Use of zeolite in broiler bedding material to absorb ammonia

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Abstract

Broiler litter is a mixture of chicken excreta, bedding, and other materials generated during broiler production (e.g., soil, feathers, insects, remaining food, water, etc.). Bedding material is used to absorb droppings and to facilitate removal of excreta. To minimize ammonia impact on animal health, research was conducted to study the capacity of zeolite to absorb ammonia from broiler litter. The aim of the work was to compare bedding material from broiler litter with and without zeolite addition in order to determine differences in ammonia absorption, ammonia concentration remaining in the building and other parameters like moisture and pH. We also studied microbial evolution during the broiler growing period to establish the influence of zeolite.

Introduction

The traditional housing of intensive broiler production in Castilla y Leon (Spain) is a closed building construction of concrete or wood with natural light or windowless with a light system. Broilers are kept on bedding material spread over the entire house floor area which, in turn, is built as a solid concrete slab. Automatic height-adjustable feeding and drinking systems are applied. Broiler litter materials commonly used are: straw and wood shavings, although rice hulls can also be found. Usually no additives are use to improve bedding material absorption capacity because it is removed at the end of each growing period, that is about 45 days long.

The study was carried out in a facility with two broiler buildings: 1) one building was used as control, where straw was used as bedding material. 2) The other building had zeolite and straw as bedding material, zeolite was spread over the entire floor and straw was placed on the top of zeolite. Buildings were located at the same place, so experimental conditions were very similar. The air temperature was held at 30-33 ºC for the chickens first week, and was progressively reduced until 18-21 ºC by their fourth week.

Natural zeolites possess several important properties including adsorption, cation-exchange, dehydration-rehydration and catalysis. They have different applications like soil improvements for water and nutrients retention, treatment of water and wastewater for removal of heavy metals and nutrients, dietary supplements form farm-raised animals and health care (Mumpton, 1999). The aim of the work was to compare bedding material from broiler litter with and without zeolite addition in order to determine differences in ammonia absorption, ammonia concentration in air and other parameters like moisture and pH. We also studied microbial evolution during the broiler growing period to establish the influence of zeolite.

Materials and methods

Two separated broiler houses were used located at the same place. The ventilation was cross-flow and each house had 5 air inlets. The house with straw as bedding material had a floor area of 350m^3 and held about 20.000 birds. The house with straw and zeolite had a floor area of 300m^3, held about 18.000 birds, all of the same strain and stocked on the same day.

Experiment lasted seven weeks sampling once per week. Temperature, moisture content and ammonia were measured with a portable thermo-hygrometer (PCE 555) in each

building in three different points. Ammonia emissions in the buildings were measured using Dräger tubes (Dräger GmbH, Lübeck, Germany). Broiler litter sampling was done in three different points in each building.

The following parameters were determined: inorganic nitrogen ($N\text{-}NH_4^+$ and $N\text{-}NO_3^-$) was determined by the Bremner method (Bremner, 1965). Total nitrogen was determined by the Kjeldahl method (Hesse, 1971). Dry matter content was measured drying the sample to 105ºC until constant weight (APHA, 1998). pH was measured with a pH-meter (Crison micro pH 2001) in a solution of 1:2.5 broiler litter:water. K (potassium) was determined by plasma emission spectrophotometry (Sims, 1991). Total and fecal coliforms analyses were done using the VRBL agar media, the enumeration of CFU (colony forming units) was carried out after 24h of incubation at 37ºC for total coliforms and at 44ºC for fecal coliforms. Enterococci enumeration was carried out after 48h of incubation at 44ºC using a SB agar media.

Results and discusión

Characteristics of bedding material with straw and with straw+zeolite are shown in table 1. The most important difference between both materials was the moisture content. Litter moisture content was higher in the house with straw, with an average of 51% compared with the treated building with 38% moisture content. Ammonia and potassium content were slightly high in the case of litter with zeolite. Both types of bedding materials had similar alkaline pH values (table 1), ranging between 8.5 and 9.5 in both cases. Although it has been reported that wet and alkaline litters are associated with high ammonia emissions (Clarkson and Misselbrook, 1991), in our essay we only found a slightly correlation between moisture content and total nitrogen in litter in the case of straw+zeolite (0.686) but not in the case of straw alone.

