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Ammonia Mitigation Practices in A Closed-House Broiler Farm in An Agrocomplex System: A Case Study from Moncongloe Bulu, Indonesia.

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Abstract. Ammonia accumulation is one of the main air-quality challenges in intensive broiler production, particularly in closed-house systems where large numbers of birds are reared under controlled environmental conditions. This study aimed to analyze the practices used to reduce ammonia (NH3) concentration in the closed-house broiler facility of CH Kembar Farm, Moncongloe Bulu, Indonesia. The study was conducted from September to November 2024 using a descriptive mixed-method approach. Data were collected through direct field observation, interviews with farm management, and NH3 measurement using an ammonia kit test (Hydrion AM-40). The findings showed that ammonia control at the farm was supported by routine maintenance of key housing equipment, including exhaust fans, blower fans, cooling pads, and backup electrical systems, as well as by regular litter management through EM-4 application and litter stirring three times per week until harvest. The measured NH3 concentration was consistently reported as 10 ppm at all observation points, indicating that the in-house ammonia condition remained below the threshold value cited in the source manuscript. These results suggest that effective ammonia mitigation in closed-house broiler production depends not only on housing technology, but also on the consistency of daily operational management. Overall, this study provides practical field-based evidence that integrated environmental-control and litter-management practices can support acceptable air-quality conditions in commercial broiler production under tropical conditions.

Keywords: air quality; ammonia concentration; broiler chickens; closed-house system; litter management

INTRODUCTION

Broiler production remains one of the most efficient systems for supplying affordable animal protein, and its continued expansion depends on production environments that support rapid growth, feed efficiency, bird welfare, and farm profitability (Muyyarikkandy et al., 2023; Rehman et al., 2026). In intensive production systems, housing is not only a physical structure but also a key biological control factor, because temperature, relative humidity, airflow, and air quality directly affect broiler performance(Fijalovych & Paskevych, 2025). For this reason, environmentally controlled or closed-house systems are increasingly used in commercial poultry farming to stabilize microclimatic conditions and strengthen biosecurity, particularly when external climatic variation may disrupt flock productivity (Bist et al., 2024; Godinho et al., 2025; Maharjan et al., 2021).

Despite these advantages, closed-house broiler production remains susceptible to indoor air-quality problems, especially ammonia (NH3) accumulation. In poultry houses, ammonia is produced mainly through microbial decomposition of uric acid and litter manure. Its concentration is influenced by interacting factors, including litter moisture, pH, temperature, ventilation rate, stocking density, and manure-management practices. As birds grow older and fecal output increases, litter commonly becomes wetter and more compact, thereby creating conditions that favor ammonia release when ventilation and litter handling are inadequate (Barbosa et al., 2024; Bist et al., 2023; Maruthamuthu et al., 2024; West et al., 2024).

Elevated ammonia concentrations are associated with adverse effects in both broilers and humans (Yazarel et al., 2025). In broilers, excessive NH3 exposure has been linked to respiratory irritation, mucosal and ocular lesions, reduced feed intake, poorer growth, impaired welfare, and increased susceptibility to health problems. For farm workers, repeated exposure may reduce occupational comfort and contribute to respiratory risk. Accordingly, ammonia control should be viewed not only as an environmental concern but also as a matter of animal welfare, occupational health, and production sustainability (Abbas & Comini, 2025).

Recent studies indicate that ammonia can be mitigated through better ventilation management, optimized air movement, real-time environmental monitoring, and litter-focused interventions. Increased air velocity has been shown to improve litter quality and reduce ammonia emissions. At the same time, wireless monitoring and gas-sensing systems can support faster management responses when environmental conditions deviate from acceptable ranges. These advances show that ammonia control in broiler housing requires an integrated approach that combines engineering performance with practical day-to-day management.

However, recent literature is dominated by general reviews, controlled experimental studies, and sensor-development research, which suggests a relative shortage of published farm-level case evidence describing how routine operational practices are combined in commercial tropical closed-house broiler farms. In this context, the research gap addressed by the present study is the limited documentation of practical ammonia-reduction efforts under real production conditions in an Indonesian commercial broiler unit. The novelty and contribution of this study lie in presenting an applied case from CH Kembar Farm, Moncongloe Bulu, by documenting routine management measures used to reduce ammonia concentration and relating those measures to observed in-house NH3 conditions. This practical perspective is relevant for commercial farms operating under similar tropical conditions and technological dependence on closed-house environmental control.

