Egypt. J. Vet. Sci. **Vol. 53,** No. 2, pp. 285-292 (2022)

Egyptian Journal of Veterinary Sciences
https://ejvs.journals.ekb.eg/

How Can Ammonia's Hygienic Problems in Poultry Houses be Alleviated? Review article

Asmaa N. Mohammed
Department of Hygiene, Zoonoses and Epidemiology, Faculty of Veterinary Medicine, Beni-Suef University, Beni-Suef 62511, Egypt.

AMMONIA is a gas that is unavoidably produced as a byproduct of poultry rearing conditions. This gas is extremely dangerous to poultry health, regardless of the species or age group affected. The permissible limit for this gas in poultry buildings is the limit that can be noticed by the human smiling, 25 ppm according to health authorities. Chronic exposure of poultry, particularly young chicks, to ammonia levels above 25 ppm causes a change of health issues ranging from decreased weight gain and performance to severe stress on the gastrointestinal tract and respiratory system, as well as increased susceptibility to microbial infections. The kerato-conjunctivitis complex can be also, a result of ammonia harmfulness. There are various methods for establishing ammonia levels inside poultry houses, ranging from simple methods to more advanced and complicated protocols. This article is attended to the application of several steps that should be taken to avoid the dangerous belongings of ammonia in those farms of young chicks, including dietary supplementation, proper ration formulation, proper bird stocking density, adjustment the temperature, ventilation control, and the reduction of ammonia emissions through composting, all of which help to increase bird comfort and reduce the hazard of ammonia toxicity in those farms.

Keywords: Ammonia levels, Sources, Odor emission, Poultry health, Options of control.

Introduction

Ammonia (NH_3) is a water-soluble alkaline gas that creates a highly hazardous environment. Ammonia pollution of soil and/or water can cause serious environmental challenges such as eutrophication, and acidification process which can interrupt biodiversity, and decrease water quality [1].

In poultry facility, ammonia is produced by the chickens themselves, who excrete unused nitrogen as ammonia, and urea [2]. Moreover, atmospheric ammonia is a major aerial pollutant of poultry buildings. The current exposure limits for ammonia of 25ppm are set on the basis of human safety rather than animal welfare. Ammonia when subjected to moisture content, it alters and forms ammonium, corrosive solution that is a primary hazard to birds. The ammonium disintegrates the chicken›s respiratory tract and cause paralyses of the epithelial cell cilia. In these circumstances, the cilia are incapable to clean up the mucus on trachea mucosal surface, and bacteria turn out to be trapped [3].

Unless there is inadequate aeration or the chickens are consumed an unbalanced diet, chickens are not exposed to very high intensities of ammonia for long periods of time. Latest study has discovered that when chickens are exposed to high intensities of ammonia for short periods of time, various molecular alterations occur. The existence of extremely high-level of ammonia in the air for any duration of time will make the birds discomfort [4].

Corresponding author: Asmaa N. Mohammed, E-mail: asmaa.mohamed2@vet.bsu.edu.eg, Tel. 01227525459
(*Received* 02/11/2021; *accepted* 04/04/2022)
DOI. 10.21608/ejvs.2022.103968.1310

Ammonia (NH_3) is a potent "oxidative stressor" that has the potential to cause inflammation. High intensity of ammonia has been shown in studies to alter ordinary organ work in animals, damage energy metabolism, generate cell apoptosis, and make mitochondrial impairment in the gastrointestinal tract mucosa [5]. A high ammonia concentration in the fowl building has a negative impact on the chicken's performance. However, quantifying the significance of such effects is difficult. So that, this study was designed to determine the ammonia sources in air, ammonia's importance in poultry facilities, and their effect on poultry health besides the options of control.

Ammonia sources and nitrogen cycle
How is ammonia gas formed?

Ammonia is a biologically arising byproduct of manure. The breakdown of nitrogen compounds in manure produces ammonia (NH_3^+) and ammonium (NH_4^-). In terms of manure pH, these two products are in equilibrium [6]. Lower pH stimulates the formation of ammonium, which does not escape as a gas (ammonia) but remains in solution in the manure. Ammonia production will be reduced if the pH, moisture, and temperature of the litter are reduced. Both of litter moisture reduction and pH adjustment are easily accessible controlling methods because fowl dwelling temperature is determined by chicken comfort. Fixation, ammonification, nitrification, and denitrification are all stages of the "nitrogen cycle". In addition, modern man has changed the nitrogen cycle by introducing large quantities of reactive nitrogen into the environment, primarily due to its significance in agriculture. The method that incorporates large amounts of it into the environment is livestock breeding, particularly in intensive systems as shown in Fig. 1. according to many authors [7,8].