Table 1. Characteristics of bedding material with straw and straw+zeolite
Data are the average of seven sampling records each one with two replicates

Parameter	straw	straw+zeolite
pH	8.84	8.73
Moisture (%)	51.44	38.50
TKN (mg/g)	10.79	10.84
NH_4+ (mg/g)	3.55	3.81
Potasium (mg/g)	4.53	5.91

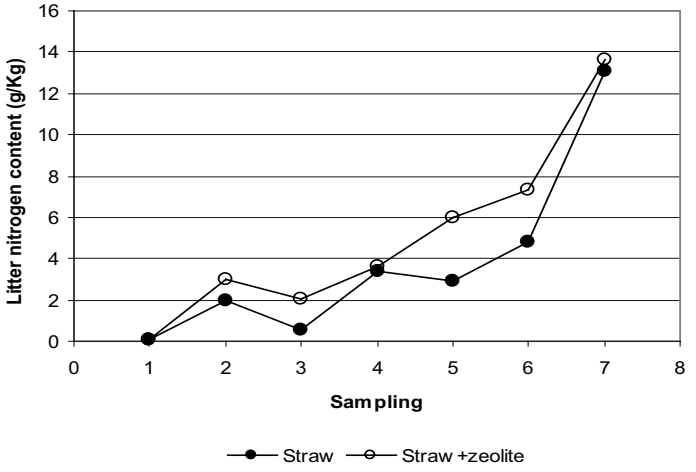
Table 2. Ammonia evolution for seven weeks sampling period
Measurements were carried out in three different points along the buildings

	Ammonia concentration (mg/L)	
Sampling	Straw	Straw+zeolite
Week 1	0	0
Week 2	10	10
Week 3	20	10
Week 4	5	5
Week 5	5	10
Week 6	10	10
Week 7	10	12

Aerial ammonia concentration were very similar in both houses (table 2), being the maximum concentration in week 3 of 20mg/L found in the building with straw. From this week until the end of the essay ammonia concentration in the houses ranged between

5-10mg/L. These values are quite low compared with other works. Amon et al., (1997) reported values of ammonia concentration between 5-30mg/L in broiler houses treated with zeolite as additive.

Figure1. Litter nitrogen content in both bedding materials: straw and straw+zeolite
Dry basis data



Microbiological parameters

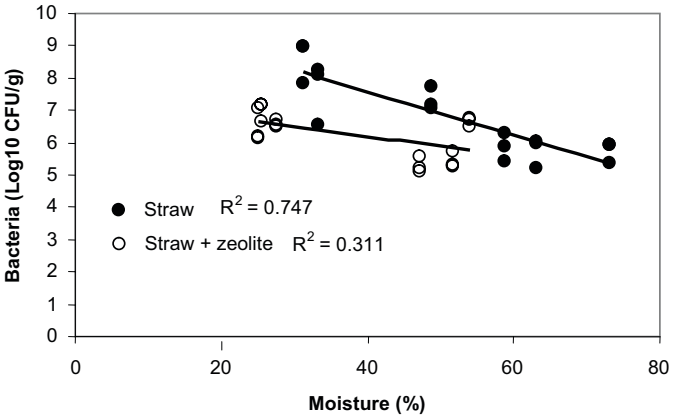
In the beginning of the essay the amount of bacteria was increasing in both bedding materials. But in the latest weeks (from week 5 to week 7) the tendency was to remain constant (table 3). This finding is in agreement with Thaxton et al., (2003), who reported that once a defined population of bacteria is established the numbers remain somewhat constant, regardless of the number o birds that have been housed on it. We also found a relationship between bacteria counts and moisture for bedding material with straw, with a correlation coefficient of 0.747 (figure 2), although no correlation was obtained for straw+zeolite, but we observed a decrease in the bacteria counts at the end of the rearing period. It is necessary to underline that moisture content was higher in straw than in straw+zeolite (table 1). These results agree with Hartel et al., (2000) that found that an increase in moisture content significantly reduced number of fecal coliforms in stacked litter.

Table 3. Bacteria counts per week in bedding material with straw and with straw+zeolite

Sampling	Straw		Straw + zeolite	
	Total coliform	Enterococci	Total coliform	Enterococci
	Log10 (CFU[1]/g of litter)			
Week 1	3.87	3.78	3.74	3.78
Week 2	8.97	7.86	6.18	7.08
Week 3	7.15	7.72	6.53	6.49
Week 4	8.25	6.54	7.15	6.66
Week 5	5.95	5.38	6.72	6.76
Week 6	5.97	5.23	5.23	5.59
Week 7	5.87	5.39	5.28	5.69

[1] CFU: Colony Forming Unit

Figure 2. Relationship between bacteria counts and moisture for bedding material with straw and straw+zeolite



Results showed that broiler litter with zeolite contained more nitrogen than litter without zeolite. Ammonia concentration in the houses were very similar without exceed 20mg/L. Total, fecal and enterococci bacterial counts decreased with moisture increase, obtaining a correlation value of 0.747 in the case of straw.

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