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EFFECT OF LITTER TREATMENT ON BROILER PERFORMANCE AND LITTER QUALITY.

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SUMMARY

Six treatments were designed to study the effects of five compounds on litter quality and broiler performance as follows: 1- litter mixed with commercial alum at the rate of 0.5 kg/m^2.2-litter mixed with calcium superphosphate at the rate of 0.7 kg/ m^2. 3-litter mixed with both alum (0.25 kg/ m^2) and calcium superphosphate (0.4 kg/ m^2). 4- a layer of sand (5-cm thick) spread on the floor and covered with a 5-cm thick layer of litter. 5- Copper sulphate (4% solution) sprayed on the top of the litter at the rate of 170 ml/ m^2. 6- ordinary litter (control). Alum treatment resulted in efficient reduction of litter ammonia nitrogen followed by superphosphate and sand treatments. Both alum and, alum and superphosphate treatments lowered litter pH after application but, after 4 weeks litter pH increased above 7 for all treatments. All treatments had no significant effect on litter moisture although the litter moisture contents were generally lower than the control group. All treatments had no significant effect on litter microbial populations (total bacterial count, coliform count and fungus plate count). Alum treatment had a negative effect on broiler performance as evaluated by average body weight and feed conversion and this might be attributed to the toxicity of alum. Calcium superphosphate may provide a safe and efficient litter amendment.

INTRODUCTION

Ammonia in poultry houses has been recognised as a problem for many years. Ammonia volatilization from poultry litter results in a build up of atmospheric ammonia in chicken houses which is detrimental to the health of both laborers and birds. Research on the effects of ammonia on poultry has shown that ammonia causes: reduced feed efficiency and decreased growth rate (Charles and Payne, 1966 a, Quarles and Kling, 1974; Reece et al., 1980; Caveny et al., 1981), decreased egg production and egg quality (Charles and Payne, 1966 b, Deaton et al., 1984), damage to the respiratory tract (Anderson et al., 1964 and Nagaraja et al., 1983), increased susceptibility to Newcastle disease (Anderson et al., 1964 and Moum et al., 1969), increased levels of Mycoplasma gallisepticum (Sato et al., 1973), increased incidence of air sacculitis (Moum et al., 1969 and Quarles and Kling, 1974), immuno-suppression (Nagaraja et al., 1984) and keratoconjunctivitis (Bullis et al., 1950, Valentine, 1964 and Quarles and Caveny, 1979).

Attempts to reduce ammonia volatilization from poultry litter has been reported early by Cotterill and Winter (1953) who used commercial superphosphate to control ammonia in poultry houses. Since then several chemicals have been tested to determine their ability to control ammonia release from poultry litter. Carlile (1984), indicated that these chemicals act either by inhibiting microbial growth, thus slowing uric acid decomposition or by combining with the released ammonia to neutralize it. The later group of chemicals include: paraformaldehyde (Seltzer et al., 1969), zeolites (Mumpton and Fishman, 1977, NaKaue et al., 1981), superphosphate and phosphoric acid (Cotterill and Winter, 1953, Reece et al., 1979), phosphoric acid (Moore et al., 1996); ferrous sulphate (Huff et al., 1984, Moore et al., 1995, Moore et al., 1996); hydrated lime and limestone (Cotterill and Winter, 1953, Sobih and Dosoky, 1990, Moore et al., 1995), yucca saponin (Johnsten et al., 1982), acetic acid and propionic acid (Parkhurst et al., 1974, Sobih and Dosoky, 1990) and antibiotics (Kitai and Arakawa, 1979). Recently, alum has been demonstrated to be an effective poultry litter treatment to reduce ammonia volatilization and increase weight gains (Moore et al., 1995).

The objectives of this study were to evaluate the effects of some chemicals on ammonia volatilization from litter and their effect on other litter quality criteria and broiler performance.

MATERIAL AND METHODS

Three hundred day old chicks (Arbor Acres) were divided into six equal groups, 50 chicks each. The birds were floor reared in six pens (2.5 X 2 m each) in an open sided house at Animal and Poultry Management Research Center, Faculty of Veterinary Medicine, Cairo University.

The birds received a commercial broiler ration, 23% crude protein and 3100 Kcal. ME\kg until the 21st day of age then shifted to 22% crude protein and 3200 Kcal\kg. ME ration until marketing age.

The following vaccination programme was adopted using eye drop method: Hitchner B1 at 7 days, La Sota at 14 days and IBD BLEN at 15 days. While inactivated ND vaccine was injected at 17 days. From the beginning of the third week, birds were sprayed weekly using Hitchner B1 vaccine.

