

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; 10(2): 607-609
www.biochemjournal.com
Received: 21-11-2025
Accepted: 26-12-2025

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Impact of calcium hydroxide and ammonium sulphate application during downtime and its influence on coccidial oocyst load and broiler performance under deep litter system: A field study

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i2h.7679>

Abstract

Coccidiosis remains a persistent problem in broiler production under deep litter systems due to the high resistance of sporulated *Eimeria* oocysts to routine disinfectants. A field trial was conducted to evaluate the effect of calcium hydroxide combined with ammonium sulphate applied during downtime on environmental oocyst load and broiler performance. This study was carried out using 5,000 Vencobb 430Y straight-run broiler chicks (2,500 birds per shed) over a five-week period. Two sheds were evaluated: a negative control (NC) without chemical treatment and a treated shed (T1) disinfected using calcium hydroxide and ammonium sulphate during downtime. Weekly performance parameters and litter oocyst per gram (OPG) counts were recorded. The treated shed showed a marked reduction in oocyst load ($p < 0.01$) along with improved feed conversion ratio and reduced cumulative mortality compared to the control. The findings confirmed the effectiveness of calcium hydroxide and ammonium sulphate as a practical, non-antibiotic strategy for coccidiosis control under deep litter conditions.

Keywords: Coccidiosis, calcium hydroxide, ammonium sulphate, oocyst, deep litter, broiler performance

Introduction

Coccidiosis is one of the oldest known diseases in poultry. It was described already by Ernest Edward Tyzzer in 1927 (Tyzzer, 1927) ^[12]. Up till today, it causes major economic losses worldwide. Despite intensive research for so many years, this disease is still not fully controlled. Yet it is clear that management, immunology and feed are important aspects to controlling coccidiosis (Chapman, 2014, Blake *et al.*, 2020) ^[6, 3]. The infective form of the coccidia is the oocyst (egg) which is shed with faeces of the infected bird (McDougald, 2003) ^[8]. A susceptible chicken gets infected when it eats one or more sporulated oocysts from the environment (Williams, 2005) ^[14]. In practice it needs usually two or three cycles like that to get sufficient infection pressure to cause clinical problems. This will only occur if birds are kept in contact with the manure (Chapman, 2014) ^[6]. In caged housing systems coccidiosis problems are rare. There is hardly any farm without oocysts. These oocysts are easily spread all over the surroundings of the farm and can survive for a long time inside and outside poultry houses. They are very resistant to common disinfectants and to environmental extremes (Chapman, 2018) ^[5]. Oocysts survive for weeks in soil, but survival in poultry litter is only a few days, due to ammonia and heat produced by composting. Coccidia have a live cycle of approximately 14 days in the intestine of the chicken and the immune system of the chicken will definitely detect these. Within a few hours after ingesting the oocyst, the host chicken begins to respond to the infection and by around four days this will lead to a protective immune response. This response is specific to the strain of coccidia (*Eimeria*) involved. The efficacy of the response depends on the number of oocysts ingested and the state of the mucosal immune system. Traditional environmental control methods using alkaline compounds and ammonia-generating agents have been shown to reduce oocyst viability. Calcium hydroxide increases litter pH, while ammonium sulphate reacts with lime in the presence of moisture to release ammonia, which is lethal to sporulated oocysts (Ruff *et*

al., 1984; Williams, 1997) [9, 13]. Hence, the present study was conducted to evaluate the field-level effectiveness of this method using weekly production data and litter oocyst counts.

Materials and Methods

A field trial was conducted in a commercial broiler farm operating a deep litter system, in Coimbatore district of Tamil Nadu state. A total of 5000 Vencobb 430Y straight-run chicks were placed in a two shed, with each 2500 birds. The experimental period lasted for five weeks. The experimental design of the trial is presented in the Table 1. During the downtime period in the empty shed (T₁), the following treatment was applied. Per 100 m² floor surface: Calcium hydroxide (slaked lime): 10 kg and Ammonium sulphate (fertiliser grade): 20 kg. The dry materials were evenly spread on the shed floor, followed by spraying approximately 100 litres of water to activate the reaction. The shed was kept closed for 24 hours, allowing ammonia generation and contact with oocysts and was then thoroughly ventilated before litter placement and chick entry.

Table 1: The experimental design of the field trial

Group	Description
NC	Negative control shed with one-month downtime and no chemical treatment
T ₁	Shed treated with calcium hydroxide and ammonium sulphate during downtime

All other management practices, including feed, water, vaccination, stocking density and biosecurity were identical for both sheds. No anticoccidial drugs were used during the trial. The feed ingredients and nutrient composition of the broiler feed used in the trial is presented in the Table 2 and 3, respectively.

Table 2: The composition (%) of the broiler feed

Ingredients	Pre starter	Starter	Finisher
Maize	53.5	55.7	60
Soybean meal	38.7	35.6	30.5
Calcite	0.9	0.9	0.9
Dicalcium phosphate	1.5	1.4	1.3
Rice bran oil	3.5	4.6	5.6
DL-Methionine	0.34	0.33	0.03
L-Lysine	0.31	0.24	0.02
Betaine	0.1	0.1	0.1
Sodium Bicarbonate	0.1	0.1	0.1
Salt	0.3	0.3	0.3
Threonine	0.05	0.05	0.05
Vitamin premix	0.6	0.5	0.5
Choline chloride	1	1	1
Inorganic Trace mineral	1	1	1
Organic mineral	0.25	0.25	0.25
Antioxidant	0.125	0.125	0.125
Phytase	0.1	0.1	0.1
Multienzyme	0.5	0.5	0.5
Emulsifier	0.25	0.25	0.25
Acidifier	1	1	1
Probiotic	0.15	0.15	0.15
Liver supplement	0.5	0.5	0.5
Toxin binder	1	1	1
Vitamin E	0.1	0.1	0.1
Total	100	100	100