Ammonia's importance in poultry facilities

Ammonia will not be detected by human being smiling until it reaches to 20- 30 ppm. However, according to the health guidelines, ammonia levels in most birds should be maintained less than 25 ppm. Most chickens' authorization systems require ammonia levels of less than 25 parts per million (ppm) **[2].** People who are frequently exposed to poultry facilities with detectable ammonia gas levels have been shown to lose their sensitivity to ammonia gas concentration. They frequently lose the ability to detect even irritatingly high ammonia levels of 50-100 ppm. Even a casual visitor to a poultry barn will become accustomed to an ammonia odor in about 20 minutes, like a guest who no longer recognizes the fresh baked smell of a pie after spending the same amount of time in your kitchen. Elevated ammonia quantities have been demonstrated to be harmful to bird respiratory function, resulting in disease challenge, and at higher levels, ammonia reduces bird productivity and farm profit. At 7 weeks of age, broilers raised up in an environment with ammonia of 25-50 ppm lost half a pound of body weight compared to birds raised in environments with less than 25 ppm ammonia. In poultry, high-level exposure to ammonia for 20 days

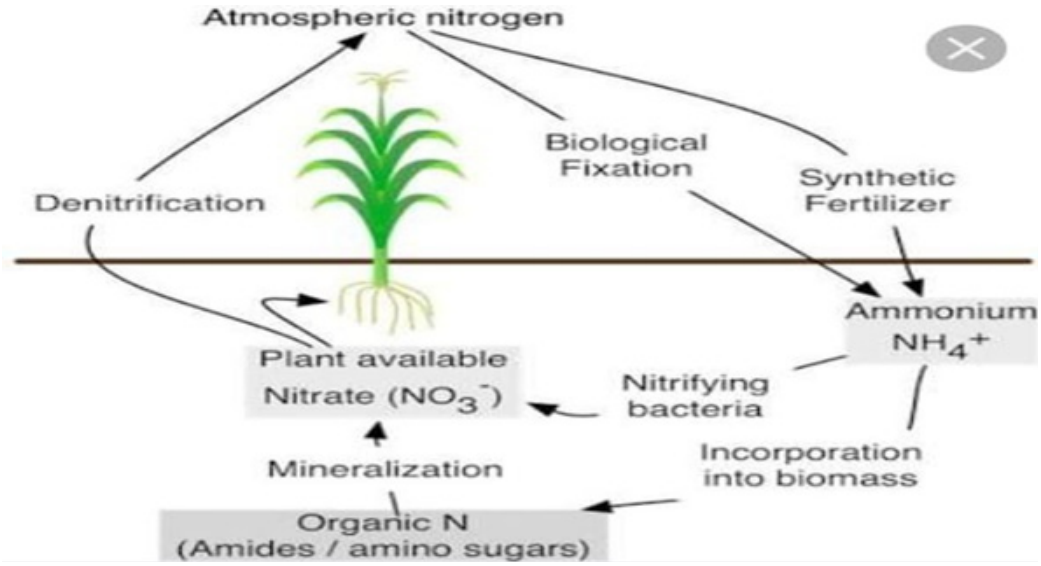

Fig.1. The nitrogen cycle simplified according to SoilDx. [8].

decreased the intestinal surface area (possibly impacting nutrient absorption), decreased the bird's resistance to oxidative stress, altered the intestinal tract's ability to break down nutrients and impacted immune organs.

Problems of ammonia odor emission

When ammonia is present in the atmosphere, it can cause global impacts and promote to the formation of nitrogen oxides, which are greenhouse gases (GHG) [9]. Additionally, ammonia in the air can contribute to the acid rain formation, which can cause soil acidification and eutrophication [9,10]. Continuous exposure has been linked to a decline in weight gain [11], troubles with eye inflammation, and the likelihood of a greater diseases' incidence [12], which can even lead to death [10]. The uncertainty associated with measurements is a problem when compiling an inventory of ammonia emissions. Accurately measuring ammonia concentrations and ventilation rates inside a facility with a natural ventilation system proves difficult [13,14]. The air inlets and outlets in facilities with natural ventilation systems are not clearly defined.

