NITROGEN CONTENT OF CHICKEN FECES AND ITS RELATION WITH FEED CONTENT IN POULTRY FARMING – A STEP TOWARDS MANAGING ATMOSPHERIC AMMONIA

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Abstract
Non-agricultural food products like poultry not only give an alternative source of income and employment but also help individuals in raising the standard of their living bringing millions of poor households out of poverty. For churning profits, farms tend to ignore proper feed, and chicken feces disposal, which harms the overall surroundings. Nitrogen in chicken feces are a major source of atmospheric ammonia along with some other gases involving greenhouse gases. The present paper focusses on calculating the nitrogen content of chicken feces whenever the diet of chicken is altered. It is observed that when protein is increased in diet the nitrogen in the chicken feces shows increasing pattern. However, the highest protein diet may not result into highest nitrogen content in the feces. The increase in nitrogen between morning and evening ranged from 0.46 to 0.64 % of 10 g of feces. On an average the 5-days increase in nitrogen ranged from 0.4 to 0.64 %. The chicken feces also act as a perfect feed for fishes. This may help in reducing the waste, increasing the profit for farmers and will help in addressing food security concerns.

Keywords: Chicken; Diet; Nitrogen excretion; Poultry farms; Waste disposal

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1. INTRODUCTION

The poultry sector is among the fastest growing agro-based industries worldwide due to increasing demand for egg and meat products [1]. Eggs are important source of animal protein [2]. Poultry farming is a technique, which mainly focuses on rearing and raising of a different variety of birds for obtaining meat and eggs through it. It can be done commercially as well as domestically. Chicken Poultry farms form the bedrock of the avian commercial farming. Chickens are raised in a variety of farms such as free cage and battery cage [3]. Free cage includes free movement of chicken in an open farm area without any cage restrictions, and battery cage involves intensive cage structures for rearing chicken. Battery cage farming is generally used for large-scale commercial farming. A chick requires a time period of 6 weeks to attain full maturity. There are different subspecies of Jungle foul and each serves different purposes. For instance, the Broiler is used for meat and Leghorn is used for egg purposes [3]. The leading producer states of egg in India are Andhra Pradesh with 23% domestic market share, followed by Tamil Nadu at 14 %, Maharashtra at 5%, Punjab at 4% and Kerala at 2% [4]. Top five poultry meat-producing states in India are Haryana with 3.52 lakh tonnes annually, followed by West Bengal with 3.28 lakh tonne annually, Uttar Pradesh with 2.70 lakh tonne annually, Tamil Nadu with 2.26 lakh tonne annually, and Maharashtra with 1.44 lakh tonne annually. India produces 75 billion eggs annually [5]. Indian poultry population is around 500 million [6] which generates over 12 million tonnes of manure.

Poultry farming has undergone a sea change. It has evolved from being a backyard activity in the early 20th century, to a full-grown commercial activity in the 21st century. Millions of chickens are bred and grown together. For feeding such a huge population of chicken, lots of feed is required. The feed composition varies according to the requirement of the chicken. Poultry feeds can be in the form of mash, crumbled, pellets and scratch. For sustaining the profit margins and to feed the ever-increasing population of human beings, the European Union allowed the

usage of growth-promoting antibiotics. Consequently, the size of chicken increased due to hormonal intervention, but the waste generated also increased and became chemically hazardous too [7]. For each 450 g of feed consumed, a chicken produces approximately 220 g of fresh manure with a moisture content of about 75 percent [8]. Large-scale Concentrated Animal Feeding Operations (CAFO) in the USA are facing such problems. Similarly, in Punjab and Haryana, there are numerous CAFO which have faced red flags by environmental authorities [3]. Improper disposal of chicken feces also has hazardous consequences [9]. Various greenhouse gases such as methane, nitrous oxide, and carbon dioxide are emitted from these CAFO's which result in environmental degradation [10]. Other than that, ammonia is also a biproduct of poultry farming. Chickens are among the most important contributors to ammonia emissions globally [11]. A large part of chicken nitrogen excretion converts to ammonia into the atmosphere [11]. It is highly likely that chicken feces that has high concentration of ammoniacal nitrogen will emit higher ammonia [11]. Around fifty percent of nitrogen in amino acids in poultry feed is released as chicken poop, which may be converted into atmospheric ammonia [12]. Ammonia has adverse impact on the health of chickens, and human being directly, or may be converted into air pollutants (particulates). More than half of atmospheric ammonia on earth is emitted from confined housing of animals including poultry [13]. Ammonia is the main gaseous pollutant generated in poultry production [14].

