Factors Affecting Enrichment Levels of Value-Added Eggs

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Problem

- Eggs can be enriched by dietary manipulation with Omega-3 Poly-Unsaturated Fatty Acid (n-3 PUFA), lutein, vitamins (A, E, Folic Acid) and minerals(Selenium, Iodine).
- Major constraint is higher cost of production.
- Bird to bird variation in ability to transfer into final product.
- Feed ingredients used to create value-added eggs can interfere with nutrient utilization efficiency.
  - Interfere with mineral absorption = shell quality= $ loss?

Hypothesis

- Our hypothesis was hens with higher metabolic efficiency will have higher levels of enrichment.
- The objective was to explore potential linkages between metabolic efficiency, intestinal length and morphology, and transfer of Omega–3 polyunsaturated fatty acid to the egg.
- Determine impact of individual hen efficiency on ability to transfer Omega-3 to the egg.

Our Approach

- Core temperature telemetry devices were surgically implanted into 20, 56 week old Lohman White Leghorn laying hens.
- Birds individually weighed, wing banded and moved to the cages for dietary treatments.
- Birds were provided with an Omega-3 PUFA enriched diet containing 17% Linpro (extruded flax product).
- Energetic efficiency was determined to score hens as efficient and non-efficient. through calculation of residual maintenance energy.
- Body weight, daily feed intake and egg production traits were determined.
- Egg yolks were collected at 0d and 14d, and egg lipid profile was determined by gas chromatography analysis.
- At 14d, birds were sacrificed to collect gut length and histomorphometric indices were measured.

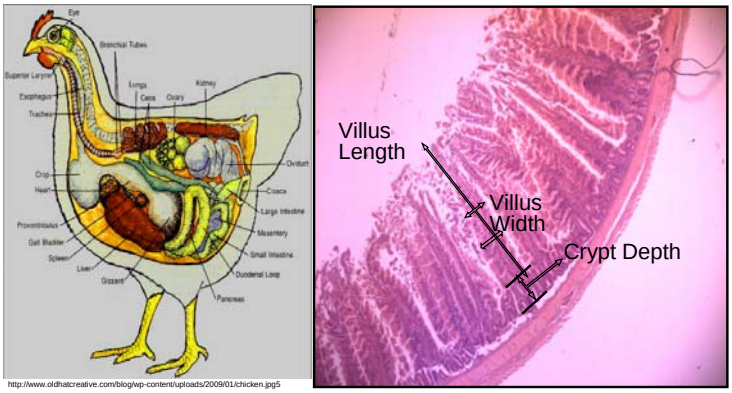
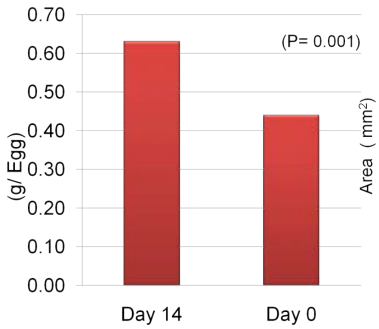


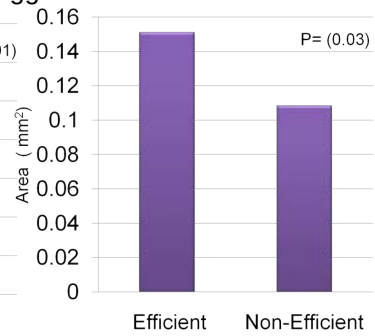
Figure 1. Cross section of hen and processed slide of duodenum at 10 X showing Villus parameter

Observation & Result

- By 14 d, concentration of Omega-3 PUFA (particularly C18:3 n3) had risen while both Omega-6 PUFA and *de novo* synthesized fatty acids were reduced .
- Birds with lower feed intake had a lower concentration of Omega-3 PUFA in the egg (P=0.07).
- Increased feed intake led to increased liver weight (r=0.51, P=0.015) and also occurred in smaller birds (r=-0.47; P=0.029); likely reflecting the demands of egg production
- Efficient hens had wider (P=0.04) and longer (P=0.08) gut villi and therefore a greater absorptive surface area/villi (0.151 mm^2) than in non-efficient birds (0.108 mm^2) (P=0.03).
- The Omega-3 PUFA enriched ration resulted in yolk size declining from 31.5% of the egg at 0d to 29.3% at 14d.



Graph 1. Amount of total n-3 PUFA in egg after 14 days of treatment base value at 0 days.



Graph 2. Total inner surface area of duodenal villus in efficient and non-efficient scored hens.

What does this mean?

- Inclusion of high rate of omega-3 PUFA in feed masked the bird to bird variation.
- In future studies, we will be working to create a less-enriched ration with more marginal Omega-3 PUFA and to determine time period to reach enrichment into the egg.
- Optimum dietary level and time period will help to know individual bird to bird variability to transfer the enrichment.
- Exploration of diet-based treatments to improve gut condition may improve uptake of value added nutrients.
- Minimum enrichment level in each egg at low cost of production.

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