Evaluation of Ammonia and Infectious Bronchitis Vaccination Stress on Broiler Performance and Carcass Quality[1]

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ABSTRACT Eighty broiler chicks were randomly assigned to each of 12 chambers in a controlled environment building. Anhydrous ammonia gas was introduced into the test chambers from 4-8 weeks of age so treatments consisted of 0, 25 and 50 parts per million (p.p.m.) of NH_3. Chicks were vaccinated at 5 weeks of age with a commercial strain of infectious bronchitis dust vaccine.

Eight week body weights and feed efficiencies of broilers exposed to ammonia were significantly reduced. At 6 and 8 weeks of age a severe airsacculitis condition was observed in the ammoniated broilers. During the eight week period airborne bacteria were significantly greater in the 25 and 50 p.p.m. NH_3 chambers. Ammonia and infectious bronchitis vaccination stress did not affect meat flavor, tenderness or juiciness, but significantly increased condemnations and undergrade carcasses.

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INTRODUCTION

AN adequate environment within poultry houses is a very important requirement for success in the poultry industry. Gases such as carbon dioxide, ammonia and methane may accumulate and reach toxic levels if adequate ventilation is not maintained.

In colder climates many poultry houses cannot maintain proper ventilation rates. Gases produced in the manure build up rapidly, often reaching harmful levels (Lillie, 1970; Kling, 1971). Levels of over 50 p.p.m. of ammonia have been found in modern poultry houses and up to 200 p.p.m. of ammonia have been found in poorly ventilated poultry houses (Anderson *et al.*, 1964a).

Damage to the respiratory tract cannot always be detected, especially if the concentration of the irritating gas is relatively low, but damage may be apparent when the subject is exposed to an infectious microorganism (Ehrlich, 1963). Anderson *et al.* (1964b) reported that chickens, turkeys, guinea pigs and mice exposed continuously to 20 p.p.m. of ammonia for six weeks showed gross or histopathological signs of damage to the respiratory tract.

Valentine (1964) reported 60 p.p.m. of ammonia was needed to produce keratoconjunctivitis and if ammonia concentrations went below 60 p.p.m. rate of recovery from eye disorder depended on severity of the ulcers.

Airsacculitis can affect shelf-life of broiler carcasses. In a study by Sauter and Peterson (1970) shelf-life comparisons were conducted on fresh broiler carcasses from 8 flocks having carcass condemnation rates, primarily caused by airsacculitis, ranging from 1.5 to 7.4 percent. Shelf-life averaged 6.4 days for fryers from the flocks having high condemnation rates compared to 8.3 days for those from low condemnation flocks.

Presence of certain diseases in the poultry house may be related to number of bacteria in the air. Quarles *et al.* (1970) reported that litter floor poultry houses containing layers had 7,000 to 10,000 bacteria per cubic foot

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of air. They observed the number of bacteria per cubic foot of air appeared to increase on days when ammonia gas was present at discernible levels in the poultry house.

Many environmental stress factors have been shown to increase the incidence of disease in chickens. This study measured response of broilers to atmospheric ammonia and infectious bronchitis vaccine.

MATERIALS AND METHODS

The experiment utilized 960 Indian River Cross male broiler chicks. Eighty chicks were randomly placed in each of 12 chambers in a controlled environment building. Standard feeder, waterer, lighting and densities were used throughout the experiment. Colorado State University broiler starter-mash was fed 0–4 weeks of age and finisher-pellets were fed 4–8 weeks. Wood shavings approximately 8 cm. deep was used for litter. Chicks were debeaked at 10 days of age and vaccinated for Newcastle disease at 14 days of age.

Anhydrous grade ammonia gas was injected by tubing into test chambers as shown in Figure 1. Treatments consisted of 0, 25 and 50 p.p.m. of ammonia and there were four replications per treatment. To assure a constant level of ammonia gas in the respective chambers, the ventilation rates were adjusted so an identical air exchange rate existed in each chamber.

At four weeks of age blood samples were taken and subjected to a serum neutralization test to determine pre-exposure of chicks to infectious bronchitis virus. According to the test the flock had not been exposed to this disease. Broilers were vaccinated at five weeks with a commercial strain of infectious bronchitis dust vaccine.