Therefore, this study aimed to analyze the efforts undertaken to reduce ammonia concentration in the closed-house broiler facility of CH Kembar Farm, Moncongloe Bulu, and to relate these management practices to the measured NH3 condition inside the house.

MATERIALS AND METHODS

This study was conducted at the closed-house broiler facility of CH Kembar Farm, Moncongloe Bulu Village, Moncongloe District, Maros Regency, South Sulawesi, Indonesia, from September to November 2024. The study employed a descriptive mixed-method approach that combined qualitative and quantitative data. Qualitative data were obtained through direct field observation and interviews with farm management, while quantitative data were obtained through measurement of ammonia (NH3) concentration inside the closed house using an ammonia kit test (Hydrion AM-40). Primary data consisted of on-site observations and NH3 measurements, whereas secondary data were derived from management interviews and farm records related to broiler type, flock number, and flock age, as well as other supporting publications relevant to the study topic.

To clarify the methodological framework reported in the original manuscript, Table 1 summarizes the study design, data sources, and observed components.

Table 1 shows that the study was designed as a farm-based applied assessment rather than a controlled experiment. This design is appropriate for documenting practical ammonia-reduction efforts under commercial conditions, but several operational details required for strict reproducibility were not reported in the source manuscript

Table 1. The evaluated treatments are summarized

Component	Description
Study location	Closed-house broiler facility of CH Kembar Farm, Moncongloe Bulu Village, Moncongloe District, Maros Regency, South Sulawesi, Indonesia
Study period	September-November 2024
Study design	Descriptive mixed-method study combining qualitative and quantitative approaches
Primary data	Direct field observation and NH3 measurement using Hydrion AM-40 ammonia kit test
Secondary data	Interviews with farm management and farm records on broiler type, number, and age; other relevant publications
Main observed aspects	Farm profile; efforts to reduce ammonia concentration in the closed house; interpretive relationship between ammonia concentration and respiratory disturbance; potential broiler feces production and associated ammonia level
Analytical approach	Qualitative and quantitative data were described in a structured manner and interpreted deductively

Observation of farm management practices covered environmental-control equipment, litter handling, and house temperature management. According to the source manuscript, the house was equipped with a climate controller system and temperature sensor, allowing automatic adjustment of house operation to maintain thermal stability. Farm staff reportedly monitored broiler condition and house environment two to three times per day, including routine temperature checks. The target house temperature was adjusted according to bird age, namely 29-34°C for 1-14 days, 21-27°C for 14-28 days, and 18-19°C for 28-42 days.

Litter management was documented as an important ammonia-control practice. The floor litter was treated with EM-4 Livestock and subsequently stirred three times per week until harvest. According to the older manuscript, the EM-4 solution was prepared by mixing 30 mL of EM-4 with 15 L of water, followed by a 24 h fermentation period before application. The solution was sprayed in the morning with an electric sprayer, and litter stirring was carried out in the afternoon on the same day using a simple, manually made stirring tool. This management practice was initiated when the birds were approximately 2 weeks old, before severe caking and litter compaction had developed.

Ammonia concentration was measured inside the closed house using the Hydrion AM-40 ammonia kit test with ammonia test paper. The older manuscript states that measurements were taken at eight points distributed across five zones of the house to obtain a representative indication of NH3 concentration. These zones were located at 15, 30, 45, 60, and 75 m along the house, with measurements taken on both the left and right sides at 15, 45, and 75 m, and at a single point at 30 and 60 m. The collected data were analyzed using a descriptive, mixed-methods approach. Qualitative information obtained from observation and interviews was organized into a structured narrative, whereas quantitative NH3 measurement results were processed mathematically and then interpreted alongside the qualitative findings. The final interpretation was discussed pragmatically and used to draw deductive conclusions about ammonia-control practices on the studied farm.

