

The Effects of Alum Application to Different Bedding Materials on Litter Characteristics

Mehmet Fatih Celen and Emine Alkis

Department of Animal Science, Faculty of Agriculture, Yuzuncu Yil University, 65080 Van, Turkey

Abstract: The effects of alum ($\text{Al}_2(\text{SO}_4)_3 \cdot 14\text{H}_2\text{O}$) amendment to different bedding materials (straw and sawdust) on litter properties was evaluated. The research was carried out in 2 parts of poultry house as control and treatment groups. Each part have 4 environmentally controlled chambers. The study was conducted for 6 weeks. Litter samples collected from poultry house at the end of study. Litter pH for the alum treated litters is lower than the control litters. The sawdust and the alum treated-sawdust litter increased content of dry matter relative to straw and the alum treated-straw litters. The alum treated-sawdust litter was higher N contents than the sawdust litter. The P contents of the alum treated sawdust was higher than the other groups. Mean total Ca, Mg and K concentrations in the straw litter were significantly affected by the alum amendment. We also, found lower total Fe and Mn concentrations in the alum treated-straw litters than in the straw litters and there were no statistical differences in total Fe and Mn between the sawdust and the alum treated sawdust. There were no statistical differences in total Zn and Cu among the litter groups. Mean total Zn and Cu concentrations in the litter were not significantly affected by the alum amendments or bedding materials. Dry matter content, pH and ammonia concentration can affect ammonia emission in poultry house.

Key words: Alum, litter, properties, straw, sawdust, ammonia

INTRODUCTION

There are issues of special concern to environment in poultry production. These environmental concerns include manure and mortality disposal relate to contamination of water resources by nitrogen, phosphorus, pathogenic microorganisms and organic matter, the contamination of soil by heavy metals and high levels of atmospheric NH_3 in poultry houses associated with ammonia volatilization (Edwards and Daniel, 1992; Hatfield and Stewart, 1998; Rechcigl and MacKinnon, 1997).

Atmospheric NH_3 pollution plays an important role in acid rain (Ap Simon *et al.*, 1987). The environmental concerns related to animal production operations and the land application of animal manures is the necessity for improved P management. Pastures fertilized of poultry litter cause high levels of phosphorus in runoff water. Water-soluble P concentrations caused to eutrophication (the over abundance of nutrients in surface waters). Most of runoff P is soluble phosphorus (85%) (Edwards and Daniel, 1993).

Possible alternative practices are introduced that, when implemented, reduce the impact of poultry production on the environment. Both ammonia volatilization and phosphorus runoff from poultry litter can be greatly reduced with the addition of chemical

amendments (Moore and Miller, 1994; Moore *et al.*, 1995, 2000; Shreve *et al.*, 1995; Do *et al.*, 2005). Alum (aluminum sulfate $\text{Al}_2(\text{SO}_4)_3$) as an amendment for poultry litter has been commonly used in poultry production.

There has been several investigation on the use of alum as amendment of poultry litters and its advantages: alum reduces P solubility by as much as 99 (%), alum inhibits NH_3 volatilization from litter in poultry house, increased weight gains and improved feed conversion and these improvements in poultry performances make this one of the few cost-effective management practices that reduces pollution and increases productivity, higher litter N and S concentrations and thus, increased fertilizer value and reductions in runoff of dissolved carbon, trace metals and growth hormones when litter is used as a fertilizer (Moore *et al.*, 1995, 1996, 1998, 1999, 2000; Nichols *et al.*, 1997; Shreve *et al.*, 1995).

Litter is very important broiler performance because it affects the profits of growers and integrators. Many products have been used as bedding materials. Sawdust is currently the most popular bedding materials. Regionally, straw can be favoured by poultry producers for litter when sawdust and pine shavings are becoming scarce.

The objective of this study, were to compare the effects of alum application to different bedding materials on litter properties.