Six treatments were designed to study the effects of five compounds as follows:

1- Litter alone (10-cm thick layer of chopped wheat straw) without any added chemicals. This served as the control group.
2- Litter mixed with commercial alum at the rate of 0.5 kg/m^2.
3- Litter mixed with calcium superphosphate at the rate of 0.7 kg/m^2.
4- Litter mixed with both alum (0.25 kg/m^2) and calcium superphosphate (0.4 kg/m^2).
5- A layer of sand (5-cm thick) spread on the floor and covered with a 5-cm thick layer of litter.
6- Copper sulphate (4% solution) sprayed on the top of the litter at the rate of 170 ml/m^2. (Sobih and Dosoky , 1990).

II- Performance:

Average body weight was determined weekly by weighing a random sample of 10 birds from each group. The feed consumption was recorded weekly and feed conversion ratio was estimated.

III- Examination of Litter:

Composite samples from surface and deep litter were collected weekly in clean polyethylene bags and examined for determination of:

1- **pH:** This was done electrochemically in a 1/10 dilution in distilled water.

2- **Moisture content:** The moisture percent was calculated after drying a 100-g sample to a constant weight at 110°C (Parsons and Baker, 1985).

3- **Litter ammonia nitrogen:** 10 g of thoroughly mixed litter was soaked in 100 ml of distilled water and left in refrigerator for 1 hour. The sample was sieved and the resulting suspension was clarified by centrifugation and used for colorimetric determination of ammonia nitrogen using Ammonia test kit (0 - 1 g/L N), Jenway, Essex, England.

4- **Microbiological Examination:** By surface plating of 0.1ml of the appropriate dilutions of 1 gm sample on Standard plate count agar, MacConkey agar and Sabouraud dextrose agar.

RESULTS AND DISCUSSION:

Litter ammonia nitrogen contents for different treatments are shown in (Table 1) and (Fig. 1). For all treatments, litter ammonia nitrogen tended to increase as might be expected from increased deposition of wastes. Therefore, in the control group, litter ammonia nitrogen showed a characteristic rise during the 4th and 5th week of age (1.35 and 2.5 g/kg respectively). Copper sulphate treated litter showed a similar pattern (1.28 and 2.47 g/kg for the 4th and 5th weeks, respectively), indicating no significant effect on ammonia nitrogen reduction. Sobih and Dosoky (1990) reported a similar finding and concluded that copper sulphate was ineffective in controlling ammonia volatilization from litter after 21 days from application.

Superphosphate treatment considerably reduced litter ammonia nitrogen until the 4th week of age, however; during the 5th week, ammonia nitrogen was highly increased (1.98 g/kg). These findings disagree with Reece et al., (1978) who reported that superphosphate became ineffective after 17 days.

Table (1): Effect of litter treatment on litter ammonia nitrogen content.

Litter Ammonia nitrogen g/kg					
Treatment	Age (weeks)				
	1	2	3	4	5
Control	0.19	0.2	0.30	1.35	2.5
Alum	0.13	0.15	0.24	0.58	0.55
Superphosphate	0.1	0.12	0.17	0.36	1.98
Alum +Superphosphate.	0.15	0.16	0.17	0.62	1.72
Sand	0.15	0.17	0.2	0.57	0.74
Copper sulphate	0.19	0.19	0.25	1.28	2.47

Table (2): Effect of litter treatment on litter pH and litter moisture %.

Treatment	Age (weeks)									
	1		2		3		4		5	
	pH	Moisture %	pH	Moisture %	pH	Moisture %	pH	Moisture %	pH	Moisture %
Control	6.5	12.7	6.5	33	7	44.2	8.5	31.6	8	39.2
Alum	4.5	8	6.5	33.4	6.5	32	7.5	25.2	8	29.3
Superphosphate	6.5	13	6.5	18.1	6	20.1	7	31.1	8	27.2
Alum+Superphos.	5.5	10.4	6.5	23.7	7	28.5	7.5	22	8	25.5
Sand	6.5	16.2	6.5	29.8	6.8	25.1	8	22.5	8	32.5
Copper Sulphate	6.5	8.5	6.5	16.8	7	26.5	8	23.7	8	42.2

Table (3): Effect of litter treatment on litter bacterial counts.

