Practical Dietary Strategies to Reduce Ammonia Emission Intensity of Table Egg Production

Egg Farmers of Alberta and Alberta Agriculture and Forestry

(Project Duration: April 2016 - March 2019)

The Problem

Ammonia (NH_3) emissions from intensive livestock production have been identified as a serious concern from the standpoint of environmental quality, worker health, and animal welfare. When introduced to naive ecosystems, NH_3 can affect biodiversity by causing abnormal proliferation of certain species over others. When deposited in aquatic ecosystems, where nitrogen (N) is typically limiting, eutrophication can result.

Ammonia is also recognized as a respiratory irritant and is therefore a bird welfare concern and potential occupational hazard for egg producers. Several studies have demonstrated negative effects on poultry productivity and welfare when ambient levels of NH_3 exceeds 25 ppm. This level is consistent with occupational short term exposure limits for workers, which is of renewed concern in light of the recent expansion of occupational health and safety standards in Alberta to include farms. It should come as no surprise therefore that reducing NH_3 emissions has been identified as a research priority by the egg industry in Alberta and Canada.

The primary source of NH_3 emissions from poultry manure is uric acid, the major form of metabolic N excreted via the urinary system. Uric acid is the waste product of protein metabolism and the amount excreted is directly related to the amount of digestible protein consumed. Uric acid is converted to NH_3 via a multi-step reaction catalyzed by microbial enzymes in the excreta (**Figure 1**).

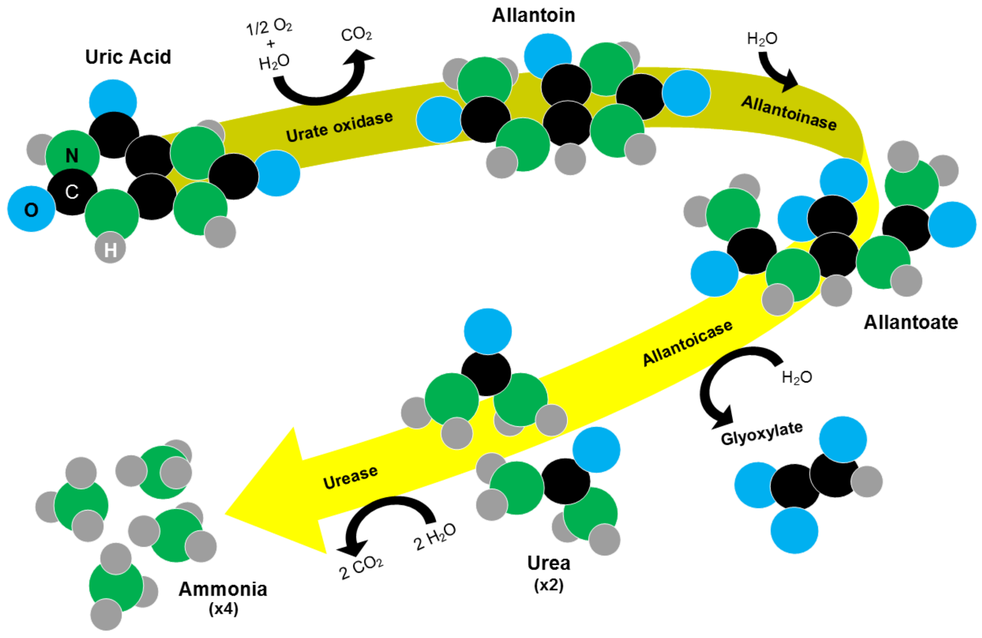

Figure 1. Hydrolysis of uric acid to ammonia. Note that a single molecule of uric acid yields 4 molecules of ammonia and 3 molecules of carbon dioxide. Adapted from Lehninger et al. (1998).

These reactions are influenced by physical conditions in the manure, such as pH and moisture. In addition, the specific enzyme activities required for these reactions are associated with some microbial genera more than others. The population profile of gut microflora therefore also has an important effect on emissions.

All of the above factors - digestible protein intake, excreta pH and moisture; and gut microflora can be influenced to a large extent through dietary interventions. In light of this, we propose to take a preventative approach to mitigating ammonia emissions by reducing the potential.

Our approach

In this study, we will be taking a three-pronged dietary approach to reducing the ammonia emissions intensity of egg production by:

1. Reducing the amount of surplus digestible protein in the diet;
2. Reducing the alkalinity of the diet by linearly replacing $CaCO_3$ (limestone) with $CaSO_4$ (gypsum) as the major dietary source of calcium; and,
3. The addition of non-nutritive functional ingredients to laying hen diets, including biochar, *Yucca shidigera* extract, Jerusalem artichoke inulin, oxidized lignite and zeolite.

The proposed mechanisms by which these dietary strategies could reduce ammonia emissions are presented in **Figure 2**.

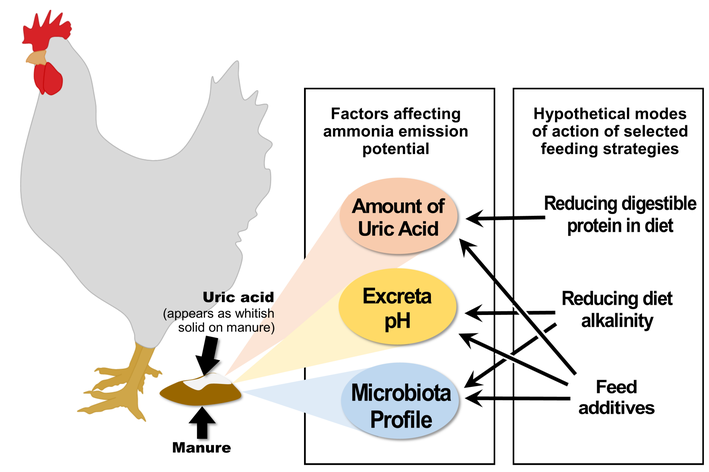

Figure 2. Hypothetical modes of action of the feeding strategies to be studied on reducing ammonia emissions from laying hen manure.

Our objective

We propose to fill in the existing knowledge gaps by conducting a holistic evaluation of several different strategies simultaneously, under Alberta conditions and feeding typical Western Canadian layer diets.

Our objective will be to identify cost effective dietary strategies to reduce ammonia emission intensity (g of NH_3 per dozen eggs) by as much as 25%.

Current status of the project

As of the end of September 2016, we have completed or are currently engaged in the following activities in support of the main 16-wk long study, scheduled to take place June through October 2017:

1. Completed - a project that will help us refine the digestible nutrient coefficients for the catalogue of feedstuffs we plan to draw on for the main study – this will allow us to conduct precision diet formulations for the hens;
2. Completed - the first part of a project looking at refining our sample collection and handling protocols, which will be critical to the accuracy of our data;
3. In progress – signing of agreements with project contributors and development of service contracts in support of the project; and,
4. In progress – recruitment of a 12-month intern from the University of Alberta who will provide technical support to the project.

For more information

For more information about this project, please contact:

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