MATERIALS AND METHODS

The study was carried out at the Animal Science Department Poultry Research Unit of the Yuzuncu Yil University. The poultry house was divided into 2 parts as control and treatment groups. Each part was separated by floor to ceiling partitions and had separate air exhaust/heating systems. In this study, 645 day old Ross 308 broiler chicks obtained from a commercial hatchery were randomly divided into 4 litter group (straw, sawdust, Alum treated-straw and Alum treated-sawdust).

All treatments were assigned 8 pens. Litter material was placed on the floor and spread to depth of 8-10 cm. Alum was added to the straw and sawdust litter at 0.091 kg/bird (Miles *et al.*, 2003). At the end of rearing subsamples of litter were collected from 5 locations in each pen and placed in one common container for mixing prior to pH and dry matter (%) analysis. Litter pH was determined with a 1: 5 L to deionized water ratio. Dry matter was determined and total N was analyzed by Kjeldahl method (AOAC, 1990). Total P was determined spectrophotometric method and total K%, Ca%, Mg%, Fe, Mn, Zn and Cu values were determined by atomic absorption devices according to Kacar (1984), respectively.

RESULTS AND DISCUSSION

Properties of the litter samples at the end of the project were shown in Table 1.

Alum amendment resulted in amore acidic litter. The results of our study were consistent with those reported in the past investigation (Sims and Luka-McCafferty, 2002). Also, the pH in the litter with the sawdust litter was significantly lower than with the straw litter. As pH increases, the ratio of NH_3/NH_4 increases. This increases cause higher ammonia volatilization and vice versa

(Moore *et al.*, 1995). pH, moisture content, wind speed, ammonia concentration and temperature affects ammonia volatilization in poultry house (Reece *et al.*, 1979).

The dry matter content of the sawdust and the alum treated-sawdust litter were higher than the straw and the alum treated-straw litters. Ward *et al.* (2001) reported that wheat straw has lower water holding capacity than wood shavings. The dry matter contents of the sawdust litters amended with alum was slightly higher than the sawdust in our study. Sims and Luka-McCafferty (2002) determined that alum treatment slightly reduced litter moisture. Litter moisture content was chiefly associated with reduction ammonia emissions (Elliott and Collins, 1982).

The N concentrations were significantly higher in the alum treated-sawdust vs. the sawdust and slightly higher in the Alum treated-straw vs. the straw. The litter treated with the Alum treatment also reduced nitrogen loss in the litter. Past investigations reported that the alum-treated litter had a slightly higher N content vs untreated litter (Moore and Edward, 2005) and alum-treated litter to have a higher N content than normal litter (Moore *et al.*, 1995). Higher N in the alum-treated litter causes to reduce ammonia volatilization and increases the fertilizer N value of the litter (Moore *et al.*, 1999).

The P contents of the alum treated sawdust was higher than the other groups. We also, observed decreases in total Ca, Mg and K due to alum amendment in straw litter and there were no statistical differences in total Ca, Mg and K between the sawdust and the alum treated sawdust.

We also, found lower total Fe and Mn concentrations in the alum treated-straw litters than in the straw litters and there were no statistical differences in total Fe and Mn between the sawdust and the alum treated sawdust. There were no statistical differences in total Zn and Cu among the litter groups.

