ISSN 2250-3153

Ammonia Emissions at Broiler Farmings in Palangka Raya Central Kalimantan

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Abstract - Ammonia (NH3) emissions from livestock sector are one of the large contributors of greenhouse gas. The objective of this research is to determine ammonia emissions at three broiler farmings in Palangka Raya, Central Kalimantan, emissions measurement was conducted at the top and bottom of the poultry house using NH3 sensor conducted in the morning, afternoon and evening. In addition, the measurement is also conducted to the climatic factor, i.e. air temperature, humidity and wind speed. An analysis of the sample of chicken manure is also conducted to determine N and crude protein contained in chicken manure and ration used by poultry farmers during the study. The result of this study reveals that a number of ammonia emissions of the three farming measured on the top of the poultry house is 20,55 ppm, 14,61 ppm and 15,85 ppm, while at the bottom is 18,81 ppm, 15,50 pm and 14,91 ppm. A lot of ammonium emissions of those three farming are influenced by the lack of waste management, crude protein in the ration is not well-digestible so the content of N in the chicken manure is still high and the factor of climatology and humidity surrounding.

Index Terms- Emissions, NH3, broiler

I. INTRODUCTION

The improvement of broiler farming in Central Kalimantan, especially in Palangka Raya is welcome in the last five years, this is proven by the increase of chicken meat fulfillment until 30% compared to the needs in 2011 (Department of agriculture and farm or Distanak 2015). However, chicken farm business is one of the factors participating to pollute the environment. Given that more or less 80% of the total of NH3 emissions in Europe and United States comes from stock waste (Corinair, 2007).

For that matter, to realize an efficient and environmentally-friendly business so the husbandry management, caging, and waste handling should be paid attention. The Ministry of Agriculture and Farm has realized the matter by issuing the Ministerial decree through the SK Mentan No. 237/1991 and SK Mentan No. 752/1994, and UU No. 32/2009 on Living environment asserting that the farm business with particular population needs to be completed with the effort of environmental management and monitoring and it should be in accordance with the regulation that poultry house is not allowed to be established around the density inhabit as it potentially causes environmental pollution. Broiler farm business with more than 15,000 chickens per cycle is located in one place, while the layers with more than 10,000 chickens are located in an overlay of location.
The largest annual contributor of NH3 emissions in the atmosphere comes from livestock sector (FAO, 2016). According to Todd et.al (2009), livestock ammonia emissions are influenced by the following factors; intake level of N, caging condition, facility of chicken manure storage, etc. The content of N in the ration is considered as the main NH3 contributor as the emissions increase with the enhancement of excretion N caused by the crude protein supply is getting high (Todd et.al., 2006).

The amount of manure produced by chicken in a day is pretty more; each chicken produces about 0.15 kg (Charles and Hariono, 1991). Fontenot et al., (1983) reports that the average production of fresh layers manure is 0.06 kg/day/chicken, and the content of the dry material is 26%, while the broilers produce manure by 0.1 kg/day/chicken and the content of its dry material is 2.5%. The pollution source of chicken farm business comes from the chicken manure containing nitrogen and sulfide, which at the time of manure accumulation or storage, the process of decomposition by the microorganism forming gas of ammonia, nitrate, and nitrite, as well as sulfide, happens. Those gasses which cause odor (Sevensson, 1990; Pauzenga, 1991). The high content of ammonia in the feces also reveals the possibility of less perfect digestion process or over protein in the cattle feed, so that not all nitrogen is absorbed as ammonia but issued as ammonia contained in the manure (Pauzenga, 1991).

This research aims to find out the concentration of ammonia of the manure sample and in the direct air using NH3 sensors (tehu,R. 2016) as well as measuring factors influencing such as air temperature, humidity, wind sped and direction, and acknowledging sanitation of livestock environment.

II. METHODOLOGY

1. Field Survey

NH3 emissions measurement was conducted at 3 different broiler farmings (2 broilers farmings and 1 layers farming). This research was carried out for a year. Table 1 indicates general condition of farming where the study is conducted.

