Reducing the Ammonia Volatilization from Poultry Droppings by Temporary Immobilization and Drying

M. Prasanthrajan and P. Doraisamy

Abstract— In poultry droppings, a large proportion of nitrogen is present in the form of uric acid and urea. The uric acid and urea are rapidly hydrolyzed to NH_3 and CO_2 by urease and uricase. Approximately 45 - 50% of total nitrogen and 60 to 70% of NH_4- N will be volatilized as ammonia within 7 to 10 days after dropping. The moisture content plays an important role in the process of ammonia volatilization. Drying had much pronounced effect on the N content of the droppings, because most of the N loss occurred from urinary compounds such as urea and uric acid. From the present study, it was observed that the ammonia loss was high in air drying than that of oven drying of poultry droppings. Keeping the poultry droppings under dry condition for the initial 3-4 days would reduce the ammonia loss considerably. Keeping the poultry droppings under dry condition throughout layer operation by mixing poultry droppings with locally available carbonaceous wastes would keep the poultry in-house under ammonia free condition. Among the carbonaceous wastes tested, coir pith, sawdust and paddy straw were found to be efficient in reducing the ammonia loss by 31 to 48%.

Keywords—Poultry droppings, Ammonia volatilization, Carbonaceous wastes, Nitrogen conservation

I. INTRODUCTION

MANY poultry farmers are looking for solutions to reduce ammonia and fly problems caused by their layer operation. Few are looking for options to make money from the litter by selling it as manure. Poultry litter can be a nuisance, especially when it is not treated well and leave it wet on a pit or outside poultry house. It releases high levels of ammonia causing poor environmental conditions for the birds and the workers inside the house as well as for the neighbours. Flies like wet litter and find it a perfect place to multiply, which in turn is not that much appreciated by farm workers and people living next door. It is for these reasons that there is an increasing interest by medium and large scale poultry producers to dry poultry droppings in as well as outside the poultry house.

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Most poultry housing systems contain a possibility to dry the droppings at the manure belt inside the house. These systems however have limited capacity and may create a lot of dust. It is therefore that some poultry farmers prefer to dry the manure outside the house. In general the poultry birds are kept in the cage for about 180 days. During this time the bird droppings are being collected in the manure collection pit. In poultry manure a large proportion of nitrogen is present in the form of uric acid and urea. The uric acid and urea are rapidly hydrolyzed to ammonia and carbon dioxide by the enzymes urease and uricase and more than 60% of ammonia can be subsequently lost through volatilization. Not only does the loss of ammonia reduce the nutrient value of the manure, but levels of ammonia exceeding 25 ppm in the poultry shed may lead to various respiratory and other problems which would affect the bird's growth.

The nitrogen in the poultry manure can be conserved either by inhibiting the hydrolysis of uric acid to ammonia or by reducing the ammonia volatilization. Some of the chemicals like formaldehyde and yucca saponin were also found to reduce uric acid hydrolysis but the usage of chemicals may affect the nitrification process and render the poultry manure unsuitable for composting. Mixing poultry manure with locally available carbon rich waste materials would reduce the ammonia loss by temporary immobilization of NH_4 ions and keeping the droppings under dry condition. Rice husk and saw dust are the most commonly used litter material for raising poultry birds. However, due to diversified industrial uses of these materials, its availability is shrinking. Besides, cost of these litter materials is also increasing day by day. Sawdust and coir pith are rich in carbon and generated in large quantities. These wastes are available near our door step or farm land, with high C/N ratio and low moisture, are capable of decreasing the NH_3 loss from poultry droppings [1]. Advanced technologies are not needed for most of the layer and broiler poultry farms, simple and efficient management systems can significantly reduce ammonia loss and odour emissions. Taking into consideration, the present investigation was undertaken.