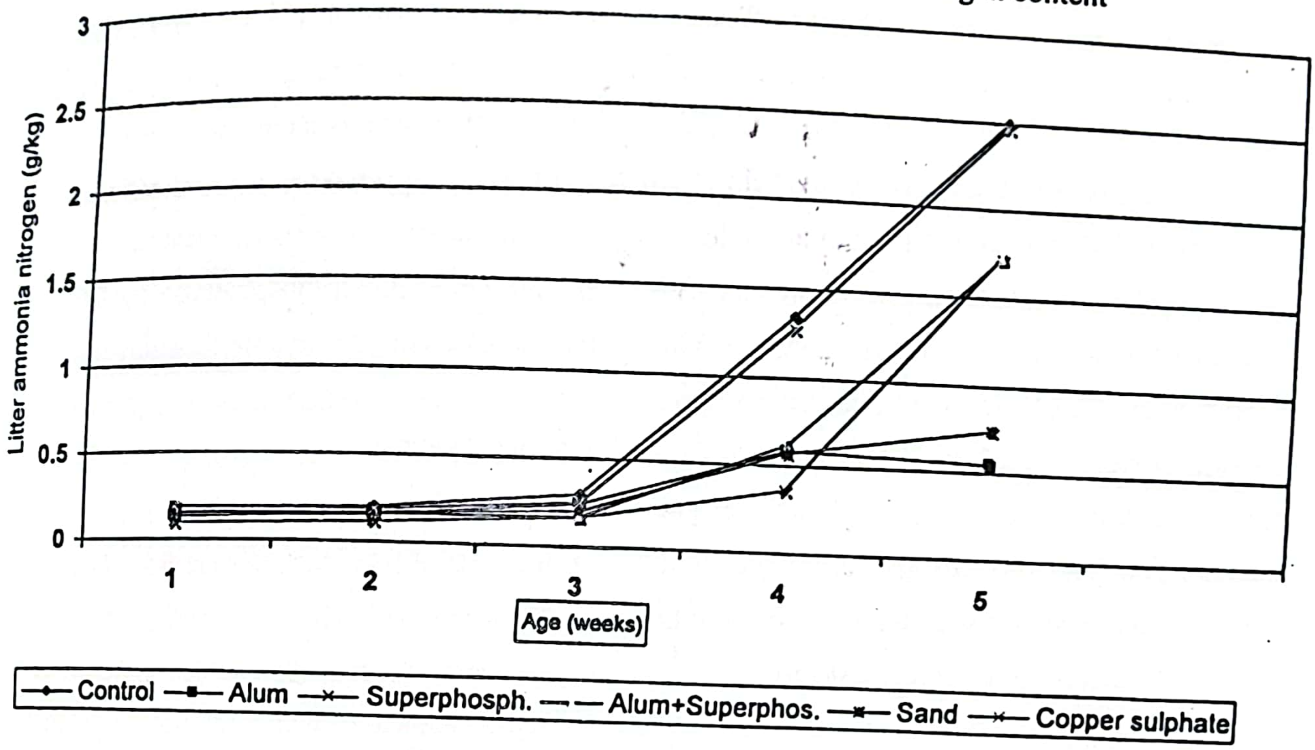
Treatment	Log bacterial counts/g dry litter														
	Age (weeks)														
	1			2			3			4			5		
	T.C.C[1].	F.P.C.[2]	C.C[3].	T.C.C.	F.P.C.[2]	C.C.	T.C.C[1].	F.P.C.[2]	C.C.	T.C.C[1].	F.P.C.[2]	C.C.	T.C.C[1].	F.P.C.[2]	C.C.
Control	6.2	5.88	6.35	7.96	8.08	6.4	7.48	7.16	6.48	7.32	6.66	6.02	7.69	7.07	6.89
Alum	6	5.1	5	7.6	6.93	5.7	7.27	6.83	5.42	7.24	7.1	5.69	7.6	6.68	6.56
Superphosphate	6.37	5.39	5.58	7.44	6.71	5.67	7.36	6.71	6.46	7.4	6.89	6.42	7.57	6.88	6.5
Alum+Superphos.	6.53	5.44	4.64	7.78	6.72	6.84	7.56	7.3	7.01	7.5	6.8	6.31	7.62	6.98	6.62
Sand	6.69	6.58	6.37	7.88	7.81	7.45	7.42	7	6.94	7.64	5.99	5.79	7.72	7.03	6.7
Copper Sulphate	5.9	5.62	5.62	7.92	6.8	7.37	7.36	6.55	6.73	7.57	7.26	6.64	7.77	7.03	6.81

Table (4): Effect of litter treatment on broiler performance.