Table 1. General boilerplate of the Location of NH3 Emissions Source

Observation	Farming		
	Layers	Broilers	Broilers
Location	Jalan Karanggan, Palangka Raya	Jalan Manduhura, Palangka Raya	Jalan Banteng, Palangka Raya
Size (ha)	10	¤ 6	6
Type of Cage	Slay System and Cage	Slat System	Slat System
Total Cage	10 cages	7 cages	7 cages
The number of population	± 20.000 chickens	± 20.000 chickens/husbandry period	± 20.000 chickens/husbandry period
A strain of cattle	Red Layers	Mb 202 P/Pt Japfa COMFEED INDONESIA	Mb 202 P/Pt Japfa COMFEED INDONESIA
Ration	Benfeed/PT JAPFA COMFEED INDONESIA	BR1 and BR2/PT CHAROEN POKPHANG INDONESIA	BR1 and BR2/PT CHAROEN POKPHANG INDONESIA
The Frequency of Feeding	2 times a day	Adlibitum	Adlibitum
Production	15,000-17,000 eggs/day	± 19.000 chickens/husbandry period	± 19.000 chickens/husbandry period
Mortality	3-5%	1-3%	1-3%

2. Measurement with NH3 sensor

Ammonia measurement was conducted at the top and the bottom of poultry housing using NH3 sensor (Teguh, R. 2016). This Nh3 sensor will detect ammonia concentration from the surrounding air through giving an indication in the form of sensor lights. The lamp will continuously light, blue indicates that the concentration is very low and changing into the red if the ammonia concentration is high. NH3 sensors will be connected to the laptop or computer which has an application named Arduino-1.8.1.window, so the sensor will read the level of concentration in the surrounding air. This NH3 sensor is indicated in the following figure.

Figure 1. NH3 sensor, temperature, humidity and Speed Direction (Teguh, R. 2016)

Microclimate measurement as the backup data is also performed to Air temperature measurement using digital Electronic Thermo-hygrometersLS-2017 and NH3 sensor (Teguh, R. 2016). Air temperature measurement was performed in and out of poultry housing on 1.5-meter height above the ground level. Daily air temperature average is calculated with equation (Tjasyono, 2004):

T daily average = (formula 1)

Description:
T Daily average = average daily temperature
T7, T13, T18 = air temperature observation at 6 am, 1 pm, and 6 pm.

Humidity is measured using digital Electronic Thermo-hygrometersLS-207 and NH3 sensor (Teguh, R. 216). Daily average air humidity is counted by the equation:
Daily average RH = (formula 2)
Description:
Daily average RH = average daily humidity
RAH7, RH13, RH18= ait temperature observation at 6 am, 1 pm, and 6 pm.

Wind speed is measured using anemometer RS 232 BTU-Psychrometer, while the wind direction is measured using simple methods, i.e. assisted by smoke and compass.

3. Laboratory Analysis

Analysis data of ammonia concentration measurement is also conducted to the chicken manure, chicken manure uptake as a sample was conducted at several points, namely two points inside the poultry house and 2 points outside the poultry house (the bottom of the poultry). The sample was then put into a clean and dry container, every sample was stuck a label of date, time, uptake point and the sample taker's name, the next step was keeping the sample of chicken manure in the freezer temperature (-10C), then being dried at the temperature of 120 C and then analyzed using proximate analysis method. The methods used to analyze gross of energy and free nitrogen are Bomb Calorimeter and Kjehdal. The cattle feed was also analyzed to find out the nutrient content within, type of analysis used is proximate, Bomb calorimeter and Kjehdal.

The data of ammonia concentration was then compared to the ambient air quality standard issued by the government as stipulated in the government regulation (PP) number 41/1999 (Legal Bureau, 1999). The data of NH3 content at broiler farming was then analyzed descriptively and then connected with the common condition of the farming location, climate condition (air temperature, humidity, wind speed and direction, and the height of anytime) during the sample uptake of air, and the husbandry management system applied at broiler farming and the nutrient content of the cattle feed and the manure.

III. RESULTS

NH3 emissions concentration measurement at broiler chicken farmings in Palangka Raya along this time has not been performed yet. Table 2 indicates the result of measurement of NH3 concentration.

