collected from the manure were ammonia production, house fly larvae population, temperature, water content and total manure production and layer performances which include hen day production, feed consumption, feed conversion ratio, egg weight, length and weight of tibia. Ammonia was measured by placing an ammonia detector (Drager Pac III version 1.1) on the manure of each

Table 1. Composition and calculated analyses of layer diet

Ingredient (%)	Level of zeolite (%) 0	6	12
Zeolite	0.00	6.00	12.00
Commercial layer feed	100.00	85.00	70.00
Soybean meal	0.00	3.50	7.50
Fish meal	0.00	2.00	3.00
Oil palm	0.00	3.25	6.75
Mineral mix	0.00	0.25	0.75
Total	100.00	100.00	100.00
Calculated analyses			
Crude protein (%)	17.00	17.06	17.01
Calcium (%)	4.00	3.55	3.03
Phosphor (%)	0.60	0.63	0.55
Metabolizable energy (kcal/kg)	2800.00	2800.45	2805.85

Table 2. The effect of different levels of zeolite in the diets and spreading on to manure

Parameter in the diet	Level of zeolite		
	0%	6%	12%
Ammonia (ppm)	21.71 [b]	15.13 [a]	14.13 [a]
Larvae population (per 200g manure)	287 [b]	150 [a]	137 [a]
Manure water content (%)	62.31 [b]	54.44 [a]	50.31 [a]
Spreading	0%	6%	12%
Ammonia (ppm)	19.60 [b]	16.76 [ab]	14.50 [a]
Larvae population (per 200g manure)	262 [b]	180 [a]	142 [a]
Manure water content (%)	60.13 [b]	55.73 [ab]	51.25 [a]

[a,b]Mean within row with different superscripts are significant different ($P<.05$)

treatment,covered by a closed transparent box (37 x 32 x 22cm). Larva's population of house fly was determined using the technique described by Southwood (1978) and water content of manure using AOAC (1984). Both tibiae were removed from the layer with a body weight the same as average in their population for measuring length and weight of tibia. The data were analyzed statistically using the factorial design (Steel and Torrie, 1980) and Duncan's multiple range test was used to determine the significant differences within each parameter.

RESULTS AND DISCUSSION

The effect of different levels zeolite in the diets (ZD) and spreading on to manure (ZS) and their interactions on the ammonia production, larvae population and manure water content are presented in Tables 2, 3 and 4.

The levels of zeolite in the diets and spreading on to manure had significantly decrease ($P<.05$) the ammonia production, house fly larvae population and manure water content (Table 2). Decreasing of these parameters showed that zeolite has the capability to absorb gas (ammonia) and water from the manure, this increasing levels of zeolite in the diet and spreading on to manure resulted in more gas (ammonia) and water were absorbed from the manure, so making the manure more drier and unsuitable for fly breeding. This study is consistent with the stated of Mumpton and Fishman (1977) that zeolite could be used to extract ammonia

Table 3. The interaction effect of different levels of zeolite in the diets (ZD) and spreading on to manure (ZS)

Interaction ZD x ZS	Ammonia (ppm)	Larvae population (per 200g manure)	Manure water content (%)
0%ZDx0%ZS	26.40 [e]	452 [c]	70.57 [e]
0%ZDx6%ZS	23.00 [e]	233 [b]	60.53 [d]
0%ZDx12%ZS	18.40 [d]	178 [ab]	56.02 [cd]
6%ZDx0%ZS	16.80 [cd]	199 [ab]	56.63 [cd]
6%ZDx6%ZS	15.26 [bc]	157 [ab]	56.20 [cd]
6%ZDx12%ZS	13.33 [ab]	129 [a]	50.48 [ab]
12%ZDx0%ZS	15.60 [bcd]	141 [a]	53.20 [ab]
12%ZDx6%ZS	14.86 [abc]	150 [a]	50.48 [ab]
12%ZDx12%ZS	11.93 [a]	121 [a]	47.25 [a]

[a,b,c]Mean within column with different superscripts are significant different ($P<.05$)

Table 4. The effect of levels zeolite in the diets

Parameter	Levels of zeolite in the diets			Significant
	0%	6%	12%	
Hen day production (%)	78.21 [b]	78.79 [b]	76.36 [a]	s
Feed conversion ratio	2.10 [a]	2.09 [a]	2.20 [b]	s
Shell thickness (mm)	0.392 [a]	0.418 [b]	0.419 [b]	s
Feed consumption (g/hen/day)	97.53	98.58	98.65	ns
Egg weight (g)	58.75	59.06	58.76	ns
Shell weight (g)	5.63	6.76	5.80	ns
Tibia length (cm)	12.16	12.13	12.77	ns
Tibia weight (g)	7.96	7.75	8.00	ns

[a,b] Mean within column with different superscripts are significant different (P<.05)

(NH_4^+) by ion exchange and it is further characterized by an ability to lose and gain water reversibly and to exchange constituent cautions without major change in structure. Interaction of ZD and ZS has a significant effect (P<.05) on ammonia production and house fly larvae population in the manure (Table 3). Increasing both levels of ZD and ZS tend to decrease ammonia production, house fly larvae population and water content in the manure, because interactions of ZD and ZS will make the manure to contain more zeolite, resulting more ammonia and water content of manure to be absorbed by zeolite. This findings are in agreement with Mumpton and Fishman (1977), where it was reported that the surface area available for absorption ranges up to several hundred square meters per gram, and some zeolite are capable of adsorbing up to about 30% of gas, based on the dry weight of the zeolite.