Age (Weeks)	Treatment																	
	Control			Alum			Superphosphate			Alum+ Superphos.			Sand			Copper sulphate		
	Body weight (g)	Feed conversiton	Mortality*	Body weight (g)	Feed conversiton	Mortality*	Body weight (g)	Feed conversiton	Mortality*	Body weight (g)	Feed conversiton	Mortality*	Body weight (g)	Feed conversiton	Mortality*	Body weight (g)	Feed conversiton	Mortality*
1	130	1.54	0	110	1.3	1	120	1.5	1	100	1.8	1	110	1.8	1	120	1.6	3
2	330	2.1	0	365	1.8	0	350	2	1	350	1.8	1	370	1.8	0	390	2.5	1
3	600	2.4	0	690	2.2	0	744	2.1	0	720	2	0	680	2.2	0	698	2.3	0
4	1300	2.3	0	1073	2.7	0	1137	2.6	0	1158	2.5	0	1329	2.2	0	1321	2.3	0
5	1680	2.4	0	1540	2.8	0	1650	2.4	0	1640	2.5	0	1700	2.4	0	1690	2.4	0

* Number of dead birds in each group.

Fig. (1): Effect of litter treatment on litter ammonia nitrogen content



Regarding sand treatment, although there was a gradual rise in litter ammonia nitrogen content throughout the rearing period, sand was still effective in controlling ammonia when compared with either the control group or copper sulphate group. Throughout the first four weeks, the effect of sand on controlling litter ammonia nitrogen was only superseded by superphosphate.

The lowest litter ammonia nitrogen content was observed in the alum treated litter (0.58 and 0.55 g/kg during the 4th and 5th weeks, respectively). This effect of alum has been reported also by Moore et al., (1995) and Moore et al., (1996). When the litter was treated with a mixture of alum and superphosphate, litter ammonia nitrogen content was under control until the 4th week (0.62 g/kg) and increased afterwards (1.72 g/kg in the 5th week).

The maintenance of litter pH below 7 is an important aspect of ammonia control, because ammonia release increases above pH 7 and is highest at pH 8 (Reece et al., 1979). At application, both alum and alum and superphosphate treatments reduced pH to 4.5 and 5.5 respectively (Table 2). However, after 4 weeks all treatments were above pH 7 and reached pH 8 by the 5th week.

Litter moisture is an important litter quality parameter. After brooding, litter moisture (Table 2), tended to increase from the initial values due to increased deposition of wastes and respiration of birds. Litter moisture contents for all treatments showed a great variation and were generally lower than the control group.

Another means by which ammonia production can be controlled is by altering the microbial populations of the litter. These treatments had no effects on either bacterial or fungal counts (Table 3). Huff et al., (1984), reported that though bacterial counts were not affected by chemical litter amendment (mixture of ferrous sulphate, magnesium and copper sulphate and propionic acid), mould counts increased with the fungi present being less filamentous and more yeast forms.

Broiler performance as judged by body weight, feed conversion and mortality is shown in (Table 4). The highest average body weight and the lowest feed conversion were observed in both sand and copper sulphate treated groups. Alum treated group showed the lowest final body weight (1540 g) and the highest feed conversion (2.8). We suspect a toxic effect of alum to broiler chickens. The toxicity of alum is attributed to the presence of high levels of aluminum, which decreases phosphorus availability of the diet to the chicks and results in decreased growth rate, increased feed conversion and affected bone formation (Huff et al., 1995).

Conclusively, although alum treatment resulted in a better ammonia control, it had a negative effect on broiler performance. Sand treatment resulted in an acceptable ammonia control in litter combined with better performance. Superphosphate treatment can provide a safe and efficient alternative to alum. However, we recommend reapplication of superphosphate on broiler litter after 4 weeks from its first application.

REFERENCES

Anderson, D. P., Beard, C. W. and Hanson, R.P. (1964): The adverse effects of ammonia on chickens including resistance to infection with Newcastle disease virus. Avian Research. 8: 369.

Bullis, K. L., Snoeyenbos, G. H. and Van Roekel (1950): A keratoconjunctivitis in chickens. Poultry Science. 29: 386 - 399.

Carlile, F. S. (1984): Ammonia in poultry houses: A literature review. World' s Poult. Sci. J. 40: 99 -113.

Caveny, D. D., Quarles, C. L. and Greathouse, G. A. (1981): Atmospheric ammonia and broiler cockerel performance. Poultry Science. 60: 513.

Charles, D. R. and Payne, C. G. (1966 a): The influence of graded levels of atmospheric ammonia on chickens. I- The effect on respiration and on the performance of broilers and replacement stock. Brit. Poultry Sci. 7: 177 - 187.

