AMMONIA EMISSION FROM OPEN SIDED BROILER HOUSES WITH DIFFERENT REARING SYSTEMS AND ITS IMPACT ON BROILER PRODUCTION

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June-2021

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REGISTRATION NO. 14-06019

A Thesis

Submitted to the Faculty of Animal Science & Veterinary Medicine,
Sher-e-Bangla Agricultural University, Dhaka-1207, in Partial
Fulfillment of the Requirements for the Degree of

MASTER OF SCIENCE (MS) IN ANIMAL NUTRITION

SEMESTER: January-June/2021

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CERTIFICATE

*This is to certify that the thesis entitled, "**AMMONIA EMISSION FROM OPEN SIDED BROILER HOUSES WITH DIFFERENT REARING SYSTEMS AND ITS IMPACT ON BROILER PRODUCTION**."*

*Submitted to the Department of Animal Nutrition, Genetics and Breeding, Faculty of Animal Science and Veterinary Medicine, Sher-e-Bangla Agricultural University, Dhaka-1207, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** (MS) in **Animal Nutrition** embodies the result of a piece of bonafide research work carried out by **S. M. EMDADUL HAQUE**, Registration No. **14-06019**, Semester: **JANUARY-JUNE/2021** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has been duly acknowledged by her.

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Dedicated

To

My Beloved Parents

ACKNOWLEDGEMENTS

All praises are due to Almighty Allah Who enable me to complete this thesis. I would like to express my heartfelt respect, deepest sense of gratitude, profound appreciation and ever indebtedness to my ***Supervisor Dr. Md. Mufazzal Hossain****, Professor, Department of Animal Nutrition, Genetics and Breeding, Sher-e-Bangla Agricultural University (SAU), Dhaka for his sincere guidance, scholastic supervision, constructive criticism, and constant inspiration throughout the course and in preparation of the manuscript of the thesis.*

The author expresses his sincere appreciation, profound sense, respect and immense indebtedness to respected ***Co-Supervisor Dr. Lam Yea Asad****, Professor, Department of Animal Nutrition, Genetics and Breeding, Sher-e-Bangla Agricultural University (SAU) for extending generous help, scholastic guidance, constructive criticism, continuous inspiration during the research work and preparation of the manuscript of the thesis.*

The author is especially grateful to Md. Mahfuj Ullah Patoary, Assistant professor, Department of Animal Nutrition, Genetics and Breeding, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207 for his advice and sincere co-operation in the completion of the study.

The author acknowledges Sher-e-Bangla Agricultural University Research System (SAURES) for providing financial aid that enable him to complete the research work more smoothly.

The author would like to express his last but not least profound gratitude to his beloved father, mother, brothers and sisters who sacrificed all their happiness during the whole study period in his life as well as during this MS study. He is grateful to all of his relatives for their inspiration, blessing and encouragement that opened the gate of higher studies in his life.

Finally, the author is also boundless grateful to all the staffs of the Department of Animal Nutrition, Genetics and Breeding, Sher-e-Bangla Agricultural University, Dhaka-1207 for their co-operation.

The Author

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LIST OF ACRONYMS AND ABBREVIATION

ABBREVIATION		FULL MEANING
ANOVA	=	Analysis of variance
Avg.	=	Average
BWG	=	Body weight gain
DP	=	Dressing percentage
e.g.	=	For example
et al.	=	And others/associates
FC	=	Feed consumption
FCR	=	Feed conversion ratio
g	=	Gram
i.e.	=	That is
L	=	Liter
MS	=	Master of science
No.	=	Number
SAU	=	Sher-e-Bangla Agricultural University
SE	=	Standard Error
SPSS	=	Statistical package for social sciences
Viz.	=	Such as
hrs.	=	Hours
℃	=	Degree Celsius
/	=	Per
%	=	Percentage
±	=	Plus-minus
:	=	Ratio
m/s	=	Meter per second
mg	=	Mille gram
Cu. Ft.	=	Cubic feet
BCR	=	Benefit Cost Ratio

Ammonia Emission from Open Sided Broiler Houses with Different Rearing Systems and Its Impact on Broiler Production

ABSTRACT

The demand for poultry products in Bangladesh has grown significantly. Poultry sector needs to increase significantly to meet the growing domestic demand. However, atmospheric ammonia inhibits broiler performance. Therefore, a study was planned to investigate the effects of ammonia emission from different types of broiler houses and its impact on productivity. A total of 135 day-old Lohmann broiler chicks were reared at SAU Poultry Farm, Dhaka-1207. Chicks were divided randomly into 3 experimental groups of 3 replications R_1, R_2 and R_3, where each replication contains 15 birds. These three treatment groups were designated as T_0, T_1 and T_2. T_0 was control group which indicated without ceiling fan. Whereas T_1 and T_2 were ceiling fan and ceiling fan with exhaust fan, respectively. Results demonstrated that the average ammonia level was same at the end of 1st week, however it varied significantly ($P<0.05$) at the end of 2nd, 3rd and 4th week. The control group (T_0) indicated the highest ammonia emissions at the end of 2nd, 3rd and 4th week and T_2 showed the lowest ammonia emissions at the end of 2nd, 3rd and 4th week. At the end of 4th week significantly ($P<0.05$) higher emissions of ammonia was found in control group T_0 ($11.63^{a}\pm0.17$ ppm) and lower was found in treated group T_2 ($6.53^{c}\pm0.14$ ppm). BWG (Body Weight Gain), BW (Body Weight) and FCR at the end of 4th week were insignificant ($P>0.05$) in different group, however better BWG, BW and FCR were found in treated group T_2 (BWG 1812.33±26.82 gm, BW 1852.76±26.82 gm, FCR 1.31±0.04). Dressing percentage was non significantly ($P>0.05$) higher in T_1 (65.10±1.05) and T_2 (65.72±0.35) than control group T_0 (64.33±0.48). The weight of spleen and gizzard in exhaust fan treated group T_2 was significantly higher ($P<0.05$) than control group (T_0). The weight of thigh, drumstick and back in exhaust fan treated group T_2 was non significantly higher ($P>0.05$) than control group (T_0). Survivability rate (%) of the chicken was significantly higher ($P<0.05$) in T_2 and T_1 group than control group (T_0). In case of cost benefit ratio analysis, BCR was significantly ($P<0.05$) higher in treatment group T_1 (1.35±0.01) and T_2 (1.35±0.01) than T_0 (1.30±0.02). Therefore, the research recommended that poultry house with exhaust fan at bird's level could be used on broiler production for better performance and profitability.

CHAPTER I

INTRODUCTION

Poultry is the most important and advanced segment of the livestock sector in Bangladesh. Over the years, the demand for poultry products in Bangladesh has grown significantly; per capita consumption per year increased to 8.5 kg poultry meat and 5.1 kg (104 pieces) eggs (DLS, 2019). However, to meet the growing domestic demand, the productivity of the Bangladesh poultry sector needs to increase significantly. But atmospheric ammonia inhibits broiler performance.

Ammonia is a colorless gas under the standard conditions and is the primary basic gas in the atmosphere. Ammonia emissions from broiler litter can not only cause environmental problems, but also be detrimental to the health, welfare, and performance of birds. High NH_3 concentrations in poultry houses reduce growth rate (Reece *et al*., 1979, 1981; Moore *et al*., 1999), feed efficiency (Caveny and Quarles, 1978; Caveny *et al*., 1981), and egg production (Deaton *et al*., 1984). Health and welfare problems associated with high NH_3 concentrations in poultry houses include damage to the respiratory tract (Nagaraja *et al*., 1983), increased susceptibility to Newcastle disease (Anderson *et al*.,1964), incidence of airsacculitis (Oyetunde et al., 1976), increased *Mycoplasma gallisepticum* (Sato *et al*., 1973), and incidence of kerato conjunctivitis (Bullis *et al*., 1950). The effects of high NH_3 concentrations in poultry facilities on human health are also a concern (Moore *et al*., 1996). Recommended ammonia concentration in broiler houses is 25 to 50 ppm (Miles *et al*., 2004). Ammonia is formed from the breakdown of nitrogenous wastes (undigested proteins and excretory uric acid) in poultry manure by microorganisms. Factors that directly control the NH_3 formation are pH, temperature, and moisture level of the litter (Elliott and Collins, 1982; Carr *et al*., 1990). Temperature, moisture, and pH have direct influence on the living environment of the microorganisms that facilitate the conversion of uric acid to ammonia. High house temperature increase both bacterial activity and ammonia production, with a 1 to 2^0 C increase having a large effect on ammonia levels.