The levels of zeolite in the diets had a significant effect (P<.05) on hen day production (HDP), feed conversion ratio (FCR) and shell thickness, but no significant effect on feed consumption, egg weight shell weight, length and weight of tibia (Table 3). Decreasing HDP and increasing FCR showed that 12% level of zeolite in the diet had a negative effect on layers, but this level can improve shell thickness. These results are similar to the findings of Nakaue and Koelliker (1981) that significant treatments effects were found in percent egg production, daily feed consumed per layer, feed conversion, and fecal moisture level, furthermore they also reported that layers fed rations containing 2.5 and 5% zeolite had significantly lower egg production, more feed and poorer feed conversion than control.

Olver (1989) noticed a significant dietary effects in favour of zeolite feeding in the number of eggs laid per hen, shell tickness, efficiency of feed utilization, dropping moisture content and mortality.

Roland and Dorr (1989) reported that the ion-exchange property of sodium zeolite A (SZA) may be responsible for the reported increase in egg shell specific gravity when SZA is fed to laying hens.

Although the addition of zeolite in the layer diets had no effect on egg weight, shell weight, length and weight of tibia, the level of zeolite in the diets must be necessary to consider especially the 12 % because indicated response than control in this experiment. As reported by Watkins and Southern (1992).that SZA had an effect on eggshell quality, egg production, growth performance, Ca absorption, femur medullary development, bone composition and strength, P utilization and incidence of tibial dyschondroplasia as also reported by Ingram *et al* (1989) that medullary bone development was greater in laying hens fed SZA compared with hens not receiving SZA.

REFERENCES

AOAC. 1984. *Official Methods of Analysis*, 14 ed. Association of Official Analysis of chemistry. Arlington.VA.

Hartung, J, and V.R. Phillips. 1994. Control of gases emissions from livestock building and manure stores. *J Agric.Engng Res.*, 57:173-189.

Huton, P., 1987. How ammonia can affect pullet and laying hens?. *Poultry International.* June. 1987.p.18-19.

Ingram, D., C.D. Aguillard, and S.M. Laurent. 1989. Bone development and breaking strength as influence by sodium zeolite-A. *Poultry Sci.*, 68 (Suppl 1):71 (Abstr).

Koerkamp, P.W.G.G. 1994. Review on emission of ammonia from housing systems for laying hens in relation to sources, processes, building design and manure handling. *J Agric. Engng.*, 59:73-78.

Koelliker, J.K., J.R. Miner., M.L Hellickson. and H.S. Nakaue., 1980. A zeolite packed air scrubber to improve poultry house environments. *Transactions of the ASAE.* 23(1):157-161.

Lysyk, T.J. and R.C. Axtell. 1986. Field evaluation of three method for monitoring populations of house flies (*Musca domestica*) (*Diptera : Muscidae*) and other filth flies in three types of poultry housing systems. *J Econ. Entomol.*, 79:144-151.

Middelkoop, K. 1995. Environmental aspect of intensive poultry production. *Would Poultry Sci J.*, 11:41-45.

Miner, J.R.1980. Controling odor from livestock production facilities: State-Of-The-Art. *Proceedings 4th International Symposium Livestock Waste-1980.* Published by American Society of Agricultural Engineers. Box 410. ST Joseph, Michigan 49085. Pp.:297-301.

Mumpton, F.A. and P. H. Fishman. 1977. The application of natural zeo-lites in animal science and aqua-culture. *J. Animal Science.*, 45:1188-1203.

Nakaue, H. S. and J .K. Koelliker. 1981. Studies with clinoptilolite in poultry. I. Effect of feeding varying levels of clinoptilolite (zeolite) to dwarf single com white leghorn pullets and ammonia production. *Poultry Sci.*, 60:944-949.

Oliver, M.D. 1980. Effect of feeding clinoptilolite (zeolite) to three strains of laying hens. *British Poultry Sci.*, 30:115-121.

Putz, R.1989. Flies are fast breeders. *Poultry International.* April 1989. Pp.:37-38.

Roland, D.A. and P .E. Dorr. 1989. Beneficial effect of synthetic sodium aluminosilicate on feed efficiency and performance of commercial Leghorn. *Poultry Sci.*, 68:1241-1245.

Seltzer, W., Moum. G.S. and T.M. Goldhaft. 1969. A method for the treatment of animal wastes to control ammonia and other odors. *Poultry Sci.*, 48: 1912-1918.

Southwood, T.R.E.1978. *Ecological Methods.* With Particular Reference to the Study of Insect Populations. London Chapman and Hall. A. Halsted Press Book. John Wiley & Sons, New York. Pp.:309.

Steel, R.C.D. and J.H. Torrie. 1980. Principles and Procedures of Statistics : *A Biometrical Aproach.* McGraw-Hill Book CO, Inc, New York. NY.

Watkins, K.V. and L.L Southern. 1992. Effect of dietary sodium zeolite A and graded levels of calcium and phosphorus on growth, plasma, and tibia characteristics of chicks. *Poultry Sci.*, 71:1048-1058.