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IMPACT OF BIOCHAR AS AIR PURIFIER ON LUNG RELATIVE WEIGHT AND PULMONARY MICROBIOTA OF BROILER CHICKENS

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ABSTRACT

This study investigates the effect of biochar as an air purifier on the relative weights of the lungs and pulmonary microbiota of broiler chickens. One-day-old Arbor Acres broiler chicks (n = 112) were randomly allotted into two treatment groups of 56 birds each: Biochar and Non-biochar (Control). At day 42 of the study, 14 birds per treatment were sacrificed. Lungs were harvested, weighed and the relative weight was calculated. Lung samples were collected into sterile bottles for microbial analysis. Lower ($p<0.05$) ammonia (NH_3) concentration (7.71±1.90 ppm) was observed in the Biochar pen compared to the Non-biochar pen (19.00±2.90 ppm). Similar ($p>0.05$) relative weight of the lungs and total microbial count in the lungs were observed in birds at both experimental units. *Staphylococcus aureus*, *Escherichia coli*, and *Klebsiella pneumoniae* were identified in the lungs of birds in both experimental groups, while *Proteus spp*. was detected only in the lungs of birds in the non-biochar pen. In conclusion, biochar effectively reduced atmospheric ammonia levels. Although lung relative weights and total microbial counts were unaffected, the absence of *Proteus spp*. in birds from the biochar pen suggests a potential role in limiting the presence of specific pathogenic bacteria.

Keywords: Air quality, Bamboo biochar, Broiler chickens, Lungs, Microbial analysis

DESCRIPTION OF PROBLEM

Air quality within broiler production environments plays a critical role in determining both the health and performance of the birds. Accumulation of airborne pollutants such as ammonia, dust particles, microbial aerosols, and volatile organic compounds can significantly compromise respiratory health, performance, and welfare of broiler chickens (2, 3). Biochar is a carbon-rich, porous material produced via pyrolysis of organic biomass. It has gained attention for its potential applications in agricultural systems, particularly as a natural adsorbent and air purifier. When applied to poultry environments, biochar has demonstrated the capacity to reduce atmospheric ammonia, adsorb harmful gases, suppress microbial load, and improve overall litter quality (1, 3). These properties suggest that biochar may play a critical role in mitigating the adverse effects of poor air quality on poultry health, especially in relation to pulmonary physiology and microbiology (2, 5). This study investigates the impact of biochar as an in-house air purifier on the lung relative weights and pulmonary microbiota profile of broiler chickens.

MATERIALS AND METHODS

Experimental site and Preparation of Biochar: The experiment was carried out at the Poultry unit of the Directorate of the University Farms (DUFARMS), Federal University of Agriculture Abeokuta, Ogun State. Biochar was produced from dry bamboo through a process of pyrolysis.

Experimental design and birds' management: A total of 112 one-day-old Arbor Acres broiler chicks were randomly allotted into two treatment groups: Biochar and Non-biochar (Control). Birds were housed for six weeks in two separate deep litter pens of similar dimensions. Each group contained 56 birds, subdivided into 7 replicates of 8 birds each in a completely randomized design. Bamboo

biochar, at 0.73 kg/m², was suspended in permeable pouches at bird height in the biochar unit, based on the recommendation of Ritz *et al*. (6). Commercial starter and finisher diets, along with water, were provided *ad libitum*. At the end of the trial (Day 42), 14 birds per treatment were sacrificed. Lungs were harvested, weighed and the relative weight (as a percentage of live body weight) was calculated. Lung samples were collected into sterile bottles for microbial analysis using conventional culturing and biochemical identification methods.

Statistical Analysis

Data collected was analyzed using T-test of Minitab statistical software package

RESULTS AND DISCUSSION

The effect of Biochar on ammonia concentration (NH_3) in the broiler pen is shown in Table 1. Lower ($p<0.05$) ammonia (NH_3) concentration (7.71±1.90 ppm) was observed in the Biochar pen compared to the Non-biochar pen (19.00±2.90 ppm). Biochar has been recognized for its adsorptive properties, capable of reducing volatile compounds and ammonia in the air (1, 3) which could explain the reduction in ammonia concentration observed in the biochar pen in this study.