Chicken feces are rich in nitrogen, which is not being put to use properly. Consequently, polluting fertile soil and groundwater. As per one study [15], about 25% of the nitrogen pollution entering the bay of Chesapeake, USA, is the result of nearby poultry farms. Poultry farms can cause nitrate leaching in the environment [16].

The main means of nitrogen entry into the broiler rearing system is feeding [14]. Feeding diet with less nitrogen is a cost-effective way to reduce the effects of atmospheric ammonia [13]. Air pollution in chicken production globally happens mainly during feeding and managing poop [11]. Feed management is the most important way of reducing nitrogen emissions in poultry industry [11].

Estimation of chicken manure (litter and faeces) nitrogen is important for managing nitrate leaching into groundwater and cropland [17].

The present study provides an insight into changes in nitrogen content in chicken feces with changes in diets. Currently, there is no detailed information about proper diet of chicken for increasing the productivity of chicken as well as increasing nitrogen content in chicken feces in India.

This study will assist entrepreneurs in setting up an eco-friendly poultry farm. It will assist producers by helping them limit the number of factors responsible for pollution. The research question is whether the nitrogen in chicken feces changes with changes in dietary pattern, particularly protein.

2. MATERIALS AND METHODS

Two organizations; one private and one government poultry farm are selected for the study in the state of Haryana, and Punjab India (Fig. 1).

The ground survey was conducted during June and July of 2018 where chicken feces is collected five times a day from two different farms. Feed timings and hygienic parameters were noted down. Semi structured interviews were done to gain information about chicken feed content.

Random sampling of chicken feces was done in order to obtain an average nitrogen content in chicken feces from a specific poultry pen. Two varieties of chicken which were Chan (for meat) and Leghorn (for eggs) were involved in the study. After every week feed was changed for specific set of chicken in order to observe the effect of feed change on nitrogen content of chicken feces.