Table 2. NH3 Concentration Data from the Chicken Farming in Palangka Raya

Emissions Source	NH3 (ppm)			Total
	Morning	Afternoon	Evening	
Layers				
Bottom of Poultry House	12,00	31,52	12,00	55,52
Top of Poultry House	10,96	38,70	12,00	61,66
Total	22,96	70,22	24,00	117,18
Broilers**				
Bottom of Poultry House	12,23	14,79	19,49	46,51
Top of Poultry House	7,83	17,25	18,75	43,83
Total	20,06	32,04	38,24	90,34
Broilers**				
Bottom of Poultry House	8,92	15,75	20,06	44,73

Top of Poultry House	10,14	17,31	20,10	47,55
Total	19,06	33,06	40,16	92,28
Total of all farmings	62,08	135,32	102,4	299,8

Description: * Layer Farming at Jalan Karanggan
** Broiler Farming at Jalan Manduhara
*** Broiler Farming at Jalan Banteng

The result of measurement using NH3 sensor indicates that from those three farmings, the highest NH3 emissions is at the layer farming measured in the afternoon and at the bottom of the poultry house, in contrary, the lowest NH3 emissions is at the broiler farming ** measured at the top of the poultry house in the morning.

The highest NH3 emissions at layer farming of the measurement in the afternoon and at the bottom of the poultry house, while the lowest NH3 emissions are also measured at the bottom of poultry house in the morning. The highest NH3 emissions of broiler farming are measured at the top of the poultry house in the afternoon, while the lowest is also at the bottom of poultry house but being measured in the morning. The highest NH3 emissions from the broiler farming***is measured at the bottom of the poultry house in the evening, while the lowest NH3 emission is measured at the top of the poultry house in the afternoon.

The research result of NH3 emission on broiler farms in Palangka Raya compared to the threshold of NH3 of broiler chickens according to Rits the (2004) is between 20-102 ppm. For that matter, broiler chicken farms in Palangka Raya is already dangerous enough for livestock, in which the average concentration, when measured at the top of the layer's poultry house, is 18.51 ppm, while at broiler's is 15.50 and 14.91 ppm, otherwise the NH3 concentration at the bottom of the layer's poultry house is 20.55 ppm and 14.61 and 15.85 ppm on broiler's chicken farming.

Table 3. NH3 and Nutrient Contained in the Chicken Manure, Nutrient Content of Ration

Manure	KA	PK	N	SK	LK	Ca	P	Abu	GE	NH3
	....%...								Kkal/kg	ml/lt
Location I	8,09	19,64	3,14	21,17	1,60	3,78	1,72	-	2563,33	2,35
Location II	8,11	22,70	3,67	22,13	2,57	1,58	0,85	-	3301,36	‘ 1,83
Location III	8,56	19,43	3,11	26,83	1,96	1,72	1,07	-	3151,15	1,26
Rations										
Layers	8,97	18,56	3,16	3,41	5,75	4,42	0,72	11,7	3894,03	
Broilers	9,47	23,06	3,57	3,77	6,22	1,19	0,68	6,12	4189,83	

Description: Location I: Broiler Farming at Jalan Karanggan
Location II: Broiler Farming at Jalan Manduhura
Location III: Broiler Farming at Jalan Benteng

The result of analysis from the Nutrition Laboratory of Faculty of Animal Husbandry, Brawijya University (table 3) indicates that the protein contained in the layers manure is higher than that of ration amounting to 19.64% while in the ration is only 18.56%. While the nutrient content of ration of broiler chicken is higher (23.06%) than that of chicken manure (22.70 and 19.43%). The concentration of N in the layers manure is 31.62, while in the broilers manure is 36.96 and 31.42%, in contrary, the concentration of N in the ration of layers is 46.95% and 53.05% for broilers.