Different supplementary cooling and ventilation systems use as heat stress alleviation methods (Liang *et al*., 2012; Mutaf *et al*., 2009; Saraz *et al*., 2011; Haeussermann *et al*., 2007; Liang *et al*., 2010; Tao and Xin, 2003). However, most of the heat stress

alleviating methods are very expensive and difficult to maintain; Some of them could create an unconducive environment for confined birds. As a result, there is a need for an alternative method to an environmental control system for enhancing heat transfer and reducing ammonia emission from broiler chickens during hot weather periods. In order to reduce heat stress in broiler buildings during hot weather, Al-dawood & Buscher (2014) conducted a study to investigate the performances of four different fans (mixing and ceiling), used as supplementary cooling system, for providing optimal air velocity for broiler chicken during hot weather. For birds to be cooled during hot weather periods, air movement provided by air velocities at the inlet, seems to be an offering and very cheap strategy (Huang *et al*., 2012; Zhu *et al*., 2005) for improving airflow at the microclimate of broiler chickens. During hot weather periods, maximum air movement is expected in the broiler occupied zones. This is difficult to achieve as a result of limited air velocity reaching the broiler occupied zone when the inlets are widely opened (Albright, 1990). Integrating inlet turbulence of the ventilation system of broiler buildings could direct air flow to the broiler occupied zones that could balance the higher temperature during hot weather periods. Since turbulence increases the cooling effect of airflow (Huang *et al*., 2014), the impact of air movement in the broiler occupied zones on the heat transfer from broilers could be increased with the incorporation of higher inlet turbulence. Sartor *et al*., 2001 evaluated the performance of evaporative cooling systems consisting of different types of ventilation systems.

Good ventilation system is essential for heat stress management. Removes the moisture loaded air from the poultry house and enter equal amount of fresh air from outside. Ventilation system should be maximized as the air movement assist removal of ammonia, moisture and carbon dioxide from the poultry house and enter fresh oxygen from outside (Butcher and Miles, 2012). Proper ventilation houses can provide consistent airflow patterns. Tunnel ventilation connects moving air of building from inlets to exhaust fans, providing high airflow speed. This fast air movement increases convective heat loss, reducing the body temperature of birds. The air velocity of tunnel ventilation is about 350 ft./min. Evaporative cooling pads works on the same cooling principle as foggers, air is cooled inside the house when it passes through the cooling pads. Circulation fans are recommended for proper ventilation in a good ventilated house for maximizes air movement over the birds to increase convective cooling. The

installation of circulation fans at 1-1.5 meter above the floor and tilted downward about 5^0 angle for producing maximum air over the birds (Daghir, 2008).

The growth of birds raised in no air movement environment was found to be slower because of their inability to eat adequately due to higher air temperature. Mitchell (1985) determined the effects of air velocity on the sensible heat loss from chickens exposed to 20 and 30^0 C. He reported that increasing air velocity over chickens exposed to 30^0 C facilitated convective heat transfer from the chickens to the surrounding air. Yahav *et al*. (2001) studied the effect of air velocity on male broiler chickens exposed to 35^0 C air temperature and 60 % relative humidity. They reported that the body weight gain, feed intake and feed efficiency of broiler chickens were 28, 15 and 12 % higher when air velocity was increased from 0.5 to 2.0 m/s.

Objectives:

From the above consideration, objectives of the study are as follows-

- ✓ To find out ammonia emission in different types of broiler housing system;
- ✓ To investigate impact of ammonia on broiler performance;
- ✓ To determine benefit cost ratio of broiler in different types of broiler housing system.

CHAPTER II

REVIEW OF LITERATURE

An attempt was made in this section to collect and study relevant information available regarding to ammonia emission from open sided broiler houses with different rearing systems and its impact on broiler production, to gather knowledge helpful in conducting the present piece of work.

2.1 Ways of ammonia production

Ammonia is a colorless, highly irritant alkaline gas, which is produced during the decomposition of organic matter by bacterial deamination or reduction of nitrogenous substances. Ammonia often accumulates in high concentration when poultry are confined in building and provided with artificial heat and ventilation. The formation of ammonia in poultry house has been attributed by several workers to microbial decomposition of uric acid in the manure. The decomposition of uric acid and subsequent production of ammonia are the results of a series of reactions in which urea is formed from allantois which in turn is a product of uric acid break down. The first enzyme in the pathway is urease which is a metal enzyme containing (Vogels and Vander Drift, 1976). The enzyme appears to be highly specific, with oxygen being the only known electron acceptor in reaction and precise mechanism of urease is not known. Urease is not present in anaerobes. The ability to decompose uric acid may be adoptive rather than constitutive as Rouf and Lomprey (1968) observed while studying aerobic urate decomposition. They recorded disappearance of uric acid with cultures of *Aerobacter aerogenes, Klebsiella pneumoniae, Serratia kiliensis, Pseudomonas fluerescens, Pseudomonas aeroginosa* and *Bacillus species*. Other system of ammonia production appears to be due to oxidation of uric acid by Lactoperoxidase-hydrogen peroxide, Verdoperoxidase-hydrogen peroxide and urease like reactions have been observed to occur via the cytochrome oxidase system (Vogels and Vander Drift, 1976). Not all the organisms are capable of decomposing uric acid and convert it completely to ammonia. Some are only able to degrade uric acid to urea or other intermediates and lack the enzyme necessary for the conversion of these intermediates to ammonia. Therefore, in the poultry litter and manure, groups of organisms must exist, their combined effect being the complete degradation of uric acid to ammonia and carbon

dioxide. Schefferle (1965) suggested that the uric acid decomposing bacteria might comprise as much as a quarter of the total bacterial population. The observation of the study was that the unused litter was strongly acidic and contained few uric acid lytic organisms while used litter was alkaline and had high number of uric acid decomposers. The aerobic population of uric acid decomposers was more significant in ammonia production than the anaerobic population. (Ivos *et al.,* 1966) reported that decomposition of uric acid and the resulting ammonia concentration in the air was thought to be dependent on a number of factors such as litter moisture content, temperature and P^H. Condensation of humidity can increase in poorly insulated houses in winter, results in wet litter, there by encouraging ammonia release.

Burnett and Dondero (1969) reported that formation of ammonia in poultry houses has been attributed to microbial decomposition of uric acid in the manure. Lovett *et al.* (1971) isolated 17 species of organisms from litter including *Penicillium species*, *Scopulariopsis species*, and *Candida species*. They found that *Penicillium species* is dominant in acidic litter and *Scopulariopsis species* is dominant in alkaline litter. Dennis and Gee (1973) studied the microbial flora before and after poultry houses had been used for a single crop of birds. They observed that *Parcilomyces species*, *Trichodenna species*, *Aurobacidium pullulans* and *Hylodendron lignicola* were predominant in fresh litter while *Scopulariopsis brevicaulus* and *Aspergillus* species were predominant in used litter. They also observed that the total bacterial counts of litter samples were consistently higher after 6 weeks of bird rearing than initial litter samples. Kitai and Arakawa (1979) demonstrated the role of microorganisms in ammonia release by sterilizing broiler excreta at 121 % for 20 minutes. When this material was incubated at 33^0 C for 24 hrs little ammonia gas was released. Elliott and Collins (1982) observed that the bacterial activity and ammonia production increased at higher temperature and a small increase in air temperature of 1-2 % will have a large effect upon ammonia levels in intensive housing. Belyavin (1992) reported that most noxious gas in animal housing was a product of bacterial breakdown of uric acid. A. Al-Homidon (2003) indicated that the most important factors influencing ammonia production were air temperature, ventilation, humidity, age of litter, litter pH, moisture content, litter type, stocking density and age of birds.

2.2 Ammonia concentration in poultry houses

Anderson *et al.* (1964a) reported 50 to 100 ppm of ammonia in commercial poultry houses during the winter months and associated this high ammonia concentration was due to reduced ventilation in poultry houses. Lebenda (1965) identified ammonia as the most common and abundant noxious gas in the atmosphere of animal building. Lillie (1970) indicated that failure to maintain proper ventilation in poultry houses in colder climate caused buildup of gases in manure rapidly which often may reach harmful levels. The symptoms of ammonia irritation included watery eyes, closed eyelids, rubbing of eyes with the wings, decreased growth rate, huddling and unthrifty appearance. Reece *et al.* (1979) reported that ammonia release was influenced by pH of the litter. Further they reported that very little ammonia was released from litter with pH less than 7 but it was rapidly released from litter with pH more than 8. Reece *et al.* (1981) found that the ammonia levels were highest during the first few weeks of growth, but as the birds grew the ammonia levels in the houses decreased. With rising cost in both labor and material in recent years a number of poultry farmers are reusing old litter (Caveny *et al.,* 1981). This has led to production of unacceptably high amounts of ammonia. The ammonia gas is detectable by humans at a concentration of 25 ppm or more, while the maximum concentration that humans can with stand is 100 ppm for eight hours (Mourn *et al.,* 1969). The problem of increased ammonia production is seen more in grown out phase of broiler production.

O'conner *et al.* (1987) recorded mean daily ambient ammonia concentration ranged from 17 to 123 ppm in broiler breeder farms in Canada and this was considered to be hazardous to both operators and birds. Theresa and Wathes (1989) found that ammonia concentration increased with increasing age of birds and reached a plateau of 15.5 pl/l by 7 weeks of age. Weaver and Meijerhof (1991) in their study shown that the ammonia levels in poultry sheds were more variable but generally increased with increase in relative humidity from 45 to 75 percent. They suggested that increased relative humidity in poultry houses also increased litter moisture leading to increased ammonia production. Wathes *et al.* (1997) in their study of twelve poultry houses in United Kingdom found that the minimum levels of ammonia concentration were significantly higher in winter but not in summer. Groot Koerkamp *et al.* (1998) in a study of ten poultry houses, with replicated measurement under summer and winter conditions,

recorded mean 24-hours ammonia concentration in poultry houses ranging from 1.5 to 30 ppm.