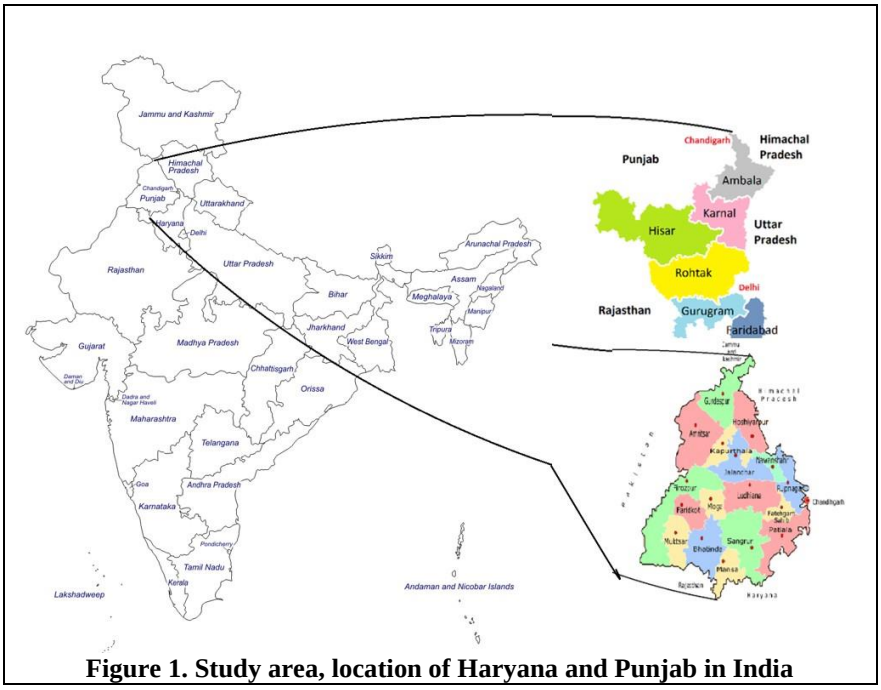

Figure 1. Study area, location of Haryana and Punjab in India

Table 1 : Table containing food sources for various poultry feed

Feed Ingredients	Sources
Cereals	Sorghum, Corn, Barley, Wheat
Fat and Oils	Tallow, yellow grease, white grease, blended animal and vegetable fat
Protein Sources	Soybean, Canola, Fish meal, Field Peas
Cereal by-products	Bran, groat, gluten feed, rice polish etc

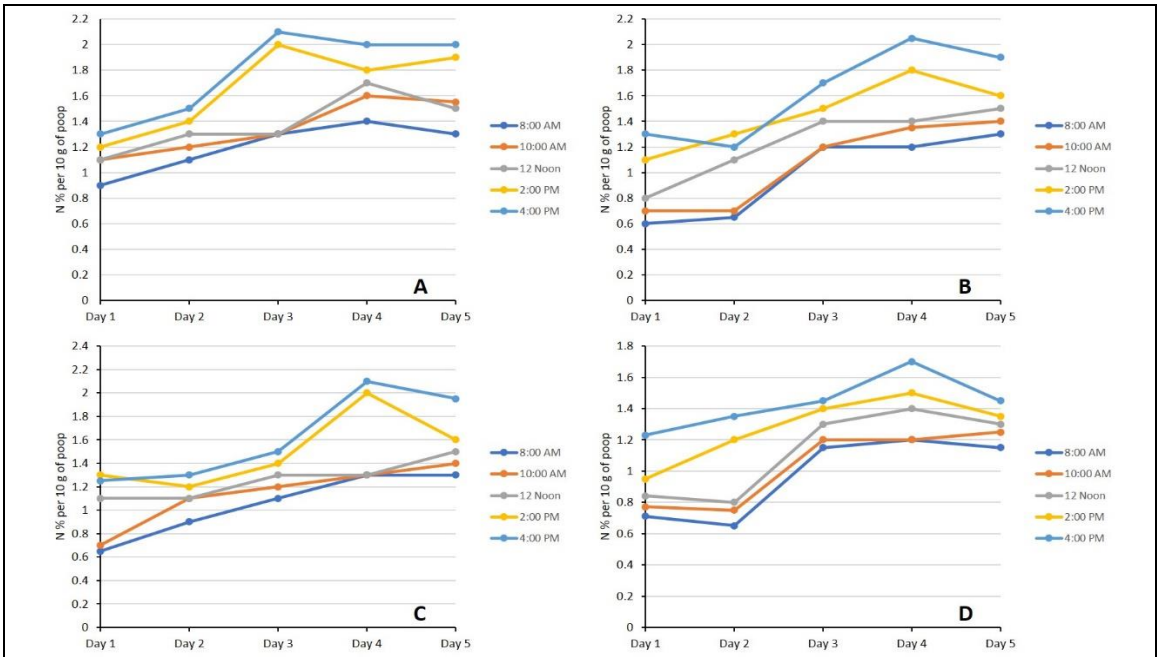

Figure 2. Changes in nitrogen in feces (% / 10 g of feces) with changes in protein (%) in feed content; for Chan (government) – A, Leghorn (government) – B, Chan (private) – C, Leghorn (private) – D. Protein percentage in feed are; 60 (Day 1), 65 (Day 2), 70 (Day 3), 75 (Day 4), 80 (Day 5)

Every day after 4:00 pm, five samples of chicken feces are collected and brought to the laboratory and then via near infra-red (NIR) spectroscopy machine the amount of nitrogen present in chicken feces is noted and tabulated [18; 19].

The feed composition varies according to the requirement of the chicken. Poultry feeds can be in the form of mash, crumbled, pellets and scratch. Some of the sources of feed production are mentioned in the table underneath [20] (Table 1).