Body weights and feed efficiency were measured at 4, 6 and 8 weeks. Ten birds per chamber were sacrificed at 4, 6 and 8 weeks of age, and posterior thoracic air sacs were observed and assigned a score from 0–4 relative to the opaqueness and exudate present. A score of zero signified a normal air sac and a score of four indicated a very

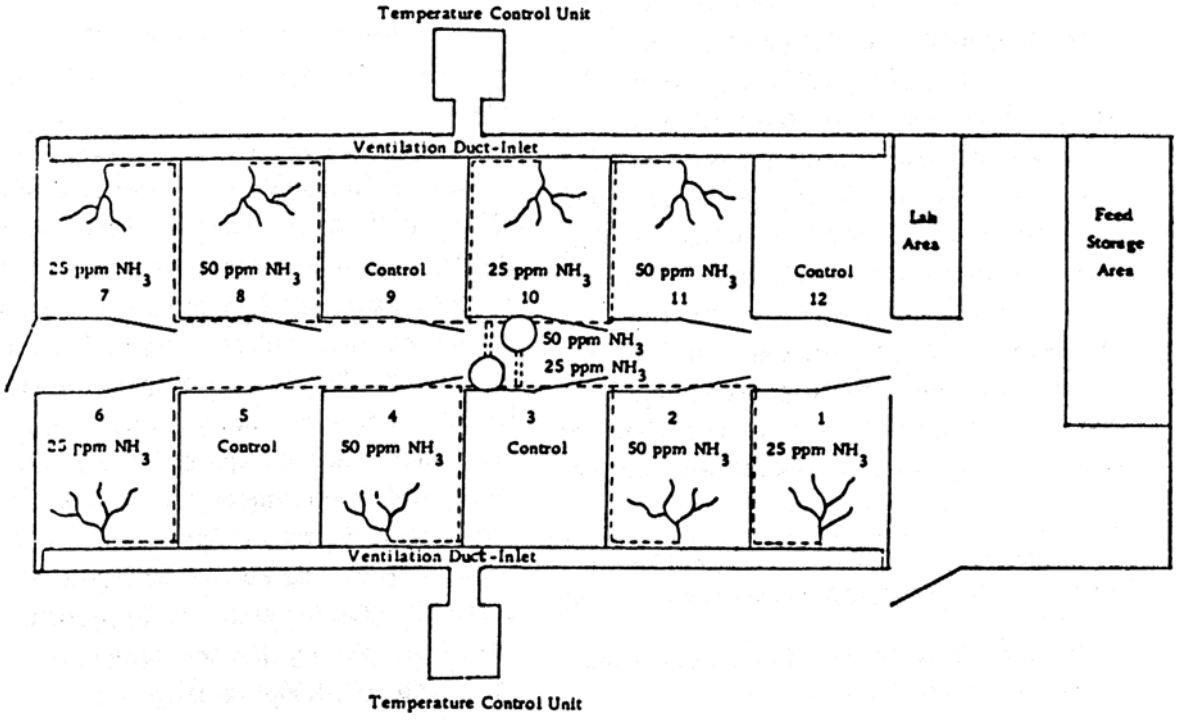

FIG. 1. Experimental design of the environmentally controlled poultry house.

severe airsacculitis infection with large amounts of exudate present.

The technique to measure total bacteria numbers in the air of poultry houses described by Quarles *et al.* (1970) was used at 4, 6 and 8 weeks of age.

Carcass quality measurements taken at the processing plant included breast blisters, grade and condemnation. Grade was determined by U.S.D.A. standards after evisceration. Tenderness was measured on a Warner-Bratzler shear press. A scale of 0-8 was used by a taste panel for sensory evaluation of flavor and juiciness.

Data were subjected to analysis of variance and Tukey's multiple range test (Snedecor, 1956).

RESULTS AND DISCUSSION

Body Weights and Feed Efficiency. Body weights and feed efficiencies did not differ significantly among treatments at 4 or 6 weeks of age (Table 1). At eight weeks of age the broilers averaged 1941, 1905 and 1835 grams in the control, 25 p.p.m. NH_3 and 50 p.p.m. NH_3 chambers, respectively. The broilers grown in the 50 p.p.m. NH_3 chambers weighed significantly ($P < 0.05$) less than broilers grown in control or 25 p.p.m. NH_3 chambers. These findings are in agreement with Charles and Payne (1966) and Kling and Quarles (1973) where it was reported ammonia stress may cause a decrease in growth rate of chickens.

At 8 weeks broilers grown in 25 and 50 p.p.m. of ammonia had significantly ($P < 0.05$) higher feed efficiences than control broilers.