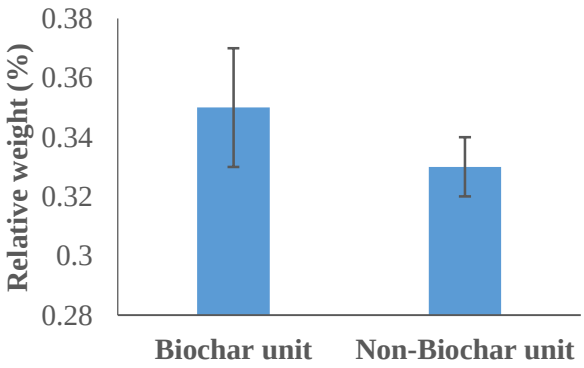
Table 1: Ammonia concentration in the broiler pens with and without Biochar

Parameter	Treatment	Overall Average
NH_3 (ppm)	Biochar	7.71±1.90[b]
	Non-Biochar	19.00±2.90[a]
	P-value	0.00

[ab] Means within same column bearing different superscripts differ significantly; NH_3: Ammonia in ppm.

Figure 1 shows the relative lung weight of broiler chickens reared in pens with and without biochar. Similar ($P>0.05$) relative weight of the lungs was observed in birds at both experimental groups. However, birds in the biochar group had numerically higher relative lung weight compared to those in the non-biochar group. Relative lung weight is often used to assess respiratory development and function. According to Liu *et al*. (4) poor air quality can increase oxidative burden in the lungs, leading to structural and functional impairments. Biochar, by adsorbing ammonia and other irritants, may indirectly protect the lungs from oxidative injury, thus facilitating healthier tissue growth.

The total microbial count in the lung of broiler chickens in the biochar unit and non-biochar unit are shown in Figure 2. No significant ($P>0.005$) variation was observed in the lung total microbial count between the biochar (13.00 x 10^5 cfu/mL) and non-biochar group (11.40 x 10^5 cfu/mL). Antimicrobial potential of biochar, particularly through the alteration of microenvironments or the trapping of airborne particles has been reported (5, 6). However, the results of this study show a higher, but not significant, total microbial count, suggesting that biochar might not reduce total bacterial counts in lung tissue. Instead, it could shift the microbial population by suppressing certain pathogenic strains (5).



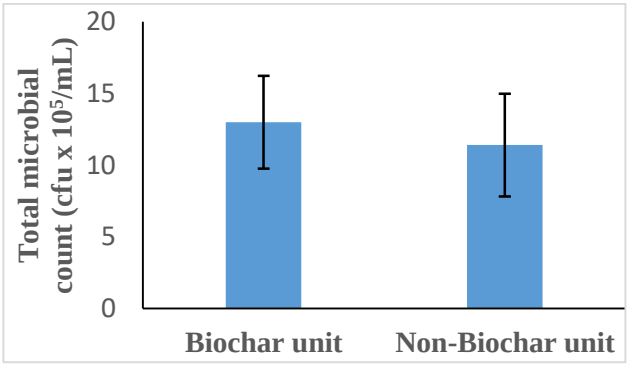


Figure 1: Relative weight of the lung of broiler chickens reared in a pen with and without Biochar

Figure 2: Lung microbial count of broiler chickens reared in a pen with and without Biochar

Table 2 shows the qualitative analysis of microbial presence in broiler chicken raised in pen with and without biochar. The analysis revealed the presence of *Staphylococcus aureus*, *Escherichia coli*, and *Klebsiella pneumoniae* in both groups, while *Proteus spp*. was detected only in the non-biochar unit. The absence of *Proteus spp.*, a known opportunistic pathogen, in the biochar group, despite a higher total microbial load, may indicate biochar's selective filtering or inhibitory role in air purification. These findings suggest that biochar may not eliminate microbial presence, but may modulate microbial diversity and pathogenic risk, possibly promoting commensal or less virulent species, resulting in a higher overall count but lower pathogenicity, which is critical in broiler production environments.

CONCLUSION AND APPLICATION

The inclusion of biochar as an air purifier in broiler housing effectively reduced atmospheric ammonia levels, which may contribute to improved air quality. Although lung relative weights and total microbial counts were unaffected, the absence of *Proteus spp.* in birds from the biochar-treated environment suggests a potential role in limiting the presence of specific pathogenic bacteria thereby enhancing respiratory health in broiler production.

Table 2: Qualitative analysis of microbial presence in broiler birds raised in biochar and non-biochar pens

Experimental unit	***Staphylococcus aurerus***	***Escherichia coli***	***Klebsiella pneumonia***	***Proteus spp***
Biochar Unit	+	+	+	-
Non-Biochar Unit	+	+	+	+

+ = Presence of microorganisms; - = Absence of microorganisms

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