3. RESULTS AND DISCUSSION

Change in nitrogen in feces with change in protein is shown in the following figure (Fig. 2). The data is for two chicken variety for private and government organization. From day 1 to day 5, Nitrogen ranged from 0.9 – 1.3 %, 1.1 - 1.5 %, 1.3 – 2.1%, 1.4 – 2%, and 1.3 – 2% respectively for Chan breed (government); from 0.6 – 1.3%, 0.65 – 1.2%, 1.2 – 1.7%, 1.2 – 2.05%, and 1.3 – 1.9%, respectively for Leghorn breed (government); from 0.65 – 1.25%, 0.9 – 1.3%, 1.1 – 1.5%, 1.3 – 2.1%, and 1.3 – 1.95% respectively for Chan breed (private); and 0.71 – 1.23%, 0.65 – 1.35%, 1.15 – 1.45%, 1.2 – 1.7%, and 1.15 – 1.45% respectively for Leghorn breed (private). Balasubramani et al. [21] observed in a study in South Africa that N % ranged between 1.6 to 3.2 in chicken manure. In India, it observed to be in the range of 3 to 5% [6].

The nitrogen percentage increases for both organization from morning (8 am) to evening (4 pm). The increase ranges from 0.3% in Leghorn-private to 0.85% in Leghorn-government. For both organizations, nitrogen increase is observed to rise and then slightly decrease by day – 5.

Amanullah et al. [22] noticed that nitrogen percentage in different types of manure from poultry are 1.7-2.2 (deep litter), 2.4-3.6 (broiler house), and 3.63-5.3 (cage manure).

From the average value (Fig. 3), the increasing pattern in nitrogen from day 1 to day 5 is clearly evident. On an average the 5 days increase in nitrogen ranged from 0.4 to 0.64 % (when protein is altered). Chan-government shows highest percentage of nitrogen in feces throughout the five days.