Table 4. The Data of Temperature, Humidity and Wind Speed

Farming	Daily Mean Temperature (^{o}C)	Daily Mean Humidity (%)	Wind Speed (mph)		
			Morning	Afternoon	Evening
Layers *			6	5	5
Bottom of Poultry House	30,65	78.53			
Top of Poultry House	30.05	78.99			
Broilers**			5	6	6
Bottom of Poultry House	30.73	79.03			
Top of Poultry Hous	30.40	80.07			
Broilers***			6	4	4
Bottom of Poultry House	30.07	78.56			
Top of Poultry Hous	30.69	79.17			

Description: * Layer Farming at Jalan Karanggan
** Broiler Farming at Jalan Manduhara
*** Broiler Farming at Jalan Banteng

The data of climatology includes air temperature, humidity and wind speed at the three farmings is presented in table 4, the highest mean temperature is at the layer farming located at Jalan Manduhara, i.e. 30.58^{o}C, followed by broiler farming located at Jalan banteng by 30.38^{o}C and the last is Layer farming at Jalan Karanggan by 30.25^{o}C. The highest humidity of the Broiler farming located at Jalan Manduhura is 79.55%, followed by broiler farming located at Jalan Banteng by 78.86% and the last is layer farming at Jalan Karanggan by 78.76%. While the wind speed between those three farmings does not indicate a significant difference, the highest one is at the broiler farming located at Jalan Manduhara by 5.33 mph, broiler farming at Jalan Karanggan by 5.33 mph and layer farming at jalan Banteng by 4.66 mph.

IV. DISCUSSION

The high degree of NH3 emissions at Broiler Farmings in Palangka Raya presented in table 2 is influenced by several factors that is husbandry management, chicken manure management, management of cattle feed and climatology factors such as air temperature, humidity and wind speed.

The result of the study reveals that the highest NH3 emissions are at the layer farming (39.07%) compared to two broiler farming's (30.13 and 30.78%). The high degree of NH3 emissions at the layer farming is due to the lack of husbandry management, there is no drainage in these three farmings, so that the wastewater used to wash poultry equipment or the spilled of chicken's drinking water is left to spill, as the result, the chicken manure is always wet. Humidity can influence a number of emissions gas resulted from the source of chicken manure emissions. The higher the humidity, the better for the microorganism to grow and develop and the much more the process of renovation which is happened. According to Ryak (1992), humidity plays a role in the metabolism of macroorganism which indirectly affects the oxygen supply. If the humidity is greater than 60%, the nutrients will be washed, the volume of air decreases, consequently macroorganism activity will decrease and will occur anaerobic fermentation that causes odor. According to Charles and Hariono (1991), the odor-producing compounds can be easily formed under the anaerobic conditions such as wet piles of chicken manure. Such compounds may be produced during the decomposition process of chicken manure.

NH3 emissions from the poultry housing can be lowered if the content of dry material of chicken manure is greater than or equal to 60%. According to Elwinger and Svensson (1996), reducing water spilled so that the manure remains dry will help reduce NH3 emissions.

Another factor that affects the high degree of NH3 emissions at layer farming is due to the waste management has not been well implemented. This farm lets the chicken manured piled between the sidelines or at the bottom of the cage. The manure is collected if only there is a buyer who will function it as fertilizer. In contrast, the two broiler farmings collect the chicken manure twice during the husbandry period (40 days or 4-5 weeks). The first collection is performed at 25 days of age and at 40 days of age or at harvest. These three farms apply the same methods to manage the chicken manure, i.e. broiler and layer feces are collected and directly loaded into sacks and then piled on the sides or in front of the cage and waiting for the buyer to carry it. The buildup of chicken manure which is covered can reduce the emission of NH3. According to J.Webb et.al. (2004), the chicken manure been collected and then directly deposits on concrete made of steel or wooden planks and roofs can reduce NH3 emissions by 80%. Closure of a liquid chicken drop shelter is also very effective at reducing NH3 emissions by up to 80%, where the lid is circular and made of steel or concrete (Sommer et al, 1993) Closure of chicken poo shelters should not be too tight, there must be ventilation to prevent the formation of methane (Rom, 1996). The next step is to reduce NH3 emissions from the source, with the management of a cost-effective, practical and widely-enforced source of emissions.