Air Sac Condition. Observations at 4 weeks of age on samples of chickens from all chambers showed no air sac lesions. At six and eight weeks some severe cases of airsacculitis existed in chickens from both the 25

TABLE 1.—*Body weights and feed efficiency of broilers exposed to 0, 25 or 50 p.p.m. of ammonia from 4-8 weeks of age*

Treatment	Pen[1] no.	Age in weeks 4 Ave. wt.	4 Feed eff.	6 Ave. wt.	6 Feed eff.	8 Ave. wt.	8 Feed eff.
		(grams)		(grams)		(grams)	
Control	3	493	1.57	1348	1.71	1923	1.93
	5	473	1.57	1246	1.72	1913	1.87
	9	462	1.59	1275	1.77	1893	1.88
	12	478	1.58	1374	1.74	2033	1.93
		477a[2]	1.58a	1311a	1.74a	1941a	1.90a
25 p.p.m. NH_3	1	488	1.51	1295	1.69	1864	1.93
	6	498	1.58	1225	1.71	1885	1.94
	7	463	1.58	1292	1.72	1914	1.98
	10	484	1.60	1301	1.81	1958	1.91
		479a	1.57a	1278a	1.73a	1905a	1.94b
50 p.p.m. NH_3	2	484	1.56	1308	1.72	1823	2.04
	4	499	1.50	1250	1.74	1839	1.93
	8	465	1.59	1228	1.74	1783	2.00
	11	491	1.56	1285	1.75	1895	1.96
		485a	1.55a	1268a	1.74a	1835b	1.98b

[1] Eighty chicks per pen at the start of the experiment.
[2] Means within age groups with the same postscripts are not significantly different from each other ($P < 0.05$).

TABLE 2.—*Total air sac scores of broilers[1] and bacteria per cubic foot of air[2] in chambers containing 0, 25 or 50 p.p.m. of ammonia from 4–8 weeks of age*

Treatment	Age in weeks 4		6		8	
	Air sac	Bacteria	Air sac	Bacteria	Air sac	Bacteria
Control	0	3,500a[3]	4a	14,000a	5a	8,000a
25 p.p.m. NH_3	0	2,800a	55b	14,000a	37b	11,000b
50 p.p.m. NH_3	0	5,400a	48b	13,000a	51b	13,000c

1. Each mean represents four replications of 40 birds per treatment.
2. Each mean represents four replications per treatment.
3. Means within age groups with the same postscripts are not significantly different from each other ($P < 0.05$).

and 50 p.p.m. NH_3 chambers (Table 2). Differences among total air sac scores of broilers grown in 25 and 50 p.p.m. of ammonia and control chambers were significant ($P < 0.05$) at 6 and at 8 weeks of age. These findings are in agreement with Kling and Quarles (1973) where ammonia levels of 25 and 50 p.p.m. caused a significant increase in airsacculitis in Leghorn chicks.

Blood tests made at the termination of the experiment indicated that the broilers were free of *Mycoplasma gallisepticum* (MG) and *Mycoplasma synoviae* (MS). The air sac scores indicate that ammonia stress and infectious bronchitis vaccination may cause an airsacculitis condition in broilers that are MG and MS negative.

Bacteria. Viable bacteria particles per cubic foot of air as measured with the Andersen Air Sampler showed no significant differences between treatments at 4 or 6 weeks of age (Table 2). The eighth week measurements were 8,000, 11,000 and 13,000 bacteria particles per cubic foot of air in the control, 25 p.p.m. NH_3 and 50 p.p.m. NH_3 chambers, respectively. These measurements were significantly different ($P < 0.05$) showing that ammonia resulted in higher bacteria levels in air of the experimental broiler house as birds approached market weight. These data are in agreement with observations reported by Quarles *et al.* (1970).

TABLE 3.—*Flavor, juiciness and shear values of meat from broilers exposed to 0, 25 or 50 p.p.m. of ammonia from 4–8 weeks of age*[1]

Treatment	Flavor	Juiciness	Shear
			(pounds)
Control	2.8a[2]	3.9a	6.2a
25 p.p.m. NH_3	3.2a	3.7a	7.4a
50 p.p.m. NH_3	3.2a	3.7a	7.1a

1. Each mean represents four replications per treatment.
2. Means with the same postscripts are not significantly different from each other ($P < 0.05$).