II. Materials And Methods

The poultry droppings were collected from Tamil Nadu Agricultural University (TNAU) poultry farm, Coimbatore, Tamil Nadu, India for the experimental purposes. Fresh poultry droppings were collected from caged system at TNAU poultry farm by scrapping the top layer of recently deposited droppings. The collected samples were immediately transferred to polythene containers and sealed tightly to avoid moisture loss. Later, these samples were used for the analyses of various biochemical parameters by following the standard methods. Micro changes in pH and moisture of the fresh poultry droppings were analyzed at different time periods during shade and oven drying. The locally available different carbonaceous waste materials *viz.*, saw dust, coir pith, paddy straw, paper waste and leaf litter (*Peltoforum ferrugenum*) were collected, air dried, powdered and sieved through 2 mm sieve for further chemical analysis. Various biochemical parameters were analyzed by following standard analytical methods. Fresh poultry droppings were collected from caged system and mixed with different carbonaceous waste material. A known quantity of 250 g mixture of poultry droppings and carbonaceous wastes were taken in glass beakers (T_1 to T_5). A control with 250 g poultry droppings (T_1) was maintained for comparison. Treatments were replicated thrice. The C/N ratio of the different mix was adjusted to 25 - 30: 1 which is considered to be an ideal C/N ratio for composting, by mixing the poultry droppings with carbon source in different quantities and incubated for about 60 days at room temperature.

III. Results And Discussion

Micro changes in pH and moisture of the fresh poultry droppings were analyzed at different time periods during shade and oven drying (TABLE I). The pH of the fresh droppings was 6.49 on the first hour of shade drying and it reached a maximum of 8.17 on 78th hour and remained same till 80th hour and started to decline thereafter (TABLE II). The initial increase of pH in the manure is due to the loss of uric acid in the form of ammonia and hydrolysis of uric acid. As soon as the ammonia emission is reduced, the pH started to decline. Also production of organic acid during the decomposition of manure may be one of the reasons for reduction in pH. During the initial period the pH value increased at increasing rate and then the rate of increase was slow followed by declining rate. It clearly indicates that the NH3 loss from poultry droppings was high during the initial hours (up to 80 hours) of drying which needs attention. Also the changes in moisture content of fresh droppings showed a decreasing trend. Around 50% of the moisture in the droppings is reduced within 168 hours. It is also evident that the dried samples had high pH resulting in increased volatilization of NH4-N. The moisture content plays an important role in the process of ammonia volatilization. Drying had much pronounced effect on the N content of the droppings, because most of the N loss occurred from urinary compounds such as urea and uric acid. It was observed that the N loss was high in air drying than that of oven drying of poultry droppings. From this study we found that keeping the poultry manure under dry condition from the initial 3-4 days would reduce the ammonia loss. Mixing the poultry droppings with dry carbonaceous wastes would be an ideal option to keep the poultry droppings under dry condition.