Table 1: Effect of alum applications on poultry litter properties

Parameters	Straw $\bar{x} \pm \text{SD}$	Alum treated-straw $\bar{x} \pm \text{SD}$	Sawdust $\bar{x} \pm \text{SD}$	Alum treated-sawdust $\bar{x} \pm \text{SD}$
pH	8.85±0.46 ^a	8.46±0.53 ^b	8.01±0.23 ^c	7.62±0.57 ^d
Dry matter (%)	64.85±2.78 ^b	62.32±0.99 ^b	73.22±0.90 ^a	74.41±1.57 ^a
N (%)	4.10±0.07 ^{ab}	4.35±0.13 ^a	3.69±0.03 ^c	3.99±0.02 ^b
P (%)	3.00±0.15 ^b	3.08±0.22 ^b	3.27±0.08 ^b	4.38±0.57 ^a
Ca (%)	5.66±0.68 ^b	8.06±0.23 ^a	7.20±0.51 ^{ab}	7.30±0.87 ^{ab}
Mg (%)	0.89±0.08 ^b	1.15±0.04 ^a	1.09±0.01 ^a	0.99±0.07 ^{ab}
K (%)	3.22±0.22 ^b	4.02±0.11 ^a	3.44±0.27 ^{ab}	3.18±0.26 ^b
Fe (ppm)	594.50±58.91 ^b	869.31±33.23 ^a	799.18±55.88 ^{ab}	865.56±103.78 ^a
Mn (ppm)	433.98±45.10 ^b	565.39±27.35 ^a	532.42±30.38 ^{ab}	482.36±22.34 ^{ab}
Zn (ppm)	603.71±104.46 ^a	641.13±52.61 ^a	739.22±61.18 ^a	719.94±43.30 ^a
Cu (ppm)	61.33±8.32 ^a	74.68±2.87 ^a	105.79±13.02 ^a	72.29±21.96 ^a

Means followed by the same letter within litter treatment are not significantly different $p < 0.05$

CONCLUSION

Alum applications to litter had a higher total N concentration at the end of the study than the untreated litter. Poultry litter amendments increased the value of poultry litter as a fertilizer source.

Alum is applied to poultry litter reduced the litter pH. The lower litter pH values and higher N concentrations in alum-treated litters could reduce ammonia volatilization in the litter.

Ammonia volatilization can be influenced by the choice of bedding material and the application of alum. Sawdust litter appears to be a better choice than straw litter.

Alum inhibits ammonia emissions from poultry litter. Lower concentrations of ammonia in poultry house cause a healthier environment for poultry and workers.

ACKNOWLEDGEMENT

This study was financed by the Scientific Research Funding Centre of Yuzuncu Yil University.