Carcass Quality. Flavor of broiler breast meat was evaluated by a panel of fifty-two people. Average flavor scores were 2.8 for the controls, 3.2 for the 25 p.p.m. NH_3 and 3.2 for the 50 p.p.m. NH_3 broilers (Table 3). The same panel had an average juiciness score of 3.9, 3.7 and 3.7 for the control, 25 p.p.m. NH_3 and 50 p.p.m. NH_3 broilers, respectively. Breast meat shear press values were 6.2 pounds for the controls, 7.4 pounds for the 25 p.p.m. NH_3 birds and 7.1 pounds for the 50 p.p.m. NH_3 birds (Table 3). The values for flavor and juiciness were not significantly different.

There were significantly ($P < 0.05$) more breast blisters on broilers grown in the ammonia chambers than on controls (Table 4). Breast blisters on carcasses measured at time of processing were 3.4 percent in the controls, 14.0 percent in the 25 p.p.m. NH_3 birds and 11.9 percent in the 50 p.p.m. NH_3 birds.

TABLE 4.—*Percent of breast blisters, undergrade carcasses and condemnations from broilers exposed to 0, 25 or 50 p.p.m. of ammonia from 4–8 weeks of age*

Treatment	No. processed	Breast blisters	Undergrade excluding breast blisters	Condemnations	
				Total	Air sac
		(percent)	(percent)	(percent)	(percent)
Control	173	3.4a[1]	1.7a	0.6a	0a
25 p.p.m. NH_3	172	14.0b	6.5b	5.2b	3.5b
50 p.p.m. NH_3	167	11.9b	8.1c	5.3b	4.1b

1. Means with the same postscripts are not significantly different from each other ($P < 0.05$).

Carcass grade based on U.S.D.A. specifications showed 1.7, 6.5 and 8.1 percent undergrade carcasses from broilers in the control, 25 p.p.m. NH_3 and 50 p.p.m. NH_3 chambers, respectively (Table 4). These mean percentages were significantly different from each other ($P < 0.05$).

Total condemnations were 0.6, 5.2 and 5.3 percent in control, 25 p.p.m. NH_3 and 50 p.p.m. NH_3 broilers, respectively (Table 4). Carcass condemnations for airsacculitis were 0 percent in the control broilers, 3.5 percent in the 25 p.p.m. NH_3 broilers and 4.1 percent in the 50 p.p.m. NH_3 broilers. Both levels of ammonia produced significantly ($P < 0.05$) more condemnations than the controls. The cause of condemnation was primarily due to air sac infections.

Results demonstrate low levels of ammonia and infectious bronchitis stresses may not affect carcass flavor, tenderness or juiciness, but can have an economically detrimental effect by decreasing growth performance and grade and increasing incidence of breast blisters and condemnation.

REFERENCES

Anderson, D. P., F. L. Cherms and R. P. Hansen, 1964a. Studies on measuring the environment of turkeys raised in confinement. Poultry Sci. 43: 305–318.

Anderson, D. P., C. W. Beard and R. P. Hansen, 1964b. The adverse effects of ammonia on chickens including resistance to infection with Newcastle disease virus. Avian Diseases, 8: 369–379.

Charles, D. R., and C. G. Payne, 1966. The influence of graded levels of atmospheric ammonia on chickens. 1. Effects on respiration on the performance of broilers and replacement growing stock. Brit. Poultry Sci. 7(3): 177–187.

Ehrlich, R., 1963. Effects of air pollutants on respiratory infections. Arch. Envir. Health, 6: 638–642.

Kling, H. F., 1971. Gas and particulate levels in a poultry house. M.S. Thesis. The Pennsylvania State University.

Kling, H. F., and C. L. Quarles, 1973. Effect of atmospheric ammonia and infectious bronchitis vaccination stress on Leghorn males. Poultry Sci. 52: 2049.

Lillie, R. J., 1970. Air pollutants affecting the performance of domestic animals. A literature review. Agricultural Handbook No. 380, United States Department of Agriculture.

Quarles, C. L., R. F. Gentry and G. O. Bressler, 1970. Bacterial contamination in poultry houses and its relationship to egg hatchability. Poultry Sci. 49: 60–66.

Sauter, E. A., and C. F. Petersen, 1970. Fryer shelf-life relation to airsacculitis condemnation rate. Poultry Sci. 49: 1434.

Snedecor, O. W., 1956. Statistical Methods. Iowa State College Press, Ames, Iowa.

Valentine, H., 1964. A study of the effect of different ventilation rates on the ammonia concentrations in the atmosphere of broiler houses. Br. Poultry Sci. 5: 149–159.