

# Effects of Dietary Fiber on Cecal Short Chain Fatty Acid and Microbial Community of Broiler and Layer Chicks

## A.S. Leaflet R2991

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### Summary and Implications

The effects of increasing concentrations of dietary fiber through the addition of dried distiller's grains with solubles (DDGS) and wheat bran to a corn-soy bean meal were evaluated for commercial broiler and layer chicks separated into 4 groups during a 21 d trial. Diets were formulated to be isocaloric and meet or exceed nutrient recommendations. Birds had unlimited access to feed and water. The increased dietary fiber had opposite effects on the production of short chain fatty acids for broilers and layers due to differences of the microbial community in the ceca. The change also included signs of decreased cecal health of the chicks, suggesting that it is not a good idea to increase dietary fiber past nutrient recommendations in chicken feed.

### Introduction

With the increase in the price of corn and feed-grade oils and fats, the use of feed ingredients high in dietary fiber has received interest from the poultry industry. Even though it is well known that increasing fiber levels decreases growth rate and feed efficiency in chickens, some has reported that fiber in diets has an important role in gut development and ultimately affects a chicken's ability to convert feed into energy. One of the intermediates of the conversion of dietary fiber into energy is the production of short chain fatty acid. In this study, we measured the production of short chain fatty acid in the ceca between broiler and layer chicks fed a lower fiber diet compared to a higher fiber diet. To help understand the difference observed, we also looked at the cecal bacterial DNA.

### Materials and Methods

A total of 250 male Ross 308 broiler chicks (Aviagen Group, Huntsville, AL) and 250 male Hy-line W36 layer chicks (Hy-Line International, Dallas Center, IA) were secured from separate commercial hatcheries and transported to the ISU Poultry Research and Teaching Unit. On d 1, chicks were individually weighed, sorted by weight, wing banded, and assigned by line and body weight within

line to raised wire battery cages (432 cm<sup>2</sup>/chick) with continuous light in an environmentally controlled room.

Starter diets for both broiler and layers chicks were formulated to be isocaloric and meet or exceed National Research Council nutrient recommendations. Both lower and higher fiber diet were based on corn-soy bean meal, but the higher fiber diet had the addition of 60.0 g/kg of DDGS and 60.0 g/kg of wheat bran for d 1-12 that increased to 80.0 g/kg for both during d 13-21. Birds had *ad-libitum* access to feed and water.

On d 21, three ceca were collected from each experimental group. One cecum underwent short chain fatty acids concentration analysis and the other two ceca underwent bacterial DNA isolation for microbial analysis. Statistical analysis was performed in SAS using PROC GLM (SAS Inst. Inc., Cary, NC).

### Results and Discussion

The short chain fatty acids analysis indicated an increase of acetic acid (P=0.04) and total short chain fatty acids (P=0.04) concentrations for broilers fed higher fiber diet and layers fed lower fiber diet (Figure 1). The microbial analysis results are summarized in table 1.

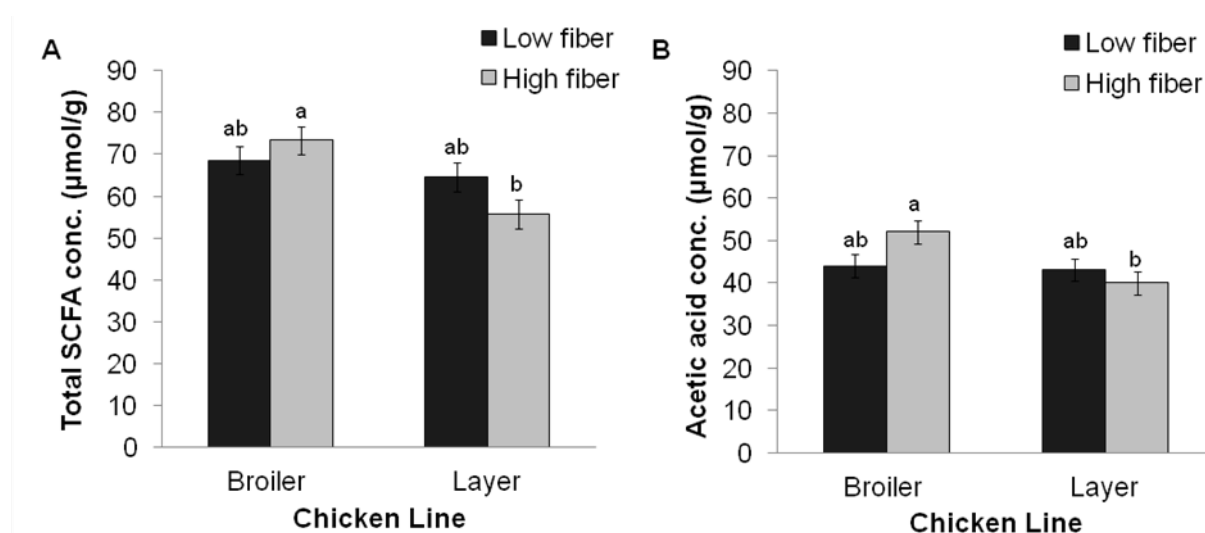
The analysis identified increases in relative abundance for species involved with fiber degradation, *Helicobacter pullorum* and *Megamonas hypermegale* for both groups that had higher short chain fatty acids production. These two treatment groups also had higher *Firmicutes/bacteroidetes* ratio, which is a signal for decreased gut health. Finally, the analysis also indicated that there is a corresponding increase in species associated with inflammatory response, *Campylobacter jejuni* (broilers) and *Escherichia coli* (both lines, for chicks fed the higher fiber diet).

In conclusion, our experiment suggests that increasing dietary fiber diet is associated with an increased production of cecal short chain fatty acids for broilers but not the layers. This difference is due to a dramatic shift in the microbial community that also included species that may have a negative impact on the chick's health due to stimulation of the inflammatory response.

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**Figure 1. Effect of increasing dietary fiber on total short chain fatty acids (SCFA) and acetic acid concentration in broiler and layer chicks at 21 days of age.** (A) Total short chain fatty acids production. (B) Acetic acid production. Values are reported as least squares means; n=44. Bars not sharing common letters differ significantly ( $P \leq 0.05$ ).



**Table 1. Selected information of species relative abundance (%) identified from microbial analysis.**

| Population                            | Broiler   |            | Layer     |            |
|---------------------------------------|-----------|------------|-----------|------------|
|                                       | Low Fiber | High Fiber | Low Fiber | High Fiber |
| <i>Helicobacter pullorum</i>          | 5.286     | 12.234     | 51.839    | 11.229     |
| <i>Megamonas hypermegale</i>          | 2.315     | 12.689     | 6.322     | 0.867      |
| <i>Campylobacter jejuni</i>           | 0.054     | 0.715      | N/A       | N/A        |
| <i>Escherichia coli</i>               | 1.935     | 12.385     | 1.182     | 1.816      |
| <i>Firmicutes</i>                     | 36.187    | 41.192     | 23.642    | 33.101     |
| <i>Bacteroidetes</i>                  | 54.785    | 26.355     | 23.119    | 49.660     |
| Ratio <i>Firmicutes/Bacteroidetes</i> | 0.661     | 1.563      | 1.023     | 0.667      |