Demmers *et al.* (1999) studied ventilation rate and ammonia emissions from a broiler house and noticed that the ventilation influenced ammonia concentration not only by dilution and extraction but also due to effects of temperature and humidity of incoming air. Wheeler *et al.* (2003) measured average ammonia concentration in 48-hours period over reused litter in a Pennsylvania commercial house. They reported that the ammonia concentration ranged from 85 to 129 ppm. Diurnal variations in ammonia concentration for this house were as much as 20 ppm above or below the average determined concentration.

2.3 Effects of ammonia on growth performance

Bullis *et al.* (1950) indicated that ammonia at concentration commonly occur in poultry house resulted in decreased weight gain and kerato conjunctivitis. Charles and Payne (1966a) observed that the chicks exposed to 100 ppm ammonia caused a reduction in respiration rate and depth. They attributed the same to a change in blood pH due to ammonia byproducts from the lungs. This in turn was thought to affect the pH sensitive center of respiratory control in the brain so causing a reduction in respiration rate. Although they have observed a small but significant changes in blood P^H after exposure to 75 ppm ammonia for 15 minutes the significance of these pH differences in relation to reduced respiration is still uncertain. They also suggested that, as body heat loss was lowered by reduced respiration rate, energy requirements were less and appetite reduced. Several workers observed reduced appetite and the resulting decreased body weight gains on exposure to ammonia. Charles and Payne (1966b) recorded reduction in feed consumption, live weight gains and total egg production, along with a marked delay in sexual maturity, when White Leg Horn chickens were exposed to 78 ppm of ammonia per liter of air. Kling and Quarles (1974) observed that ammonia stressed birds had significantly lower body weight than unstressed birds at 8 weeks of age. They reported increased ammonia with increased litter moisture which might have caused by increase in relative humidity which lead to ammonia stress in birds.

Caveny and Quarles (1978) stated that exposure of broiler to ammonia at concentrations of 0, 25 and 50 ppm during 1 to 28 days brooding period reduced their feed efficiency.

Quarles and Caveny (1979) recorded reduced body weight and feed efficiency when broilers were exposed to ammonia (<50 ppm) during growing period (4-8 weeks). Reece and Lott (1980) studied the effect of ammonia during brooding on body weight gain, feed conversion and mortality pattern. Broilers exposed to ammonia (25 to 200 ppm) for four weeks of brooding period showed less body weight as compared to controls. Caveny *et al.* (1981) observed a significant reduction in the feed efficiency in broilers exposed to 50 ppm ammonia from 1-49 days of age. Feed efficiency was found to improve with lower levels of ammonia. Johnson *et al.* (1991) found that a combination of stressors (ammonia exposure and heat) affected not only feed intake but also feed conversion efficiency of chicks. Emeash *et al.* (1998) found reduction in feed intake, weight gain and feed conversion efficiency in 2 weeks old broiler chicken exposed to a combination of aerial pollutants (ammonia, dust and carbon dioxide).

Kristensen *et al.* (2000) recorded changes in the behavior of laying hens when exposed to ammonia concentration ranging from 0 and 25 ppm. Authors further suggested that ammonia may be aversive to poultry with a threshold between 0 and 25 ppm. Miles *et al.* (2004) studied the effect of ammonia on modern commercial broilers. They found that the final body weight was significantly depressed by 6 and 9 per cent for 50 and 75 ppm concentration of ammonia. There was a reversal in body weight gain after ammonia treatment was discontinued at 4 week of age.

2.4 Adverse effects of ammonia on health

Ammonia is recognized as one of the most prominent contaminants in poultry houses. Ammonia is water soluble and can thus be absorbed in dust particles and litter as well as in mucous membranes (Visek, 1968) producing ammonium hydroxide. It is toxic to animal cell and known symptoms of ammonia poisoning include kerato conjunctivitis, coughing, sneezing and dyspnea (Blood and Studdert, 1993). Seasonal variation in ammonia concentration can occur as a result of reduced ventilation rates in the winter months in order to conserve heat (Maghirang *et al.,* 1991). Distribution of ammonia in the poultry houses depends on the ventilation system, particularly the air circulation as well as poorly maintained waterers and drinkers, bird stocking density and flock behavior (Weaver and Meijerhof, 1991). Bullis *et al.* (1950) reported kerato conjunctivitis in chickens featured by corneal lesions, marked photophobia, rubbing of the eyes and slight lacrimation due to ammonia gas in the poultry houses. Faddoul and

Ringrose (1950) observed that exposing birds to high concentration of ammonia for long duration lead to kerato conjunctivitis in turkeys. Dalhamm (1956) suggested that irritant gases such as ammonia impaired mucus flow and ciliary action in the trachea resulting in lowered resistance to respiratory infections. Caranghan (1958) observed outbreak of kerato conjunctivitis in broilers and suggested that the presence of ammonia in broiler houses was the cause for outbreak. Affected birds had closed eyelids, photophobia, frequent rubbing of eyes with the wings and back. Valentine (1964) suggested that ammonia concentrations of 60 to 70 ppm predisposed the birds to respiratory disease and increased the risk of secondary infections.

Anderson et al. (1966) exposed birds to 30 ppm of ammonia, 5000 ppm of carbon dioxide and 0.39 mg/cu. ft. of dust for six days. They observed loss of cilia and increased goblet cell activity both in the nasal and tracheal epithelium. Anderson *et al.* (1968) noted considerable loss of cilia in the tracheal epithelium along with increase in mucous secreting goblet cells and inflammation of lungs in turkeys exposed to 100 ppm of ammonia. Further, they also noticed areas of consolidation in lungs. Ernst (1968) reported that birds breathing in an atmosphere containing increased concentration of ammonia could develop pathologic changes in their respiratory tract including air sacculitis. Secondary bacterial and viral infections can then complicate the damage. Sato *et al.* (1973) demonstrated that ammonia in the poultry shed remarkably enhanced the multiplication of *Mycoplasma gallisepticum* and *E. coli* in the respiratory tract. Quarles and Kling (1974) noticed that at low levels of ammonia concentration, damage to the respiratory tract became obvious when the birds were subjected to infectious microorganisms. According to them, this apparent decrease in resistance to infection due to ammonia appeared to be a factor in vaccination stress.

Christopher (1975) recorded that chicks exposed to high concentration of ammonia had extensive degeneration in liver, congested firm lungs and hemorrhagic kidneys and trachea. Oyetunde *et al.* (1978) reported that exposing birds continuously for four weeks to 100 ppm of ammonia in addition to dust and *E. coli* resulted in mild to moderate pathological changes in trachea, lungs and air sacs. When exposed to a combination of *E. coli* and either ammonia or dust, the birds manifested marked deceleration of the epithelium of the upper portion of the trachea and increased mucus secretion leading to multiplication of *E. coli* organism. The latter resulted in acute

inflammatory response, characterized by congestion, edema, heterophill and mononuclear cell infiltration in the respiratory tract. Poll *et al.* (1982) observed that the exposure of chickens to ammonia gas caused loss of cilia and epithelium degeneration in the trachea and pulmonary alveoli.

Nagaraja *et al.* (1983) described scanning electron microscopic features of trachea of turkey exposed to 10 and 40 ppm of ammonia. They reported deterioration of mucociliary apparatus in birds exposed to higher dose. Whereas, excessive mucus production, matted cilia and segmented declination in trachea were the features in birds subjected to low levels of ammonia (10 ppm). Nagaraja *et al.* (1984) exposed turkeys to *E. coli* and ammonia at a concentration of 10 and 40 ppm by aerosol method. They noticed significant damage to the tracheal mucus membranes. Further, the turkeys exposed to ammonia had higher number of *E. coli* in their lungs than the controls. Al-Mashhnadani and Beck (1985) studied the surface ultrastructure of the lung and trachea by scanning electron microscopy in broiler birds exposed to 0, 25, 50, 75 and 100 ppm ammonia for seven days. At 100 ppm of ammonia concentration the birds exhibited large number of mucus secreting cells and ciliary loss from the tracheal epithelium. In the lungs there was an increase in the thickness of the atrial walls and shrinking of air capillaries.

2.5 Effects of ammonia on immunosuppression

Anderson *et al.* (1964b) demonstrated experimentally that exposure of chicks to 20 ppm ammonia for 72 hours or 50 ppm ammonia for 48 hours prior to infecting birds with New Castle disease virus by aerosol route, significantly increased the susceptibility of the respiratory tract to the New Castle disease infections. Mourn *et al.* (1969) observed that continuous exposure of birds to 20 ppm ammonia, increased susceptibility to New Castle disease and air sacculitis. Kling and Quarles (1974) noticed that when the birds were exposed to 25 and 50 ppm ammonia from 4-8 week of age, the bursa of fabricius weighed less after infectious bronchitis vaccination than those not exposed to ammonia. They suggested that ammonia stress might have resulted in a more severe reaction to the vaccine eliciting a greater response from the bursa. Quarles and Kling (1974) noticed that at lower concentration of ammonia damage to the respiratory tract only became obvious when the birds were subjected to infectious microorganisms. They

vaccinated the ammonia exposed birds against infectious bronchitis disease at 5 week of age and found that there was decrease in resistance to infection. They suggested that ammonia might be a factor in causing vaccination stress. Karen Devis (1998) reported that production of circulating antibodies by bursa Fabricius was impaired by ammonia, so that when pathogens are inhaled, and the immune cells of the respiratory tract cannot mount a response, neither can the lymphoid system respond. Also ammonia in the air is absorbed into the blood of turkey causes immune-suppression. It prevents phagocytosis of *E. coli* organisms in the blood and suppresses the lysis of *E. coli* organisms within the macrophage cells. It can be a major factor for outbreak of diseases.