REFERENCES

- AOAC, 1990. Official methods of Analysis. Association of Official Analytical Chemists. 15th Edn. Washington DC.
- Ap Simon, H.M., M. Kruse and J.N.B. Bell, 1987. Ammonia emissions and their role in acid deposition. *Atmos. Environ.*, 21: 1939-1946. DOI: 10.1016/0004-6981(87)90154-5.
- Do, J.C., I.H. Choi and K.H. Nahm, 2005. Effects of chemically amended litter on broiler performances, atmospheric ammonia concentration and phosphorus solubility in litter. *Poult. Sci.*, 84: 679-686. <http://ps.fass.org/cgi/reprint/84/5/679.pdf>.
- Edwards, D.R. and T.C. Daniel, 1993. Effects of poultry litter application rate and rainfall intensity on quality of runoff from fescue plots. *J. Environ. Qual.*, 22: 361-365. <http://jeq.scijournals.org/cgi/reprint/22/2/361.pdf>.
- Edwards, D.R. and T.C. Daniel, 1992. Environmental impacts of on-farm poultry waste disposal: A review. *Bioresour. Technol.*, 41: 9-33. DOI: 10.1016/0960-8524(92)90094-E.
- Elliott, H.A. and N.E. Collins, 1982. Factors affecting ammonia release in broiler litter. *Am. Soc. Agric. Eng.*, 25: 413-418, 424.
- Hatfield, J.L. and B.A. Stewart, 1998. Animal waste utilization: Effective use of manure as a soil resource. Ann. Arbor Press, Chelsea, Michigan. Sleeping Baer Press, United States of America, United States MI.
- Kacar, B., 1984. Practice Guide of Plant Nutrition. Ankara University, Publications of Agricultural Faculty No. 900 Practice Guides No. 214, Ankara (in Turkish).
- Miles, D.M., P.A. Moore, D.R. Smith, D.W. Rice, H.L. Stilborn, D.R. Rowe, B.D. Lott, S.L. Branton and J.D. Simmons, 2003. Total and water-soluble phosphorus in broiler litter over 3 flocks with alum litter treatment and dietary inclusion of high available phosphorus corn and phytase supplementation. *Poult. Sci.*, 82: 1544-1549. <http://ps.fass.org/cgi/reprint/82/10/1544.pdf>.
- Moore, P.A. Jr. and D.R. Edwards, 2005. Long-term effects of poultry litter, alum-treated litter and ammonium nitrate on aluminum availability in soils. *J. Environ. Qual.*, 34: 2104-2111. DOI: 10.2134/jeq2004.0472.
- Moore, P.A., Jr. and D.M. Miller, 1994. Decreasing phosphorus solubility in poultry litter with aluminum, calcium and iron amendments. *J. Environ. Qual.*, 23: 325-330. <http://jeq.scijournals.org/cgi/reprint/23/2/325.pdf>.
- Moore, P.A., Jr., T.C. Daniel and D.R. Edwards, 2000. Reducing phosphorus runoff and inhibiting ammonia loss from poultry manure with aluminum sulfate. *J. Environ. Qual.*, 29: 37-49. <http://jeq.scijournals.org/cgi/reprint/29/1/37.pdf>.
- Moore, P.A. Jr., T.C. Daniel, D.R. Edwards and D.M. Miller, 1995. Effect of chemical amendments on ammonia volatilization from poultry litter. *J. Environ. Qual.*, 24: 293-300. <http://jeq.scijournals.org/cgi/reprint/24/2/293.pdf>.
- Moore, P.A. Jr., T.C. Daniel, D.R. Edwards and D.M. Miller, 1996. Evaluation of chemical amendments to reduce ammonia volatilization from poultry litter. *Poult. Sci.*, 75: 315-320. <http://www.poultscience.org/ps/abs/Mar96ab315.html>.
- Moore, P.A. Jr., T.C. Daniel, J.T. Gilmour, B.R. Shreve, D.R. Edwards and B.H. Wood, 1998. Decreasing metal runoff from poultry litter with aluminum sulfate. *J. Environ. Qual.*, 27: 92-99. <http://jeq.scijournals.org/cgi/reprint/27/1/92.pdf>.
- Moore, P.A. Jr., T.C. Daniel and D.R. Edwards, 1999. Reducing phosphorus runoff and improving poultry production with alum. *Poult. Sci.*, 78: 692-698. <http://ps.fass.org/cgi/reprint/78/5/692.pdf>.
- Nichols, D.J., T.C. Daniel, P.A. Moore, D.R. Edwards and D.H. Pote, 1997. Runoff of estrogen hormone 17-Estradiol from poultry litter applied to pasture. *J. Environ. Qual.*, 26: 1002-1006. <http://jeq.scijournals.org/cgi/reprint/26/4/1002.pdf>.

- Rechcigl, J.E. and H.C. MacKinnon, 1997. Agricultural Uses of Byproducts and Wastes. In: Jack, E.M. Rechcigl and Herbert C. MacKinnon (Eds.). ACS Symp. Series 668. American Chemical Society, Washington, DC. ISBN: 0841235147. http://lib3.dss.go.th/fulltext/c_book/630-649/631.8AGI.pdf.
- Reece, F.N., B.J. Bates and B.D. Lott, 1979. Ammonia control in broiler houses. *Poult. Sci.*, 58: 754-760.
- Shreve, B.R., P.A. Moore Jr., T.C. Daniel and D.R. Edwards, 1995. Reduction of phosphorus in run-off from field-applied poultry litter using chemical amendment. *J. Environ. Qual.*, 24: 106-111. <http://jeq.scijournals.org/cgi/reprint/24/1/106.pdf>.
- Sims, J.T. and N.J. Luka-McCafferty, 2002. On-farm evaluation of aluminum sulfate (alum) as a poultry litter amendment: Effects on litter properties. *J. Environ. Qual.*, 31: 2066-2073. <http://jeq.scijournals.org/cgi/reprint/31/6/2066.pdf>.
- Ward, P.L., J.E. Wohlt and S.E. Katz, 2001. Chemical, physical and environmental properties of pelleted newspaper compared to wheat straw and wood shavings as bedding for horses. *J. Anim. Sci.*, 79:1359-1369.<http://jas.fass.org/cgi/reprint/79/6/1359.pdf>.