Table 3: The nutrient composition (%) of the broiler feed

Nutrients	Pre starter	Starter	Finisher
Crude Protein	22.49	21.26	19.29
ME Mcal/Kg	2.99	3.09	3.19
Calorie protein ratio	133.00	145.09	165.44
Crude Fibre	3.92	3.80	3.62
Crude fat	5.42	6.53	7.59
Lysine %	1.48	1.34	1.18
Methionine	0.73	0.70	0.65
Cystine	0.37	0.35	0.33
Methionine + cystine	1.10	1.06	0.98
Arginine	1.58	1.48	1.32
Threonine	1.01	0.95	0.86
Tryptophan	0.25	0.23	0.21
Digestible Lysine	1.32	1.19	1.04
Digestible Methionine	0.67	0.64	0.59
Digestible Cystine	0.31	0.29	0.27
Digestible Methionine +Cystine	0.97	0.94	0.86
Digestible Arginine	1.45	1.36	1.21
Digestible Threonine	0.88	0.83	0.75
Digestible tryptophan	0.22	0.21	0.19
Calcium	0.80	0.76	0.73
Total Phosphorus	0.64	0.61	0.58
Available Phosphorus	0.41	0.38	0.36
Linoleic acid	2.37	2.79	3.22
Chloride	0.31	0.30	0.29
Sodium	0.16	0.16	0.16
Potassium	0.93	0.88	0.79

The performance parameters recorded in the trial were weekly feed intake, weekly body weight, feed conversion ratio (FCR), weekly mortality (%) and cumulative mortality (%). The performance parameters were presented descriptively as the study involved one shed per treatment under commercial field conditions. At the end of trial, litter samples were collected from different locations within each shed and pooled into four representative samples. Oocyst prevalence and environmental contamination were quantified by counting oocysts per gram (OPG) of litter/fecal samples using a flotation and microscopic enumeration technique as described by Smith *et al.* (2023) [11]. Further, the OPG egg count of four representative litter samples per treatment were subjected to independent t-test, using SPSS 25.0.

Results and Discussion

The present study demonstrated that although overall growth performance parameters were broadly similar between the two sheds (Table 4), oocyst per gram (OPG) counts were markedly lower ($p<0.01$) in the treated shed (Table 5), indicated effective reduction of environmental contamination (Mathis *et al.*, 2025) [7]. High OPG values in the negative control confirmed the persistence of sporulated *Eimeria* oocysts under deep litter conditions, even after routine downtime, which aligns with recent findings that emphasize the importance of environmental control to reduce infection pressure (Boreddy & Tallapally, 2024) [4]. The observed reduction in environmental oocyst load in the treated group suggests that the combination of calcium hydroxide and ammonium sulphate, which raises litter pH and produces ammonia, interrupted the sporulation cycle of *Eimeria*, similar to how environmental manipulation could influence oocyst viability reported in numerous recent reviews (Mathis *et al.*, 2025; Ahmad *et al.*, 2024) [7, 1].

While performance differences were modest, the improved feed conversion ratio (FCR) and lower cumulative mortality in the treated shed are likely due to decreased subclinical intestinal damage caused by lower coccidial challenge (Mathis *et al.*, 2025) [7]. Recent research underscores how reduction in infection pressure and improved gut integrity support nutrient absorption, leading to better productive performance and overall bird health, particularly under high-intensity systems like deep litter housing (Sharma & Kim, 2024) [10]. Even with emerging alternative strategies such as herbal additives, vaccines and probiotics, environmental control remains a key component of integrated coccidiosis management (Bharti *et al.*, 2025; Sharma & Kim, 2024) [2, 10]. As an overall, the data from this field study confirmed that ammonia-based litter treatment during downtime can be an effective, non-antibiotic strategy to reduce environmental oocyst load and improve broiler performance under deep litter systems.

Table 4: Performance parameters of experimental birds

Groups	1 st week	2 nd week	3 rd week	4 th week	5 th week
Body weight g/day					
NC	193	496	888	1260	1940
T ₁	188	449	875	1430	2030
Feed intake g/day					
NC	183	582	1190	1890	3280
T ₁	171	534	1170	2120	3220
Feed Conversion Ratio					
NC	0.95	1.17	1.34	1.35	1.69
T ₁	0.91	1.18	1.34	1.48	1.62
Mortality %					
NC	1.28	1.04	0.95	0.84	1.70
T ₁	1.01	0.93	0.93	0.93	1.22
Cumulative mortality %					
NC	1.28	2.32	3.27	4.11	5.34
T ₁	1.01	2.00	2.85	3.50	4.20

Table 5: Oocyst per gram egg counts of experimental groups at the end of trial

Sample No.	NC	T ₁
1	14333	432
2	10333	553
3	6733	884
4	7000	438
Mean ± SE	9600 ^a ± 1704	577 ^b ± 108
p value	0.002	

Conclusion

The present field study demonstrated that the application of calcium hydroxide combined with ammonium sulphate during downtime effectively reduced environmental coccidial oocyst load. Further, it improved the feed efficiency, body weight and reduced mortality in broiler flocks. This method represented a simple, economical and non-antibiotic approach for coccidiosis control in broiler farms operating under deep litter systems.

Acknowledgments

The author was very thankful to the farm management, for providing facilities for conduction of field trial with their immense support and cooperation during entire trial period.

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