2.6 Alleviation of harmful effects of ammonia

Seltzer *et al.* (1969) observed that addition of 4.5kg of paraformaldehyde to 26 m of litter reduced the atmosphere pH to 7 (equivalent to 5 ppm ammonia). However, 21 days after treatment the ammonia concentration was greater than 100 ppm. Paraformaldehyde was found to be effective in controlling ammonia but it decomposes quickly and loses its neutralizing ability within 3 weeks, suggesting that retreatment may be necessary. Torii (1974) reported that clinoptilolite (zeolite) applied directly on dropping or used as boxes containing clinoptilolite hanging from the ceilings of poultry houses reduced the ammonia levels. Parkhurst *et al.* (1974) treated pine saw dust litter with 60 percent acetic acid and 40 percent propionic acid at rates of 1 percent and 3 percent (W/W). A significant reduction in litter pH was observed for 2 weeks at 1 percent level and for 3 weeks at 3 percent level. Authors were of the opinion that reduction in litter pH may suggest reduced ammonia release possibly due to decrease in microbial activity. Reece *et al.* (1979) used monobasic calcium phosphate (superphosphate) and phosphoric acid to suppress ammonia in litter. Phosphoric acid (2.5 molar) solution was sprayed at rate of 1.7 l/m on litter and superphosphate at rate of 0.5 kg/in and 1 kg/m. The ammonia concentration was measured using Matheson-Kitagawa gas detector. They found that phosphoric acid was more effective in controlling ammonia. They also found that all treatments were found to be relating ineffective by 17 days suggesting the need for retreatment. Kitai and Arakawa (1979) studied the use of antibiotics for controlling ammonia production. Thiopeptin or Zinc bacitracin was used at the rate of 100 mg/kg in the diet. The ammonia concentration was measured using Kitagawa gas detector. They found that addition of Thiopeptin or

Zinc bacitracin reduced ammonia production and also had growth promoting properties. Nakaue *et al.* (1981) suggested that surface application of clinoptilolite on clean wood shavings was effective in reducing ammonia at 28 days than at 21 days. An application rate of 5 kg/m on 2P day reduced ammonia concentration by 15 per cent while 5 kg/m on 28 days reduced ammonia concentration by 35 per cent. Moore *et al.* (1994) reported that aluminium sulphate and ferrous sulphate reduced ammonia volatilization from litter by as much as 99 per cent and 58 per cent respectively.

CHAPTER III

MATERIALS AND METHODS

3.1 Statement of the experiment

The research was conducted at Sher-e-Bangla Agricultural University poultry farm, Dhaka, with 135 day-old commercial broiler chicks (Lohmann meat) for a period of 28 days from 18th June to 15th July, 2021 to assess the individual and combined effects of ammonia emission from open sided broiler houses with different rearing systems and its impact on broiler production.

3.2 Collection of experimental birds

A total 135 day-old Lohmann meat broiler chicks were collected from Kazi hatchery distribution point, Savar, Dhaka.

3.3 Experimental materials

The chicks were collected from Kazi hatchery and carried to the university poultry farm early in the morning. Then the chickens were kept in the electric brooders for 7 days by maintaining standard brooding protocol. During brooding time only control treatment was given. After successful brooding the chicks were distributed randomly in three (3) treatments. Each treatment had three (3) replications like R_1, R_2 and R_3 where each replication contains 15 birds. The total number of treatments were three (3) and their replications were nine (9).

3.4 Experimental treatments

T_0: Control-open sided (without exhaust fan) broiler house without ceiling fan facilities
T_1: Open sided (without exhaust fan) broiler house with ceiling fan facilities
T_2: Open sided broiler house with exhaust fan (at bird's level) and ceiling fan facilities.

Table 1: Experimental layout

Distribution of treatments and birds			No. of birds
T_1R_3 (15)	T_2R_2 (15)	T_0R_1 (15)	45
T_0R_2 (15)	T_1R_1 (15)	T_2R_3 (15)	45
T_2R_1 (15)	T_0R_3 (15)	T_1R_2 (15)	45
Total birds			**135**

3.5 Collection of ammonia test kit

To evaluate ammonia emission from broiler houses in different systems and to differentiate the impact on the treatment groups. Ammonia test kit was collected from Netherland because of unavailability in our country.

Table 2: Ammonia test kit description

Parameters	Feature
Brand name	Hydrion
Weight	120.0 gm
Model	CAT# AM-40
NH_3 range	0 to 100 PPM

(Source: Netherland)

3.5.1 Ammonia recorded procedure

Ammonia test kit was used to estimate ammonia emission from broiler houses. At first about 1inch paper was cut from the test kit. Then 1 or 2 drops of distilled water was poured on paper and shaken about 15-20 seconds at bird's level. The color change of paper indicates the amount of ammonia present at bird's level.

3.6 Preparation of experimental house

The experimental house was properly cleaned and washed by using tap water. Ceiling, walls, floor, feeder and waterer were thoroughly cleaned and disinfected by spraying diluted disinfectant solution. The house was divided into 9 pens of equal size using wood materials after proper drying. A group of 15 birds were randomly shifted to each

pen of the 3 treatments. One feeder and one waterer were distributed each pen. The stocking density was 1 m^2/10 birds.

3.7 Experimental diets

Starter and grower commercial Kazi broiler feed were purchased from the market. Starter diet was enriched with following elements:

Table 3: Nutrient contents in starter broiler ration

Name of the elements	%
Protein	21.0
Fat	6.0
Fiber	5.0
Ash	8.0
Lysine	1.20
Methionine	0.49
Cysteine	0.40
Tryptophan	0.19
Threonine	0.79
Arginine	1.26

(**Source**: Kazi Feed, 50 kg feed packet)

Table 4: Nutrient contents in grower broiler ration

Name of the elements	%
Protein	19.0
Fat	6.0
Fiber	5.0
Ash	8.0
Lysine	1.10
Methionine	0.47
Cysteine	0.39
Tryptophan	0.18
Threonine	0.75
Arginine	1.18

(**Source**: Kazi Feed, 50 kg feed packet)

The feeding program was divided into two phases including starter and grower diets that were fed from 0 to 14 days and 15 to 28 days respectively.

3.8 Management procedures

Feed intake and body weight were recorded every week. Survivability was recorded for each replication up to 28 days of age. The following management procedures were followed during the whole experiment period.

3.8.1 Brooding of baby chicks and lighting program

The experiment was conducted 18 June, 2021. The average temperature was 28.07^0 C and the relative humidity was 68 % in the poultry house. Brooding will be done for 1st 2 weeks, in first day temperature will be set 33^0 C and then lowered stepwise to ambient temperature. For the first 4 days, lighting program will be 24 hrs. of light and then stepwise lowered to 21 hrs. of light and 3 hrs of dark. The birds will be housed in three different house, one is an open-sided house with ceiling fan and other is an open-sided house with ceiling fan and tunnel ventilation.

3.8.2 Room temperature and relative humidity

Daily maximum and minimum room temperature and humidity were recorded with the digital hygrometer. Average room temperature and percentage of relative humidity for the experimental period were recorded and collected in a fixed time every day.

3.8.3 Litter temperature

The thermometer was set up in the litter to determine litter temperature. Then this thermometer was held in the litter about 1 minute and read the temperature.

3.8.4 Litter management

Rice husk was used as litter at a depth of 6 cm. Every day remove ammonia gas along with harmful gasses to running exhaust fan of the tunnel ventilation and to reduce parasite infestation. After 3 weeks of age droppings on the upper layer of the litter were cleaned and fresh litter was added.

3.8.5 Feeding and watering

Feed and fresh clean water were given to the bird ad-libitum. One feeder and one drinker were provided in each pen for one group of birds. Everyday feeders were cleaned and drinkers were washed daily morning.

3.8.6 Bio security measures

Recommended vaccination, sanitation program was performed in the farm and which help to prevent the disease from the farm. All chicks were provided Vitamin-ADEK, Vitamin-C, Vitamin-B Complex, Ca and electrolytes.

3.8.7 Vaccination

Vaccines were collected from medicine shop (HIPRA Company) and provided to the birds according to the schedule (Table 4).

Table 5: The vaccination schedule

Age of birds	Name of the disease	Name of vaccine	Route of administration
4 days	IB+ND	HIPRAVIR B1/H120	One drop in each eye
9 days	Gumboro	HIPRAGUMBORO GM97	Drinking water
17 days	Gumboro	HIPRAGOMBORO GM97	Drinking water

3.8.8 Medication

Medicine were collected from medicine shop and offered to the birds according to the schedule. The medication schedule is given in Table 5.