Ammonia's Effects on the Poultry Health

Effects on growth rate and mortalities

Ammonia has been found in high concentrations in bird excreta, according to Mendoca et al. [15]. Because of its effects such as reduced growth rates and increased mortality, this gas causes economic losses. Similarly, Beker et al. [16] found that higher-than-normal quantities of ammonia in poultry houses reduced performance and enhanced disease vulnerability. Miles et al. [17] discovered lower body weight gains in broilers exposed to ammonia levels of 25 ppm or higher. Furthermore, exposing poultry to ammonia concentrations as small as 20 ppm for an extended period during the production period may be harmful to the birds [3]. Reduced mass gain and increased vulnerability to diseases in ammonia-exposed poultry could be attributed to lower feed utilization and feed efficiency. Reduced feed intake and feed efficacy have been stated in broilers exposed to ammonia levels ranging from 25 to 125 ppm [18-19] as displayed in Fig. 3. This also confirms the findings of a study conducted by Caveny et al. [20] who found that exposing poultry to ammonia at 25 ppm for 42 days developed in reduced feeding efficiency. High levels of ammonia have a negative impact on overall livability, weight gain, feed conversion, condemnation rate at processing and the immune system of the birds.

Effects on the gastro-intestinal tract and respiratory system

The scientists in previous literature noticed that when ducks exposed to ammonia level at a concentration of 75 ppm had altered intestinal microbiota and had lower productive performance and laying rates compared to ducks exposed to 10 ppm [23]. These findings were nearly reported by Kers et al. [5]. Moreover, Naseem and King [4] conducted a review of the various impacts of ammonia level on the bird health, including ocular, nasal, and intestinal problems. Furthermore, ammonia causes snicking, tracheal irritation, air sac inflammation, and dyspnea in poultry owing to its irritating impact on the respiratory system [24].

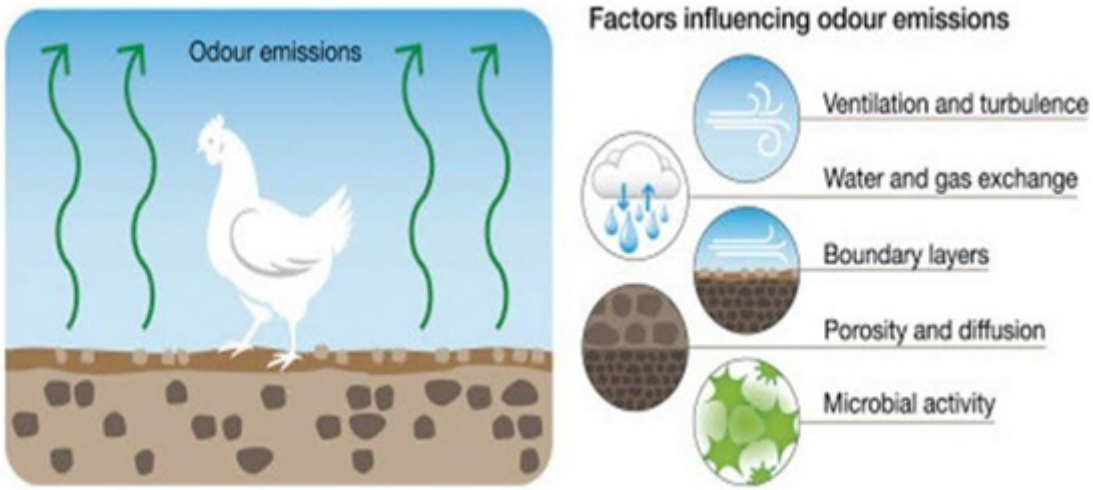

Fig.2. Factors affecting odor emission from poultry litter [14]