Charles, D. R. and Payne, C. G. (1996 b): The influence of graded levels of atmospheric ammonia on chickens. 2- Effects on the performance of laying hens. Brit. Poultry Sci., 7: 189.

otterill, O. J. and Winter, A. R. (1953): Some nitrogen studies on built-up litter. Poultry Science. 32: 365 - 366.

caton, J. W., Reece, F. N., and Lott, B. D. (1984): Effect of atmospheric ammonia on pullets at point of lay. Poultry Science. 63: 365 - 366.

uff, W. E., Malone, G. W., and Chaloupka, G. W. (1984): Effect of litter treatment on broiler performance and certain litter quality parameters. Poultry Science. 63: 2167 - 2171.

uff, W. E., Moore, Jr. P. A., Balog, J. M., Bayyari, G. R. and Rath, N. C. (1995): Evaluation of the toxicity of alum (aluminum sulfate) in young broiler chickens. ARS Report Number: 0000066133, USDA/ ARS Poultry Prod. RE, Univ ARK, POSC O-303, Fayetteville.

hnston, N. L., Quarles, C. L. and Fagerberg, D. J. (1982): Broiler performance with DSS 40 yucca saponin in combination with Monensin. Poultry Science. 61: 1052.

itai, K. and Arakawa, A. (1979): Effect of antibiotics and caprylohydrozamic acid on ammonia gas from chicken excreta. Br. Poult. Sci. 20: 55.

loore, P. A. Jr., Daniel, T. C., Edwards, D. R. and Miller, D. M. (1995): Effect of chemical amendments on ammonia volatilization from poultry litter. Journal of Environmental quality, 24 (2): 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.

Moum, S. G., Seltzer, W. and Goldhaft, T. M. (1969): A simple method of determination of ammonia in animal quarters. Poultry Science. 48: 347.

Mumpton, F. A. and Fishman, P. H. (1977): The application of natural zeolites in animal science and aquaculture. Journal of Animal Science. 45: 1188.

Nagaraja, K. V., Emery, D. A., Jordan, K. A., Sivanandan, V., Newman, J. A. and Pomery, B. S. (1983): Scanning electron microscopic studies of adverse effects of ammonia on tracheal tissues of turkeys. Am. J. Vet. Res. 44: 1530 - 1536.

Nagaraja, K. V., Emery, D. A., Jordan, K. A., Sivanandan, V., Newman, J. A. and Pomery, B. S. (1984): Effect of ammonia on the quantitative clearance of Escherichia coli from lungs, air sacs, and livers of turkeys aerosol vaccinated against Escherichia coli. Am. J. Vet. Res. 45: 392 - 395.

Nakaue, H. S., Koelliker, J. K. and Pierson, M. L. (1981): Studies with clinoptilolite in poultry. 2- Effect of feeding broilers and the direct application of clinoptilolite (zeolite) on clean and re-used broiler litter on broiler performance and house environment. Poultry Science. 60: 1221.

Parkhurst, C. R., Hamilton, P. B., and Baughman, G. R. (1974): The use of volatile fatty acids for the control of microorganisms in pine sawdust litter. Poultry Science. 53: 801.

Parsons, A. H. and Baker, S. L. (1985): Softwood chipping fines: efficacy as poultry litter. Poult. Sci., 64: 2292 - 2295.

Quarles, C. L. and Caveny, D. D. (1979): Effect of air contaminants on performance and quality of broilers. Poultry Science. 58: 543.

Quarles, C. L. and Kling, H. F. (1974): Evaluation of a monia and infectious bronchitis vaccination stress on broiler performance and carcass quality. Poultry Science 53: 1592 - 1596.

Reece, F. N., Bates, B. J. and Lott, B. D. (1979): Ammonia control in broiler houses. Poultry Science. 58: 754 - 755.

Reece, F. N.; Lott, B. D., and Deaton, J. W. (1980): Ammonia in the atmosphere during brooding affects performance of broiler chickens. Poultry Science. 59: 486 - 488.

Sato, S., Shaya, S. and Kobayashi, H. (1973): Effect of ammonia on Mycoplasma gallisepticum infection in chicks. Natl. Inst. Anim. Health Q., Tokyo. 13: 45 - 53.

Seltzer, W., Moum, S. G. and Goldhaft, T. M. (1969): A method for the treatment of animal wastes to control ammonia and other odours. Poultry Science. 48: 1912.

Sobih, M. A. and Dosoky, R. (1990): Field trials to reduce ammonia content of air in broiler houses. Assiut Vet. Med. J. 24 (47): 159 - 163.

Valentine, H. (1964): A study of the effect of different ventilation rates on the ammonia concentrations in the atmosphere of broiler houses. Br. Poult. Sci. 5: 149