Table 6: The medication schedule

Medicine	Purpose	Dose	Time (Days)
Renasol AD_3E	Vitamin A, D and E	1 ml/1-2 L Water	3-5
CAVIT-P	Calcium and Phosphorus	5 ml/1-2 L Water	4-6
HIPRACHOK AMINO	Vitamin + Amino acid	1 ml/1 L Water	3-5
Liva-vit	Against liver disease	1ml/1 L Water	5-7

3.8.9 Ventilation

The broiler shed was open sided. Due to having short wall, it was very easy to enter fresh air into the farm and remove polluted gas from the farm. Besides ventilation was maintained as per requirement by polythene screen. Exhaust fan was also used in treatment group T_2 for ventilation that reduce NH_3 in broiler house.

3.8.10 Sanitation

Strict sanitary measures were taken during the experimental period. Disinfectant was used to disinfect the feeders, waterers and house also.

3.8.11 Study parameters

Every day, ammonia emission was measured by ammonia test kit in the same time morning 10 a.m. Besides, litter temperature and light intensity was measured also same time. Weekly feed consumption, weekly live weight and death of chicks were recorded to calculate mortality percentage. FCR was calculated from final live weight and total feed consumption per bird in each replication. After slaughter liver, heart, spleen, gizzard, thigh, drumstick, back, wing, and intestine were measured from each broiler chicken. Dressing yield was calculated for each replication to determine the dressing percentage.

3.9 Data collection

3.9.1 Live weight

The initial live weight of day old chicks and weekly live weight of each replication was kept to find out the final live weight record per bird.

3.9.2 Feed consumption

Daily feed consumption was recorded of each replication to get weekly and total feed consumption.

3.9.3 Mortality of chicks

Daily death record for each replication was counted till 28 days to calculate chick's mortality.

3.9.4 Dressing yield

Dressing yield was calculated by using the following formula-

Live weight – (blood + feathers + shank + head + liver + heart + digestive system)

3.9.5 Dressing percentage determine procedures of broiler chicken

Three birds were taken randomly from each replication at the 28th days of age and slaughtered to calculate dressing percentage of broiler chicken. All birds were slaughtered by halal method with knife. All the live birds were weighed before slaughter. Birds were slaughtered by severing jugular vein, carotid artery and the trachea by a single incision with a sharp knife and prefer to complete bleed out at least for 2 minutes. Outer skin of the broiler chicken was removed by sharp scissor and hand. Then the carcasses were washed manually to remove loose feathers and other foreign materials from the carcass. Then the carcass was eviscerated and dissected according to the methods by Jones (1982). Liver and heart were removed from the remaining viscera and then the gall bladder was removed from the liver. Then the gizzard was removed. Lastly dressing yield was calculated by subtracting feathers, blood, head, shank, heart, liver and digestive system from the weight.

3.10 Calculation

3.10.1 Live weight gain

The average body weight gain of each replication was calculated by deducting initial body weight from the final body weight of the birds.
Body weight gain = Final weight – Initial weight

3.10.2 Feed intake

Feed intake was calculated dividing the total feed consumption in the replication by number of the birds in each replication.

$$\text{Feed intake(g/bird)} = \frac{\text{Feed intake in a replication (gm)}}{\text{Number of birds per replication}}$$

3.10.3 Growth performance and Feed conversion ratio

Birds of each replication pen were weighed by digital balance at the end of every week to calculate average weight gain (AWG) weekly. The average weekly feed intake (AWFI) was calculated by considering the difference of given and unconsumed feed at the end of each week. The feed efficiency or FCR was calculated in every week. Mortality of the birds was recorded daily to calculate and adjust the feed intake and feed efficiency.

Feed Conversion Ratio (FCR) was calculated as the total feed consumption divided by weight gain in each replication.

$$\text{FCR} = \frac{\text{Feed intake(kg)}}{\text{Weight gain(kg)}}$$

3.10.4 Benefit Cost Ratio

Benefit cost ratio(BCR) was calculated as the total income of the study divided by total cost of production.

$$\text{BCR} = \frac{\text{Total income (Tk.)}}{\text{Total cost of production(Tk.)}}$$

3.11 Statistical analysis

Total data were complied, tabulated and analyzed in according to the objectives of the study. Excel program was practiced for the preliminary data calculation. The collected data was subjected to the statistical analysis by applying one-way ANOVA using Statistical Package for Social Sciences (SPSS version 25.0) in according to the principles of completely randomized design (CRD). Differences between means were tested using the Duncan's multiple comparison test, and significance was set at $P<0.05$.

Some photographic view during this experimental period

Plate 1: Preparation of broiler farm

Plate 2: Chick management

Plate 3: Data collection

Plate 4: Medication

Plate 5: Vaccination

Plate 6: Feeding and watering

Plate 7: Supervision of honorable supervisor

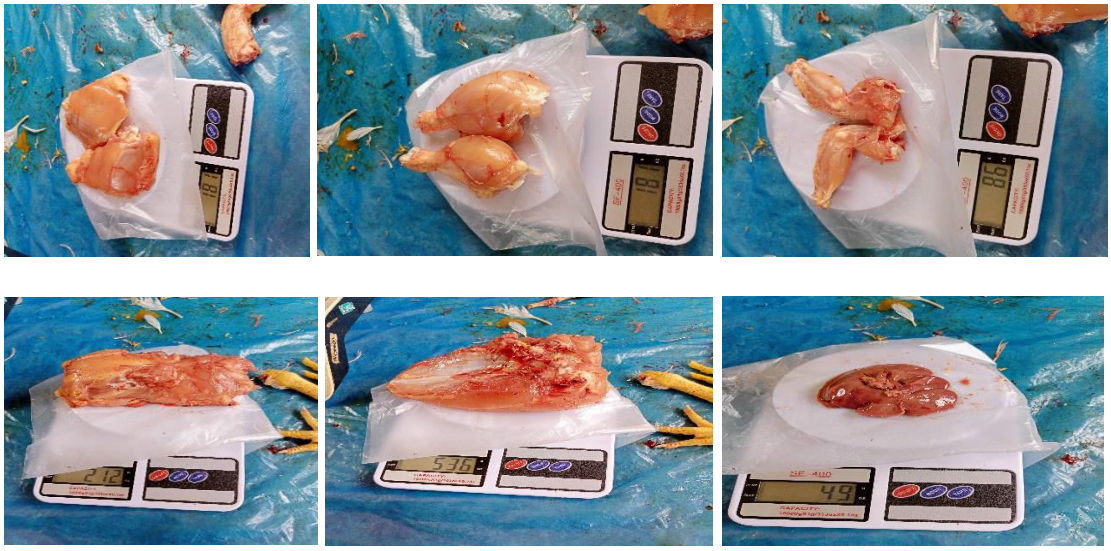

Plate 8: Different parts of Carcass

CHAPTER IV

RESULTS AND DISCUSSION

Results obtained from the present study have been presented and discussed in this chapter with a view to study the impact of ceiling and exhaust fan in broiler production. The data are given in different tables and figures. The results have been discussed and possible interpretations of the research are given under the following headings.

4.1 Emission of ammonia (ppm) from different types of broiler houses

Data presented in table 7 showed the ammonia emission (ppm) level from different types broiler houses in this experimental study. At the end of days7 in different treatment groups was 4.00±0.00, as brooding period for all birds of the first week was common.

Ammonia emission (ppm) at the of days14 in different treatment groups were 5.50±0.17 (T_0), 5.46±0.30 (T_1), 3.40±0.10 (T_2); days21 were 8.8±0.05 (T_0), 8.3±0.11 (T_1), 5.3±0.15 (T_2); days28 were 11.63±0.17 (T_0), 10.36±0.26 (T_1), 6.53±0.14 (T_2), respectively (Table 7).

Table 7 also showed the emissions of ammonia (ppm) from bird's level of T_1 group is higher than T_0 and T_2 group; the emissions of ammonia (ppm) from bird's level different treatment groups (T_1 and T_2) of the research was significantly lower ($P<0.05$) in days14, days21 and days28 than control group (T_0). However, T_2 group showed less ammonia production than T_1 and T_0 group. It might be due to effect of exhaust fan in T_2 group. Shane (1983) reported that increasing the rate of air movement through ceiling and exhaust fan over the birds is necessary to protect them against high temperature and other harmful gas emission; Ceiling and exhaust fans can play an important role in ventilating poultry houses and reducing the side effect of heat stress harmful gas emission. The present findings are contradictory with ammonia concentration in broiler houses is 25 to 50 ppm (Miles *et al*., 2004).

Table 7: Impact of ceiling and exhaust fan on emission of NH_3 (ppm) from different types of broiler houses at different weeks

Treatments	Days7	Days14	Days21	Days28
T_0	4.00±0.00	5.46^{a}±0.17	8.8^{a}±0.05	11.63^{a}±0.17
T_1	4.00±0.00	5.50^{a}±0.30	8.3^{b}±0.11	10.36^{b}±0.26
T_2	4.00±0.00	3.40^{b}±0.10	5.3^{c}±0.15	6.53^{c}±0.14
Mean±SE	**4.00±0.00**	**4.78±0.36**	**7.46±0.54**	**9.51±0.77**

Here, T_0= Control, T_1= Without tunnel ventilation broiler house with ceiling fan facilities, T_2= Tunnel ventilated broiler house with ceiling fan facilities; Values: Mean±SE (n=9); Applying: One-way ANOVA (SPSS, Duncan's method)

- Mean with the different superscripts are significantly different (P<0.05)
- Mean with the same superscripts don't differ (P>0.05) significantly
- SE= Standard Error

4.2 Production performances

The health promoting impact of ceiling and exhaust fan reduce ammonia production from broiler house that helps the body growth of broiler chicken. The chicks were randomly divided into three experimental treatment groups. The three groups were T_0 (control), T_1 (without tunnel ventilation broiler house with ceiling fan facilities) and T_2 (tunnel ventilated broiler house with ceiling fan facilities). The performance traits *viz*. Body weight, body weight gain, feed consumption, FCR, dressing percentage, different dressed organ weight, survivability rate and benefit cost ratio were discussed in this chapter.