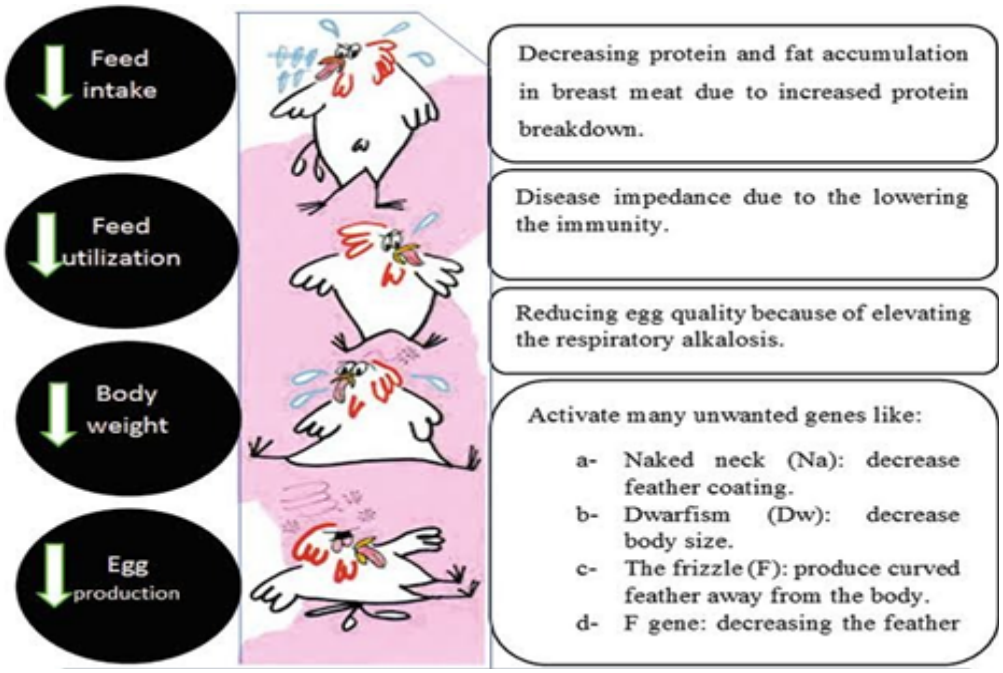

Fig. 3. The adverse impacts of ammonia increased in poultry farms [21]

TABLE 1. The significant effect of NH_3 on the growth performance of 3 weeks' broiler chickens [22].

Production mass NH_3 level (ppm)	Average daily feed intake (ADFI) (g)	Body weight (B.W) (g)	Feed/ gain ratio (g : g)
52	43.54 ±2.4	644±29.7	1.53±0.03
26	44.14±2.0	662±32.7	1.51±0.11
13	44.371.6±	667.3429.7±	1.500.06±
Control (0.0 ppm)	44.97±1.6	768.17±25.5	1.49±0.02

In a similar manner, persistent exposure of poultry to 20 ppm ammonia caused significant respiratory tract damage [3]. As previously reported, ammonia exposure ranging from 75-100 ppm caused alterations in the respiratory epithelium, cilia loss, and a rise in the number of mucus-secreting cells [25-26]. Eye damage refers to ammonia-induced corneal erosion and keratoconjunctivitis have been observed in birds exposed to levels ranging from 46 to 102 ppm [27].

Ammonia detection and measurement

Ammonia be measured at bird level to document the conditions under which they are living. When humans smell ammonia, it means that its concentrations are higher than recommended. It is recommended that simple instruments be used to measure ammonia levels before they become significant. Fortunately, simple, and low-cost instruments for determining ammonia levels in fowls surrounding are available. These instruments are now commonly used by company advisory personnel for spot checks or collaborating with producers to troubleshoot a poultry house environment control system [28].

More precise and sophisticated instruments are also available, but at a much higher cost. Colorimetric Tube instruments are the most affordable ammonia instruments with reasonable

accuracy (about 20% of readings) (also known as Detector Tube). Because the tube contents react with the gas, the pen-sized glass tube color alters along its length after being exposed to the gas. The color change in the detector tube indicates the intensity of ammonia [28]. Reading a scale along the tube to determine the ammonia concentration.

Diffusion tubes (also known as Passive tubes or Dosimeter tubes) are a less costly colorimetric choice for monitoring ammonia level in the surrounding environment as no sampler pump is needed. Another advantage of diffusion tubes over pull tubes is that they provide ammonia level over a period. Ambient air slowly diffuses into the tube's contents, causing a color change due to a chemical reaction with ammonia in the air [28]. A dosimeter tube collects data in the form of ppm-hr over a period of 2 to 10 hours. A scale is provided on the side of the tube used for direct reading. During the monitoring period, the average ppm is determined by dividing the concentration-time reading by the number of hrs. of exposure to the barn air. The tube can be positioned near the animals for welfare reasons, and/or it can be used to calculate emissions from building ventilation exhaust. The dosimeter tube process has the drawback of needing two visits to the animal environment, one hour apart, to place the tube and save the concentration reading.

Colorimetric Tube Options for Gas Detection Thin glass colorimetric tubes are available for a wide range of gases. There are numerous forms of sampling pumps accessible, however the pump and pull pipes should be manufactured by the same company to meet the amount of ambient air moved across the tube with the response rate of the tube matters. Pumps, like other instruments, must be checked on a regular basis for problems such as leakage of older worn seals (tube instructions offer a quick test for leakage). Pull tubes and diffusion tubes are available in a variety of measurable ranges, allowing for appropriate analysis. These tubes are available in a variety of scales**.** Colorimetric tubes offer reliable and proven technology for roughly estimating ammonia gas concentration in animal environments. They are relatively low cost, compared to other ammonia detection instrumentation.