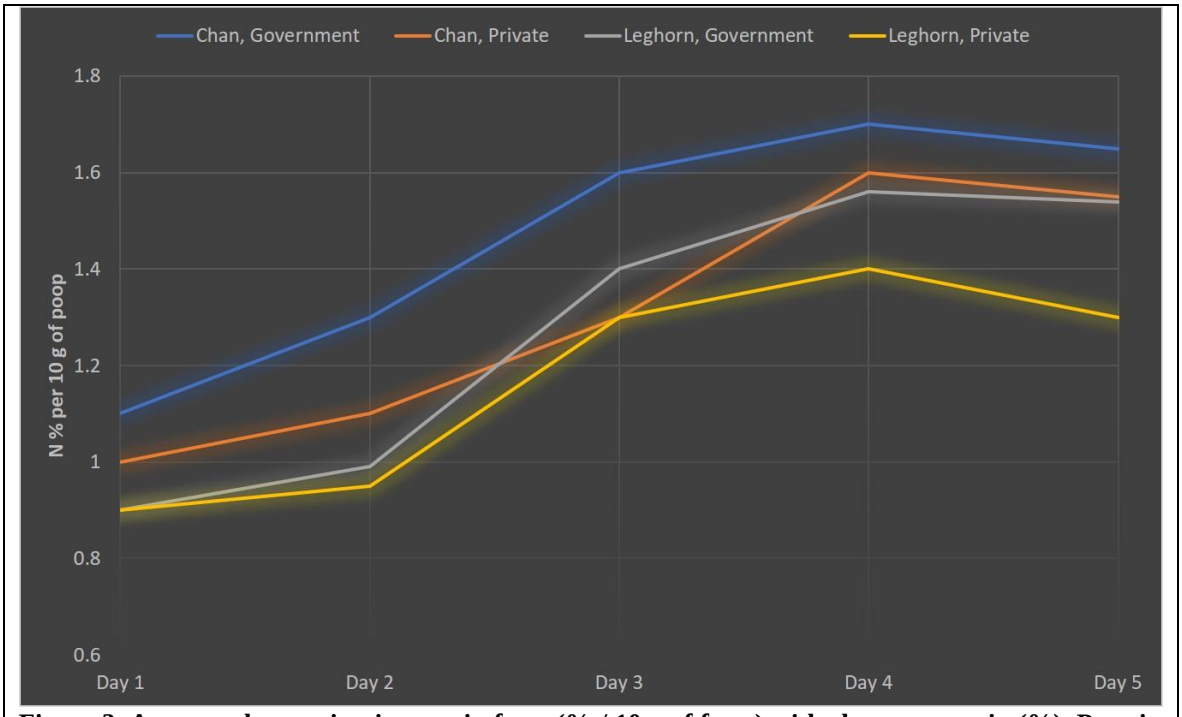

Figure 3. Average changes in nitrogen in feces (% / 10 g of feces) with changes protein (%). Protein percentage in feed content are 60 (Day 1), 65 (Day 2), 70 (Day 3), 75 (Day 4), 80 (Day 5).

It is observed that when the protein section of feed gets altered there is a stark change in the percentage of nitrogen available in the chicken feces from the previous levels. When the diet is changed for protein, Chan bred (grown in cage-free government farm) produces more nitrogen in comparison to the Chan bred (grown in battery cage private farms). Similarly, the Leghorn bred grown in cage-free government farms, produces more nitrogen in comparison to its battery cage counterpart.

The above results gave an insight about the effect of altering the feed composition on the nitrogen content of the chicken feces. When the protein percentage of the feed is increased, the nitrogen content in the chicken feces increases. In free cage farms like that in Government farm, the increase in the nitrogen content of the chicken feces is more. In battery cage farms like that in the private one, the increase in nitrogen content of the chicken feces is not as much as in the case of free cage farm, but certainly, there is an increase in the percentage of the nitrogen content of chicken feces in both the farm types. Hence, we can say that, increase in protein content of the diet increases the nitrogen content of the chicken feces. Although, in a study by Ferguson et al. [23], it is observed that litter nitrogen content can be reduced by reducing the crude protein in diet and without reducing the dietary amino acids, Murakami et al. [24] in a study in Japan observed that the crude protein percentage in diets don't have a significant effect on the total nitrogen in chicken litters (manure, bedding materials, and feather). As per United States Department of Agriculture, USDA, dietary adjustments can be made to reduce excessive nutrient excretion [25]. Reduced protein in the diet can help nitrogen reduction in excreta up to 10-15% [25]. To provide the correct amount of amino acids in the intestinal tract, accurate quantity of protein is important [26].

Chicken feces is an agricultural residue material with a high biomass potential [27] and also valued for its contribution as nitrogen fertiliser. Higher the organic nitrogen content in the chicken feces, more beneficial it is for generating the organic fertilizers for the field. High nitrogen concentrations in manure if used as fertilizer can negatively impact crops also, and can also leach to groundwater [16].

The nitrogen content can be managed by diets [24]. It is possible to reduce crude protein in diet and still meet the requirement of amino acids for chickens [16].

This can reduce the excretory nitrogen without negatively impacting the animal [16]. Overfeeding of dietary protein to chicken is commonly practiced to meet the growth requirements [28].

More efficient diet such as avoiding overfeeding can reduce environmental concerns through surplus nitrogen excretion from poultry [16]. Arbitrary increase or decrease in dietary protein should be avoided to help curb adverse impact on environment, profit, and performance [11].

4. CONCLUSIONS

Altering the feed of the chicken within certain limits, surely has an impact on the amount of nitrogen present in the chicken feces. The nitrogen content in chicken feces from cage-free farms tend to outperform the battery cage counterparts.

Therefore, it can be conclusively said that waste litter from cage-free farms can be utilized more effectively. The higher nitrogen content in chicken feces, when segregated properly can act as a nutritious fish feed. Hence, fish farming can be integrated with poultry farming. This eco-friendly combination of farming will not only help in cutting the cost of fish feed, but will also help in reducing the negative externality of poultry waste in the surroundings.

The most innovative technique calls for rearing fishes in waterlogged rice fields. Probable applications of chicken feces involve using chicken feces in bio-digester to generate methane which in turn can produce electricity. The slurry obtained with controlled nitrogen from the digester can work as a perfect bio-manure for land.

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