4.2.1 Body weight

Table 8 showed the effect of treatments on body weight. The relative body weight (g) of broiler chickens in the different treatment groups T_0, T_1 and T_2 were 1815.13±47.46, 1849.74±22.92 and 1852.76±26.82, respectively. The highest body weight was found in T_2 and lowest in T_0. The higher body weight in T_2 group might be due to treatment with both of ceiling and exhaust fan which helps to maintain optimum temperature and less ammonia concentration inside the poultry house. Similarly, Miles *et al*. (2004) found that the final body weight was significantly depressed by 6 and 9 percent for 50 and 75 ppm concentration of ammonia.

4.2.2 Feed consumption (FC)

Table 8 showed the total feed consumption (g) of broiler chicken. Here, the relative total feed consumption (g) of broiler chicken in different treatment groups were 2401.81±66.3 (T_0), 2453.38±84.29 (T_1) and 2383.95±67.14 (T_2), respectively. The highest feed consumption was found in T_1 and lowest in T_2. The overall feed consumption of different treatment groups showed that there was no significant ($P>0.05$) effects on feed consumption. Emeash *et al.* (1998) found reduction in feed intake, weight gain and feed conversion efficiency in 2 weeks old broiler chicken exposed to a combination of aerial pollutants (ammonia, dust and carbon dioxide). Dagtekin *et al.* (2009) studied the performance characteristics of pad evaporative cooling system in broiler house in Mediterranean climate and reported that at 33^0 C temperature with relative humidity below 50 % prevent the negative effect of heat stress on efficiency of feed consumption.

Decrease in feed intake and increase water intake of poultry under hot climate to control the body temperature; Feed intake reduced by 1.2 % for every 1^0 C rise in the temperature range of 22-32^0 C and 5 % for 1^0 C rise in the temperature range of 32-38^0 C (Gous and Morris, 2005; Sohail *et al*., 2012).

4.2.3 Feed Conversion Ratio (FCR)

Table 8 showed the FCR of this experimental study. The FCR of the different treatment groups T_0, T_1 and T_2 were 1.35±0.01, 1.35±0.03 and 1.31±0.04, respectively. There was no significant ($P>0.05$) difference in the FCR of the research. However, T_2 treatment is better among different treatment groups, might be due to treat with both ceiling and exhaust fan which help to maintain optimum temperature and less ammonia concentration inside the poultry house. Sartor *et al.* (2001) reported that ventilator systems were found to be effective to improve the performance of poultry birds in terms of increased weight gain and better FCR. High NH_3 concentrations in poultry houses reduce growth rate (Reece *et al*., 1979, 1981; Moore *et al*., 1999), feed efficiency (Caveny and Quarles, 1978; Caveny *et al*., 1981).

Table 8: Impact of ceiling and exhaust fan on body weight (BW), total FC and FCR

Treatments	Body weight±SE (g)	Total FC±SE (g)	FCR±SE
T_0	1815.13±47.46	2401.81±66.3	1.35±0.01
T_1	1849.74±22.91	2453.38±84.29	1.35±0.03
T_2	1852.76±26.82	2383.95±67.14	1.31±0.04
Mean±SE	**1839.21±18.10**	**2413.05±37.98**	**1.33±0.01**

Here, T_0= Control, T_1= Without tunnel ventilation broiler house with ceiling fan facilities, T_2= Tunnel ventilated broiler house with ceiling fan facilities; Values: Mean±SE (n=9); Applying: One-way ANOVA (SPSS, Duncan's method)

- SE= Standard Error

4.3 Dressing percentage

Table 9 showed the live weight (g), dressing yield (g) and dressing percentage of the different treatment groups. Dressing percentage of broiler chicken in different treatment groups T_0, T_1 and T_2 were 64.33, 65.10 and 65.72, respectively. There was no significant difference ($P>0.05$) in the dressing percentage in this research. However, dressing percentage in exhaust fan treated group T_2 was the highest than control group (T_0). This is might be due to the effect of exhaust fan compared with control group.

Table 9: Impact of ceiling and exhaust fan on dressing percentage

Treatments	Live weight±SE (g)	Dressing yield±SE (g)	Dressing percentage±SE
T_0	1825.00±32.53	1174.33±28.05	64.33±0.48
T_1	2025.00±91.15	1320.00±76.10	65.10±1.05
T_2	1900.66±36.52	1249.33±22.46	65.72±0.35
Mean±SE	**1916.88±41.73**	**1247.88±30.20**	**65.05±0.42**

Here, T_0= Control, T_1= Without tunnel ventilation broiler house with ceiling fan facilities, T_2= Tunnel ventilated broiler house with ceiling fan facilities; Values: Mean±SE (n=9); Applying: One-way ANOVA (SPSS, Duncan's method)

- SE= Standard Error

4.4 Carcass characteristics

4.4.1 Liver, Heart, Spleen and Gizzard weight (gm) of broiler chicken

Data presented in table 10 showed the Liver, Heart, Spleen, Gizzard and Intestine weight (g) of broiler chickens in different treatment groups. The relative weight (g) of liver in different treatment groups T_0, T_1 and T_2 were 34.22, 47.88 and 44.72, respectively; the relative weight (g) of heart in different treatment groups T_0, T_1 and T_2 were 8.93, 11.79 and 10.75, respectively; the relative weight (g) of spleen in different treatment groups T_0, T_1 and T_2 were 2.11, 2.16 and 2.73, respectively; the relative weight (g) of gizzard in different treatment groups T_0, T_1 and T_2 were 44.01±6.47, 44.33±9.44 and 56.17±2.04, respectively. The weight (g) of spleen and gizzard in T_2 was significantly higher ($P<0.05$) than the other groups including control group (T_0).

Table 10: Impact of ceiling and exhaust fan Liver, Heart, Spleen and Gizzard weight (g) of broiler chickens

Treatments	Liver±SE (g)	Heart±SE (g)	Spleen±SE (g)	Gizzard±SE (g)
T_0	34.22^{b}±0.63	8.93^{b}±0.29	2.11^{b}±0.00	44.01±6.47
T_1	47.88^{a}±2.02	11.79^{a}±0.81	2.16^{b}±0.09	44.33±9.44
T_2	44.72^{a}±1.98	10.75^{a}±0.28	2.73^{a}±0.22	56.17±2.04
Mean±SE	**42.27±2.22**	**10.49±0.49**	**2.33±0.12**	**48.17±3.90**

Here, T_0= Control, T_1= Without tunnel ventilation broiler house with ceiling fan facilities, T_2= Tunnel ventilated broiler house with ceiling fan facilities; Values: Mean±SE (n=9); Applying: One-way ANOVA (SPSS, Duncan's method)

- Mean with the different superscripts are significantly different ($P<0.05$)
- Mean with the same superscripts don't differ ($P>0.05$) significantly
- SE= Standard Error

4.4.2 Thigh, Drumstick, Back and Wing weight (gm) of broiler chicken

Table 11 showed the Thigh, Drumstick, Back and Wing weight (g) of the different treatment groups. The relative weight (g) of thigh in different treatment groups T_0, T_1 and T_2 were 175.99±9.68, 186.31±1.20 and 192.69±11.72, respectively; the relative weight (g) of drumstick in different treatment groups T_0, T_1 and T_2 were 161.60±7.55, 174.53±4.42 and 179.94±10.33, respectively; the relative weight (g) of back in different treatment groups T_0, T_1 and T_2 were 202.10±4.13, 213.66±1.56 and 227.78±17.17, respectively; the relative weight (g) of wing in different treatment groups T_0, T_1 and T_2

were 79.53, 95.29 and 86.32, respectively. The weight (g) of thigh, drumstick and back in T_2 were non significantly (P>0.05) higher than the other groups including control. The better result in T_2 group might be due to the positive effect of exhaust fan compared with control group (T_0).