RESULTS AND DISCUSSION

Farm profile and housing context

CH Kembar Farm is located in Moncongloe Bulu Village, Moncongloe District, Maros Regency, South Sulawesi, Indonesia. Construction began on 6 July 2022, and production began on 15 February 2023. At the time described in the manuscript, the farm operated one modern two-deck closed-house unit and raised Cobb broilers under a partnership system. The source manuscript also reports a total capacity of 27,000 birds, with 13,500 birds per floor. These characteristics indicate that the present study represents a single-farm commercial case in a relatively young closed-house operation rather than a multi-farm comparative assessment.

Practical measures used to reduce ammonia concentration

Field observations and interviews showed that ammonia control at CH Kembar Farm was based on a combination of operational safeguards and litter management practices rather than a single intervention. The reported measures are summarized in Table 2.

Before presenting the measured NH3 data, it is useful to summarize the practical management actions implemented by the farm, as these form the basis of the farm's ammonia-control strategy.

Table 2. Reported ammonia-control measures implemented at CH Kembar Farm

Management component	Reported practice in the manuscript	Intended role in ammonia control
Backup power supply	A generator set was prepared to maintain closed-house operation during power outages.	Prevents interruption of ventilation and climate-control functions that are needed to remove heat, moisture, and harmful gases
Warning system	The house was equipped with a siren/alarm that sounded during an electrical failure; one such event reportedly occurred during the study period.	Enables rapid operator response so that generator power can be activated immediately
Maintenance of climate-control equipment	Cooling pads, exhaust fans, blower fans, and generator units were checked and cleaned after each production cycle.	Supports stable airflow and environmental control, thereby reducing conditions that favor ammonia accumulation
Litter material	Rice husk litter was used on the floor	Provides an absorbent bedding base for manure and moisture management
EM-4 spraying	EM-4 Livestock was sprayed on the litter from approximately 2 weeks of age until harvest, 3 times per week, in the morning	Intended to support litter decomposition and odor reduction
Litter stirring	Litter was stirred or loosened 3 times per week, on the same days as EM-4 application, in the afternoon.	Intended to reduce caking, maintain litter friability, and limit moisture accumulation

Table 2 indicates that the farm relied on a layered control approach: infrastructure reliability, rapid emergency response, ventilation and equipment maintenance, and active litter management. This approach is consistent with recent literature showing that ammonia emissions in broiler houses are strongly influenced by litter condition, ventilation efficiency, temperature, humidity, and manure-handling practices. Experimental evidence also shows that improved air movement can reduce ammonia release by improving litter condition, while environmental monitoring systems can support faster correction when house conditions begin to deteriorate (Bist et al., 2023; Godinho et al., 2025).

The litter-management component deserves particular attention because it was the most direct intervention aimed at the manure-litter interface, where ammonia is generated. The manuscript states that EM-4 spraying and litter stirring were started at approximately 2 weeks of age and continued three times weekly until harvest. The authors also observed that this practice helped maintain drier, less compact litter and improved ease of litter handling. This field observation is directionally consistent with a recent Indonesian study reporting reduced ammonia concentration in semi-closed broiler housing after EM4 spraying. However, the present manuscript did not include a controlled before-versus-after comparison (Azzahra et al., 2024).

Measured ammonia concentration inside the closed house

The manuscript reports NH3 measurements at eight points distributed across five longitudinal zones of the house. All recorded values were 10 ppm. The reported observations are reorganized in Table 3 for clarity.

To improve readability, the measurement results are reorganized below without changing the reported values.

Table 3. Reported NH3 concentrations at the measurement zones in CH Kembar Farm.

Measurement zone	Sampling points reported	NH3 concentration (ppm)
15 m	2 points (left and right sides)	10
30 m	1 point	10
45 m	2 points (left and right sides)	10
60 m	1 point	10
75 m	2 points (left and right sides)	10

Table 3 shows no spatial variation in the reported NH3 measurements, with all eight points yielding the same value of 10 ppm. Within the limitations of the reported method, this finding suggests that air exchange and gas distribution were relatively uniform at the moment of observation. The result also supports the authors' interpretation that the climate-control system and litter-management routine were functioning adequately at the time measurements were taken. However, because repeated measurements over time were not reported, this result should be interpreted as a point observation rather than evidence of stable ammonia control throughout the entire production cycle.