The C/N ratios of the different mix were adjusted between 25 to 30:1 and the low C/N ratio in poultry droppings is due to high nitrogen content. Periodical samples were drawn from the incubated mixes and the processed samples were analyzed for various parameters *viz*., pH, EC, organic carbon, total N, NH4-N, NO3-N, total P, total K, NH3 and CO2. Initial loss in the total nitrogen content of fresh droppings was recorded which was due to the loss of nitrogen in the form of ammonia. The coir pith, saw dust and paddy straw mixed poultry droppings recorded higher total nitrogen content. During the process of decomposition, the C/N ratio of the poultry droppings increased due to the loss of nitrogen through ammonia volatilization. The C/N ratio increase in the poultry droppings continued up to 30th day which confirmed that the loss in nitrogen continued up to 30th day. The C/N ratio of the poultry droppings started to decline after 30 days, indicating the process of decomposition and no more loss of nitrogen in the form of ammonia occurs. Poultry droppings mixed with carbonaceous waste material recorded decreasing trend in C/N ratio. It is mainly due to the reduction in carbon and increase of total nitrogen content in the mix. The rate of organic matter decomposition during composting is principally dependent upon the C/N ratio of the materials. Ammonia volatilization from the decomposing manure increased linearly with time. The NH3 loss was greater from untreated poultry droppings than the treated one (TABLE III). The highest amount of NH3 volatilization was recorded in poultry droppings alone (349 mg 100 kg^{-1}). The sawdust and coir pith added poultry droppings mix greatly reduced the ammonia loss. Amongst the carbonaceous materials examined, coir pith, sawdust and paddy straw were found to be superior in reducing the ammonia loss by 40.1%, 45.3% and 38.96% respectively followed by leaf litter (30.7%) and paper waste (19.5%). In an earlier study it was reported that wheat straw was found to be superior in reducing the NH3 loss by 33.5% followed by Sphagnum peat (25.8%), wood chips (20.6%) and paper waste (13.6%) [2]. The reduction in nitrogen loss was mainly due to the immobilization of $NH4^+$ ions by the carbonaceous materials. The partially decomposed nature of the sawdust and coir pith may be one of the reasons for their efficiency in reducing the loss of $NH3^-$ whereas the high levels of N-free lignin and low levels of soluble carbohydrates contents of paper waste resulted in only small reduction in NH3 loss from the poultry droppings. Volatilization of NH3 is mainly a pH dependent phenomenon and therefore it is also possible to reduce the volatilization of NH_3 by increasing the acidity of the poultry droppings compost. Since all the carbonaceous waste materials are acidic in nature, it could have contributed to the reduction of NH_3 from the droppings.

TABLE I
EFFECT OF OVEN DRYING OF FRESH POULTRY DROPPINGS ON MOISTURE CONTENT AND PH

Hour	Moisture content (%)	pH
1	75	6.51
2	64	7.05
3	52	8.01
4	46	7.86
5	39	7.43
6	24	7.28

Values are the means of four observations.

TABLE II
EFFECT OF SHADE DRYING OF FRESH POULTRY DROPPINGS ON MOISTURE CONTENT AND PH

Day	Hour	Moisture content (%)	pH
	1	78	6.45
1	12	71	6.73
	24	65	7.09
	36	61	7.52
2	48	58	8.18
	60	54	8.23
	72	52	8.06
3	84	48	7.89
	96	47	7.85
	108	44	7.72
4	120	41	7.54
	132	38	7.42
	144	35	7.32
5	156	34	7.31
	168	32	7.31

Values are the means of four observations.

The dry carbonaceous wastes reduced the moisture content of the poultry droppings and there by minimized the ammonia loss [3]. Among the five wastes tested, coir pith, sawdust and paddy straw were found to be efficient in reducing the ammonia loss by 31 to 48%. Hence these wastes materials can be effectively utilized for conserving the nitrogen in the poultry in-house manure collection pit.

TABLE III
EFFECT OF AEROBIC INCUBATION OF POULTRY DROPPINGS WITH DIFFERENT CARBONACEOUS WASTE ON CUMULATIVE NH3 RELEASE

Treatments	Cumulative NH_3 release (mg 100 g^{-1})				
	0^{th} day	15^{th} day	30^{th} day	45^{th} day	60^{th} day
T_1 - PD	0	130	243	313	349
T_2 - PD+SD (1:1)	0	76	141	177	191
T_3 - PD+CP (1:1.5)	0	89	159	193	209
T_4 - PD+PS (1:1.25)	0	79	146	192	213
T_5 - PD+PW (1:1.25)	0	111	203	255	281
T_6 - PD+LL (1:1.5)	0	104	188	242	266

Values are the means of four observations. Results are expressed on air dry weight basis.

T_1 – PD, T_2 - PD+SD (1:1), T_3 - PD+CP (1:1.5), T_4 - PD+PS (1:1.25), T_5 - PD+PW (1:1.25), T_6 - PD+LL (1:1.5)

PD – POULTRY DROPPINGS, SD – SAWDUST, CP – COIRPITH, PS – PADDY STRAW, PW – PAPER WASTES, LL – LEAF LITTER

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