Table 11: Impact of ceiling and exhaust fan on Thigh, Drumstick, Back and Wing weight (g) of broiler chicken

Treatments	Thigh±SE (g)	Drumstick±SE (g)	Back±SE (g)	Wing±SE (g)
T_0	175.99±9.68	161.60±7.55	202.10±4.13	79.53^{b}±4.01
T_1	186.31±1.20	174.53±4.42	213.66±1.56	95.29^{a}±4.11
T_2	192.69±11.72	179.94±10.33	227.78±17.17	86.32^{ab}±4.53
Mean±SE	**184.99±5.02**	**172.02±4.76**	**214.51±6.32**	**87.05±3.11**

Here, T_0= Control, T_1= Without tunnel ventilation broiler house with ceiling fan facilities, T_2= Tunnel ventilated broiler house with ceiling fan facilities; Values: Mean±SE (n=9); Applying: One-way ANOVA (SPSS, Duncan's method)

- Mean with the different superscripts are significantly different (P<0.05)
- Mean with the same superscripts don't differ (P>0.05) significantly
- SE= Standard Error

4.5 Survivability rate

Data presented in figure 1 showed the survivability rate (%) of the experimental study. The relative survivability rate (%) of broiler chicken in different treatment groups T_0, T_1 and T_2 were 94.87, 100.00 and 100.00, respectively. Survivability rate (%) was higher in treated group T_1 and T_2 than control group T_0. There was no significant difference (P>0.05) in Survivability rate (%). The better result in T_1 and T_2 group might be due to the effect of ceiling and exhaust fan compared with control group (T_0). Miles *et al*. (2004) found that ammonia is the most prominent toxic gas in poultry houses, it originates from the breakdown of undigested proteins and excretory uric acid in the litter and adversely affects the health, growth performance of broilers and also increased the number of dead birds. Health welfare and survivability problems associated with high NH_3 concentrations in poultry houses include damage to the respiratory tract (Nagaraja *et al*., 1983), increased susceptibility to Newcastle disease (Anderson *et al*.,1964), incidence of airsacculitis (Oyetunde *et al*., 1976), increased *Mycoplasma gallisepticum* (Sato *et al*., 1973), and incidence of kerato conjunctivitis (Bullis *et al*., 1950).

When ambient temperatures are above that in the chicken zone, air velocity must be kept relatively high to reduce bird body heat (Mostafa *et al*., 2012). According to (Bustamante *et al*., 2015) high air velocity values about 2 m/s in the poultry house can help for chicken thermoregulation by increasing the convective flux heat of them and therefore decrease their thermal stress and increase survivability.

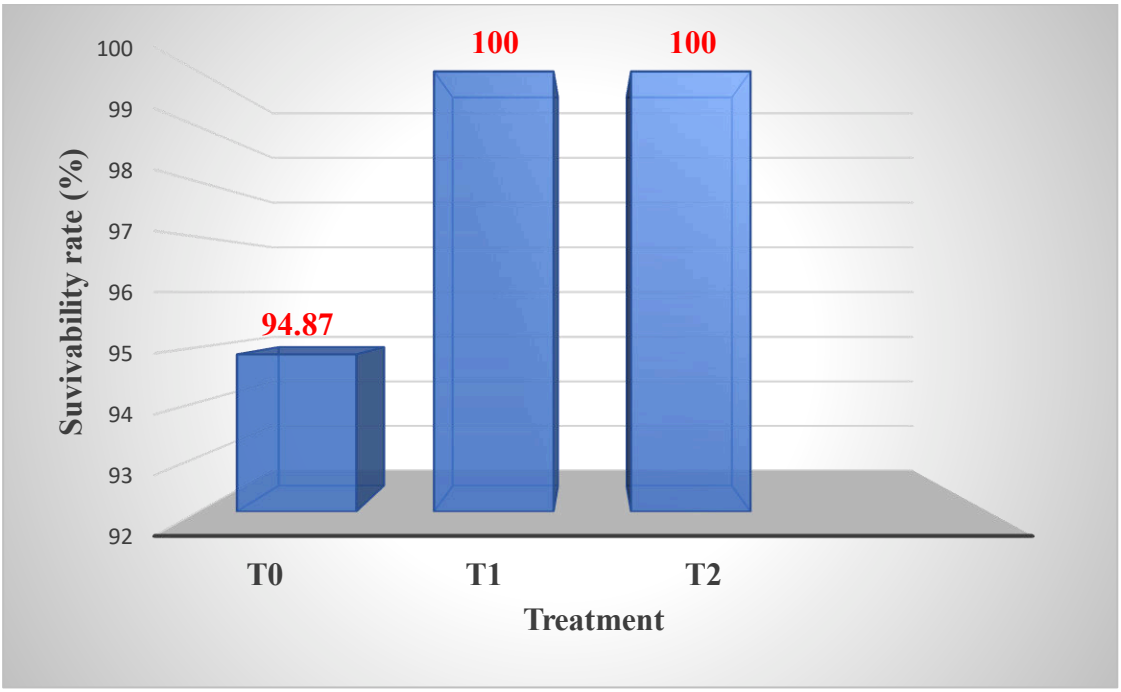

Figure 1: Survivability rate (%)

Here, T_0= Control, T_1= Without tunnel ventilation broiler house with ceiling fan facilities, T_2= Tunnel ventilated broiler house with ceiling fan facilities.

4.6 Cost benefit ratio analysis

Cost benefit ratio analysis are presented in Table 12. Benefit cost ratio (BCR) of the experimental study in different treatment groups T_0, T_1 and T_2 were 1.3, 1.35 and 1.35, respectively. BCR is significantly higher ($P<0.05$) in treatment groups T_1 and T_2 than control group (T_0). This is might be due to the effect of ceiling and exhaust fan cost.

Table 12: Cost benefit ratio analysis of different treatment groups

Treatments	Total cost±SE (Tk./Bird)	Sell price±SE (Tk./Bird)	Profit±SE (Tk./Bird)	BCR±SE
T_0	195.79±2.76	255.5±4.39	59.71^{b}±4.17	1.3^{b}±0.02
T_1	188.84±3.91	264.32±8.07	75.48^{a}±4.79	1.35^{ab}±0.01
T_2	193.92±2.53	261.99±1.44	68.06^{ab}±1.29	1.35^{ab}±0.01
Mean±SE	**192.85±1.87**	**260.6±2.99**	**67.75±2.94**	**1.35±0.01**

Here, T_0= (Control), T_1= Without tunnel ventilation broiler house with ceiling fan facilities, T_2= Tunnel ventilated broiler house with ceiling fan facilities; Values: Mean±SE (n=9); Applying: One-way ANOVA (SPSS, Duncan's method)

- Mean with the different superscripts are significantly different ($P<0.05$)
- Mean with the same superscripts don't differ ($P>0.05$) significantly
- SE= Standard Error
- BCR= Benefit Cost Ratio

CHAPTER V

CONCLUSION AND RECOMMENDATION

A study was conducted with broilers to investigate the effects of ammonia (NH_3) emissions from different types of broiler houses. The study was also planned to determine the comparative production performance of commercial broilers in different rearing system. A total of 135 day-old Lohmann broiler chicks were reared in SAU Poultry Farm, Dhaka-1207. Chicks were divided randomly into 3 experimental groups of 3 replications R_1, R_2 and R_3, where each replication contains 15 birds. These three treatment groups were designated as T_0, T_1 and T_2. T_0 (without ceiling fan) was the control group. Whereas T_1 and T_2 were ceiling fan and ceiling fan with exhaust fan respectively. Result demonstrated that the NH_3 (ppm) level was same at the end of 1st week, however it varied significantly ($P<0.05$) at the end of 2nd, 3rd and 4th week. At the end of 3rd and 4th week control group (T_0) indicated the highest NH_3 emission and T_2 group showed the lowest NH_3 emission significantly ($P<0.05$). At the end of 4th week significantly ($P<0.05$) higher emission of NH_3 was found in control group T_0 ($11.63^{a}\pm0.17$) and lower was found in treated group T_2 ($6.53^{c}\pm0.14$). The body weight (BW) was non significantly ($P>0.05$) higher in exhaust fan treated group T_2 (1852.76 ± 26.82) than control group T_0 (1815.13 ± 47.46) also. FCR at the end of 4th week was non significantly ($P>0.05$) in different groups but better in treated group T_2 (1.31 ± 0.04) than control group T_0 (1.35 ± 0.01). Dressing percentage was non significantly ($P>0.05$) higher in T_2 (65.72 ± 0.35) than control group T_0 (64.33 ± 0.48). The weight of spleen and gizzard in T_2 group was significantly higher ($P<0.05$) than control group (T_0). The weight of thigh, drumstick and back in T_2 group was non significantly higher ($P>0.05$) than control group (T_0). Survivability rate (%) of the birds was significantly higher ($P<0.05$) in T_2 and T_1 than control group (T_0). BCR was significantly ($P<0.05$) higher in treatment group T_2 and T_1 than control group (T_0). Therefore, it could be concluded that more NH_3 was found in T_0 group and less NH_3 in T_2 group. Best growth performance and FCR were found in T_2 group. Highest dressing percentage and BCR were also found in T_2 group. The result of T_2 (ceiling fan with exhaust fan) group was better than T_1 (ceiling fan) and control group (T_1). So, the research recommended that poultry house with exhaust fan at bird's level could be used on broiler production for better performance and profitability.