Preventive control of ammonia and odor emission

Dietary management and ration composition through Utilization of lower crude protein (CP) diets with supplemented essential amino acids and using components such as the extract of Yucca schigidera, which plays a role in binding ammonia and reducing blood urea and ammonium ions, lead to decrease extreme nitrogen breakdown in the ceca and bind ammonia so it stays in the manure instead of being released as gas. It is critical to provide a well-balanced, complete diet. Problems caused by high-performing inheritances, feed preparation, and treatment can rise in wet manure production, resulting in enhanced ammonia and odor statement as well as lowered broiler performance and feed productivity. Improve the poultry stocking density to help limit extra moisture in the fowls building, thereby lowering anaerobic process. Mendes et al. [29] recorded that the correct stocking rate of broiler chicken is 16 birds/m^2 of floor space for winter period and 10 birds /m^2 for summer period. More aeration is required as ammonia levels rise. Though, this would be done in agreement with the microclimate factors and temperature of the fowls building. Temperature adjustments must be done in relative to the house climate and welfare. Improving nutrient digestibility could also be accomplished by supplementing diets with additives such as (Extract of *Yucca schigidera*). "Composting" is a popular, low-cost, and socially acceptable method of treating solid or semisolid biodegradable waste that can be converted into a stabilized composite that can be used as fertilizer [30]. When poultry manure was blended with wheat-straw, Janczak et al. [31] discovered that using biochar reduced ammonia releases in both "the gaseous and liquid phases". Wlazlo et al. [32] reported that the ammonia-absorbing properties of sodium bentonite and zeolite were confirmed in ex situ conditions. They went on to say that aluminosilicates can be utilized to neutralize ammonia emitted by poultry farms. According to Shu et al. [33] supplemental feeding with *Bupleurum falcatum* L Saikosaponins (SP) represent a group of oleanane derivatives, usually as glucosides, which are ubiquitously found in plants [34] might be helpful in alleviating the detrimental effects of NH_3 on the ileum development in broilers.

Conclusions

Ammonia gas has a powerful negative impact on the poultry health and performance of all species and age groups of poultry. Furthermore, ammonia exposure makes birds more susceptible

to infectious diseases and increases mortalities, which has a negative economic impact on the poultry industry. As a result, it is critical to develop effective methods for measuring and monitoring ammonia quantities in poultry dwellings, besides suitable control methods for avoiding undesirable high amounts of ammonia and controlling the level of emission in the poultry facilities.

Acknowledgement

To all stuff in the department

Conflict of interest

The authors do not have any competing interests.

Funding statement

Self-funding

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كيف يمكن تخفيف مشاكل الأمونيا الصحية في حظائر الدواجن؟

أسماء نادى محمد
قسم الصحة والأمراض المشتركة والوبائيات - كلية الطب البيطري - جامعة بني سويف - بني سويف 62511 - مصر

إن الأمونيا عبارة عن غاز ينتج كمنتج ثانوي لظروف نظام التربية فى الدواجن. هذا الغازيمثل خطورة بالغة للغاية على صحة الدواجن ، بغض النظر عن النوع أو الفئة العمرية المتأثرة. ووفقًا للجهات والسلطات المختصة الصحية ، فإن الحد المسموح به لهذا الغاز في مساكن الدواجن هو الحد الذي يمكن اكتشافه بواسطة الشم (عن طريق الإنسان) وهو ٢٥ جزءًا في المليون. يتسبب التعرض المزمن للدواجن ، وخاصة الطيور الصغيرة ، لمستويات الأمونيا التي تزيد عن ٢٥ جزء في المليون في مجموعة متنوعة من المشكلات الصحية تتراوح من انخفاض الوزن وزيادة الأداء إلى الإجهاد الشديد على كلا من الجهاز الهضمي والجهاز التنفسي ، فضلاً عن زيادة التعرض للعدوى الميكروبية. يمكن أن يحدث التهاب القرنية والملتحمة أيضًا بسبب سمية الأمونيا. هناك عدة طرق لتحديد مستويات الأمونيا داخل حظائر الدواجن ، تتراوح من الطرق البسيطة إلى البروتوكولات الأكثر تقدمًا وتعقيدًا. لذا استنتجت الدراسة الى أنه يجب تطبيق و اتخاذ عدة خطوات لمنع الآثار الخطيرة للأمونيا في مزارع الدواجن ، بما في ذلك المكملات الغذائية وتركيب العلائق المناسبة، والكثافة المناسبة لتربية الطيور ، ودرجة الحرارة المثالية ، والتحكم في التهوية ، وتقليل انبعاثات الأمونيا ، حيث أن ذلك يساعد على زيادة الراحة للطيور وتقليل مخاطر الأمونيا في مزارع الدواجن.

الكلمات المفتاحية: مستويات الأمونيا ، المصادر ، انبعاث الرائحة ، صحة الدواجن ، خيارات المكافحة.