The content of N in chicken manure on three farms where the study was 3.14%, 3.67% and 3, 11% (table 3), on the contrary, the results also showed that N content in laying chicken rations and broiler rations was 3.16% and 3.57%. It is obvious that the N contained in the ration can not be completely digested by the chicken because the N content in chicken manure is also still very high. In general, rations are needed by livestock to meet basic living needs and for production. According to Rots (2004), to increase the utilization of N in the ration, so the quantity and quality of protein must be precise so as to maximize production with low ration cost.

Ration supply with amino acid content or crude protein that suits the needs can decrease the amount of N secretion in feces and urine. Provision of essential amino acid can reduce the crude protein supply, certainly without affecting the level of livestock production. However, the reduction of crude protein in the ration should consider the price of synthetic amino acid and other ration materials, so that the livestock production remains optimal and NH3 emissions can be reduced (Clark et al., 2005).

Reduction of the crude protein content in the ration is an effective way to reduce the excretion of N in the urine of monogastricanimals; the use of high fiber sources such as fermented carbohydrates can change the excretion of N from urine to feces and be able to reduce NH3 emissions (Payeur et al 2002). Adjustment of protein intake in the ration is required for the production rate and to reduce the excretion of N. Excess of the N-protein will be excreted in the form of urea (uric acid in poultry) (Cattle: Smiths et al. 1995; Pigs: Kay and Lee 1997; poultry: Elwinger and Svensson 1996), is a major source of NH3 emissions from livestock manure. Reducing protein intake will reduce NH3 emissions, then emissions will be reduced at all stages of manure management.

The mean temperature between the measurements above the ingredients and under the layer farm and two broiler farms is 30.35^{o}C, 30.57^{o}C and 30,38^{o}C, otherwise, the NH3 emissions from the three farms are 58,59 ppm, 45,17 ppm, and 46,14 ppm. The data states that the higher the temperature, the lower the NH3 emissions. Soedomo (2001) states that air temperature directly affects the condition of atmospheric stability. In stable conditions, ie, during the air temperatures which is lower than the environment, air pollutant masses can not rise but remain in the atmosphere and accumulated, thereby increasing the concentration of pollutants. Conversely, when the air temperature is higher than the air temperature of the environment, then the air pollutant mass will rise and spread, so there is no deposition on the surface and will minimize the concentration of pollutants. According to Misselbrook et al. (2005) temperature and wind speed show a significant influence when the chicken manure drops to the ground.

This study reveals that temperature is proven influencing NH3 emissions, although other factors could also affect, such as livestock density, rainfall and chicken manure management (method of collecting chicken manure and its frequency). To reduce NH3 emissions, the best thing to do is always paying attention the management of livestock waste, chicken manure collection of productive layer farming should be done twice a week, so the buildup of chicken manure can be avoided. Making the waste shelters permanently and closed. Poultry farmers pay more attention to the nutritional needs of the chicken, especially their protein so that ammonia emissions can be reduced and cost of feeing can also be lowered.

V. CONCLUSIONS

This study concludes that the average NH3 emissions measured at the top of the poultry house from those three farms are 18.51; 15.50 and 14.91 ppm, in contrary, NH3 emission at the bottom of the poultry house is as follows, 20.33; 14.61 and 15.85 ppm. Factors influencing the high average of NH3 emissions in those three farms is humidity and wind speed, where the average daily temperature is at the top of the poultry house by 30.64^{o}C, 30,79^{o}C and 30.07^{o}C and at the bottom of the poultry house by 30.05oC, 30.40oC and 30.69oC, while the average humidity at the top of cage is 78.53%, 79.03%, and 78.56%, while at the bottom of poultry house is 78.99%, 80.07%, and 79.17%. With each wind speeds is 5.33 mph, 5.33 mph, and 4.66 mph.

Another factor also influencing is the livestock waste management, i.e. chicken manure, at which for layer farming, it is done anytime, while the broiler farm collects it two times per husbandry period. In addition, the high protein content and N in rations that exceed the needs of chicken livestock also plays a role.

VI. ACKNOWLEDGMENTS

The writers want to say thank you to THE MINISTRY OF RESEARCH AND HIGHER EDUCATION for funding support for the implementation of this research (doctoral grant) and to Mr. H. Suluhuddin and Mr. Andi Bustan, the owner of the farm where the research was conducted.

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