From a practical standpoint, the measured value of 10 ppm is below the 25 ppm threshold value discussed in the source manuscript. It therefore indicates an acceptable in-house condition at the time of testing. This is important because recent studies have shown that ammonia risk in broiler houses rises as housing conditions deteriorate and that elevated ammonia exposure is associated with increased health and welfare problems. Accordingly, the present result is best interpreted as evidence that the farm’s combined management practices were sufficient to keep NH3 at a relatively low level during the specific observation period (Barbosa et al., 2024).

Ammonia concentration and respiratory implications

The original manuscript discusses the relationship between ammonia exposure and respiratory disturbances among workers. However, no direct medical examination, pulmonary-function testing, or standardized health assessment was reported for either workers or birds. Therefore, this part of the discussion should be interpreted as a literature-based health implication rather than as a measured health outcome of the present study.

Even with that limitation, the discussion remains relevant because ammonia is recognized as a poultry-house air pollutant. Recent studies and reviews indicate that ammonia exposure is associated with respiratory irritation and broader health and welfare risks, and that these risks tend to increase with increasing concentration and exposure duration. In this context, the recorded level of 10 ppm at CH Kembar Farm is more favorable than levels commonly associated with poor litter condition and increased risk. Nevertheless, the manuscript appropriately notes that worker protection is still necessary during litter removal after harvest, because ventilation systems may be turned off and localized ammonia release from disturbed litter may temporarily increase.

Estimated feces production and interpretive limitations

The manuscript also presents a theoretical estimation of manure production for the reported flock size of 27,000 birds. Using an assumed feces production rate of 0.15 kg/bird/day over a 42-day rearing period, the manuscript estimates total feces generation at 170,100 kg per cycle, equivalent to 170.1 t/cycle. Based on the cited conversion used in the draft, this value was further translated into a theoretical ammonia mass of approximately 2.9 t/cycle. These calculations may be retained as rough indicators of potential manure load under the stated assumptions.

However, the subsequent conversion of total theoretical ammonia mass into an in-house concentration expressed in ppm should be treated with caution and is not retained here as a validated concentration result. Airborne ammonia concentration is a dynamic variable that depends on emission rate, house volume, ventilation rate, air exchange, litter moisture, temperature, pH, and timing of measurement. For that reason, a cumulative cycle mass of potential ammonia cannot be directly equated with a single in-house ppm value without additional assumptions and time-resolved emission data. Recent literature consistently emphasizes that indoor NH3 concentration reflects the interaction between manure properties and environmental management, not manure mass alone. Therefore, the measured 10 ppm should be regarded as the actual empirical result of this study. In contrast, the manure-based calculations should be treated only as an illustrative estimate of potential waste load.

Overall, the results indicate that CH Kembar Farm maintained a relatively low measured NH3 concentration through a practical combination of backup electrical preparedness, alarm-based emergency response, maintenance of ventilation equipment, and routine litter treatment. The main strength of this study is its documentation of real farm practice under commercial tropical conditions. Its main limitation is that the evidence is based on a single farm, a single monitoring approach, and a limited measurement description, so the findings are best interpreted as a well-documented case study rather than a generalizable performance benchmark for all closed-house broiler systems.

CONCLUSION

This study demonstrated that ammonia control in the closed-house broiler system at CH Kembar Farm, Moncongloe Bulu, was supported by the integrated implementation of environmental-control management and litter-handling practices. Routine maintenance of exhaust fans, blower fans, cooling pads, and backup electrical systems, together with regular litter treatment through EM-4 application and litter stirring, constituted the main strategy used to reduce ammonia accumulation inside the house. Within the observational scope of this study, these practices were associated with a reported NH3 concentration of 10 ppm at all measurement points, indicating that the in-house ammonia level remained within an acceptable range during the measurement period. The results indicate that effective ammonia mitigation in closed-house broiler production depends not only on the availability of modern housing technology but also on the consistency of daily operational management. In this context, the study provides practical field-based evidence that routine management interventions can support air-quality control in commercial broiler production under tropical conditions.

Future studies should adopt a more rigorous monitoring design by measuring ammonia repeatedly across different production phases and by integrating additional environmental and production indicators, including litter moisture, litter pH, ventilation rate, bird performance, and health-related outcomes. Comparative studies across farms and housing systems are also needed to evaluate the broader applicability of the management practices identified in this study.

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