CHAPTER VI

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CHAPTER VII

APPENDICES

Appendix I: Impact of ceiling and exhaust fan on NH_3 level (ppm)/weekly

Treatments	Replications	Days7	Days14	Days21	Days28
T_0	R_1	4	6.3	8.9	11.3
T_1	R_1	4	5.9	8.1	10.4
T_2	R_1	4	3.2	5.2	6.5
T_0	R_2	4	6.2	8.7	11.9
T_1	R_2	4	5.7	8.5	9.9
T_2	R_2	4	3.5	5.6	6.3
T_0	R_3	4	6.2	8.8	11.7
T_1	R_3	4	5.8	8.3	10.8
T_2	R_3	4	3.5	5.1	6.8

Appendix II: Impact of ceiling and exhaust fan on average body weight (g) weekly

Treatments	Replications	1st week	2nd week	3rd week	4th week
T_0	R_1	257.75	633.85	1246.15	1841.07
T_1	R_1	257.75	639.23	1234.61	1893.85
T_2	R_1	257.75	650	1230	1806.15
T_0	R_2	257.75	660.42	1154.61	1723.07
T_1	R_2	257.75	651.15	1222.31	1816.92
T_2	R_2	257.75	640	1319.17	1853.07
T_0	R_3	257.75	656.15	1234.17	1881.25
T_1	R_3	257.75	618.46	1208.46	1838.46
T_2	R_3	257.75	645.38	1319.17	1899.07

Appendix III: Impact of ceiling and exhaust fan on average body weight gain (g)

Treatments	Replications	1st week	2nd week	3rd week	4th week	Total BWG
T_0	R_1	217.32	372.31	580	576.15	1800.65
T_1	R_1	217.32	380	595.38	594.92	1853.42
T_2	R_1	217.32	383.07	612.31	659.58	1765.72
T_0	R_2	217.32	398.75	610	603.07	1682.64
T_1	R_2	217.32	369.73	571.15	625.72	1776.49
T_2	R_2	217.22	383.07	658.75	594.61	1812.64
T_0	R_3	217.32	396.92	579.23	609.33	1840.82
T_1	R_3	217.32	373.07	590	647.08	1798.03
T_2	R_3	217.32	393.85	543.33	630	1858.64

Appendix IV: Impact of ceiling and exhaust fan on average feed consumption (g)/bird

Treatment	Replication	1st week	2nd week	3rd week	4th week	Total FC
T_0	R_1	224.13	436.54	780	947.3	2387.98
T_1	R_1	224.13	450.77	770.76	1146.92	2592.59
T_2	R_1	224.13	453.07	791.92	971.92	2441.05
T_0	R_2	224.13	467.67	757.08	1018.33	2294.51
T_1	R_2	224.13	441.54	757.69	878.07	2301.43
T_2	R_2	224.13	443.46	702.3	880.38	2250.15
T_0	R_3	224.13	465	902.16	931.66	2522.96
T_1	R_3	224.13	413.46	787.3	1041.23	2466.13
T_2	R_3	224.13	448.46	805.76	982.3	2460.67

Appendix V: Impact of ceiling and exhaust fan on average FCR of the study

Treatments	Replications	1st week	2nd week	3rd week	4th week	Final FCR
T_0	R_1	1.03	1.17	1.27	1.59	1.32
T_1	R_1	1.03	1.18	1.29	1.73	1.39
T_2	R_1	1.03	1.18	1.36	1.68	1.38
T_0	R_2	1.03	1.17	1.14	1.48	1.36
T_1	R_2	1.03	1.12	1.32	1.47	1.29
T_2	R_2	1.03	1.16	1.15	1.26	1.24
T_0	R_3	1.03	1.17	1.72	1.44	1.37
T_1	R_3	1.03	1.1	1.33	1.65	1.38
T_2	R_3	1.03	1.13	1.58	1.72	1.32

Appendix VI: Impact of ceiling and exhaust fan on dressing percentage

Treatments	Replications	Ave. Live weight (g)	Dressing Yield (g)	Dressing percentage	Giblet (%)	Breast (%)	Drumstick (%)
T_0	R_1	1890	1223	64.7	8.83	28.14	9.31
T_1	R_1	2140	1430	66.82	9.48	27.66	8.83
T_2	R_1	1830	1196	65.35	9.18	29.36	9.01
T_0	R_2	1790	1157	64.63	8.77	29.16	8.43
T_1	R_2	1845	1171	63.46	9.37	27.8	8.63
T_2	R_2	1920	1263	65.78	8.9	29.38	9.21
T_0	R_3	1795	1143	63.67	8.74	27.46	8.74
T_1	R_3	2090	1359	65.02	9.13	27.7	9.13
T_2	R_3	1952	1289	66.03	9.22	28.46	9.22

Appendix VII: Impact of ceiling and exhaust fan on weight (g) of different organs

Treatments	Replications	Liver (g)	Heart (g)	Gizzard (g)	Spleen (g)
T_0	R_1	34.27	9.13	52.29	2.13
T_1	R_1	51.9	13.24	57	2.17
T_2	R_1	41.5	11.32	56.37	2.31
T_0	R_2	33.1	9.31	48.51	2.1
T_1	R_2	46.34	10.43	25.87	2.32
T_2	R_2	44.32	10.53	59.61	3.1
T_0	R_3	35.31	8.35	31.25	2.12
T_1	R_3	45.4	11.71	50.13	2
T_2	R_3	48.34	10.42	52.53	2.78

Appendix VIII: Impact of ceiling and exhaust fan on weight (g) of different organs

Treatments	Replications	Thigh (g)	Drumstick (g)	Back (g)	Wing (g)
T_0	R_1	195.32	176.3	197.4	86.45
T_1	R_1	207.41	188.93	245.24	101.74
T_2	R_1	183.9	165.78	212.85	77.92
T_0	R_2	165.31	151.21	210.35	72.54
T_1	R_2	169.53	159.32	193.44	87.65
T_2	R_2	187.37	177.83	211.45	93.49
T_0	R_3	167.35	157.31	198.55	79.61
T_1	R_3	201.13	191.57	244.67	96.5
T_2	R_3	187.67	180	216.69	87.57

Appendix IX: Impact of ceiling and exhaust fan on survivability rate (%) of the research

Treatments	Replications	Number of Birds (No.)	Survival number of birds (No.)	Survivability rate (%)
T_0	R_1	13	13	100
T_1	R_1	13	13	100
T_2	R_1	14	14	100
T_0	R_2	13	12	92.3
T_1	R_2	13	13	100
T_2	R_2	14	14	100
T_0	R_3	13	12	92.3
T_1	R_3	13	13	100
T_2	R_3	14	14	100

Appendix X: Cost benefit ratio analysis

Treatments	Replications	Feed cost (Tk./Bird)	Total expenditure (Tk./Bird)	Sell price (Tk./Bird)	Profit (Tk./Bird)	BCR
T_0	R_1	123.62	195.04	247.02	51.98	1.27
T_1	R_1	114.23	183.15	258.24	75.09	1.41
T_2	R_1	118.45	189.01	259.63	70.62	1.37
T_0	R_2	129.92	200.91	261.76	60.85	1.3
T_1	R_2	117.52	187.03	254.42	67.39	1.36
T_2	R_2	121.32	195.31	261.73	66.42	1.34
T_0	R_3	119.4	191.43	257.74	66.31	1.35
T_1	R_3	124.35	196.34	280.32	83.98	1.42
T_2	R_3	1228.21	197.46	264.61	67.15	1.34

Appendix XI: Litter temperature (^{0}C)

Treatments	Replications	Days7	Days14	Days21	Days28
T_0	R_1	31	28.5	31	31.8
T_1	R_1	30.3	28	30.6	31.3
T_2	R_1	30	28.7	30.8	31.5
T_0	R_2	30.5	28.3	30.4	31.7
T_1	R_2	30.5	27.9	30	32
T_2	R_2	30.4	29	29.8	31.9
T_0	R_3	31	28.6	30.4	31.3
T_1	R_3	31	28.8	30.1	31
T_2	R_3	30.3	28.2	30	31.8

Appendix XII: Light intensity (lux)

Treatments	Replications	Days7	Days14	Days21	Days28
T_0	R_1	432	543	506	956
T_1	R_1	783	673	453	1103
T_2	R_1	346	1316	375	1468
T_0	R_2	261	870	967	1182
T_1	R_2	355	1027	781	854
T_2	R_2	576	623	598	1021
T_0	R_3	322	347	748	1114
T_1	R_3	233	531	652	1039
T_2	R_3	540	653	763	838

Appendix XIII: Broiler house temperature (^{0}C)

Days	Maximum	Minimum
01	35.1	30.3
02	34.7	29.6
03	33.6	28.7
04	33.9	28.8
05	31.8	28.5
06	33.9	28.9
07	33.6	28.6
08	34.6	28.5
09	34.5	28.1
10	34.1	28.5
11	33.6	28.4
12	32.3	27.1
13	31.8	27.00
14	32.7	26.1
15	28.6	26.2
16	29.3	27.2
17	30.4	27.3
18	31.4	28.5
19	33.9	28.9
20	33.4	27.9
21	31.9	27.9
22	33.4	27.00
23	31.9	28.3
24	32.2	28.1
25	33.1	29.2
26	33.7	28.5
27	33.2	28.3
28	33.8	28.8

Appendix XIV: Relative humidity (%)

Days	Maximum	Minimum
01	89	57
02	88	59
03	91	62
04	98	70
05	82	81
06	92	64
07	97	52
08	99	60
09	92	61
10	93	68
11	95	65
12	87	74
13	93	80
14	94	79
15	91	82
16	86	73
17	94	76
18	98	58
19	95	68
20	94	70
21	88	63
22	97	59
23	94	73
24	92	70
25	95	60
26	93	53
27	86	64
28	91	51