Effects of partly defatted insect meal (Hermetia illucens) or microalgae (Spirulina platensis) in mixed diets on intestinal mucosal surface and mucin secretion of meat type chicken

E. Gruber-Dujardin1, S. Velten2, C. Neumann2, F. Liebert2

German Primate Center, Pathology Unit, Kellnerweg 4, 37077 Göttingen, 2Department of Animal Sciences, Chair Animal Nutrition, Georg-August-University Göttingen, Kellnerweg 6, 37077 Göttingen

Aim of the study
Insects or algae are promising alternatives to replace soybean meal (SBM) in animal nutrition. As part of the multidisciplinary project “sustainability transitions” the study aimed to investigate effects of replacing 50% SBM by partly defatted Hermetia meal (HM) from larvae of the black soldier fly (Hermetia illucens) or blue green algae (Spirulina platensis) meal (SM) in mixed chicken diets on mucosal surface and microstructure by unbiased stereological morphometric analysis of the small intestine.

Material and Methods
Animals: 180 one-day-old male growing chickens (Ross 308); 6 birds per pen

Growth study (34d): 3 diets; feed/water supply on free choice level; 8 birds per diet slaughtered after 12 hrs fastening (n=24)

Control diet: starter (1-21d)/ grower (22-34d) diets with 39/32% SBM; basic supplementation of Lys and Met

HM & SM diet: 50% of SBM replaced by HM or SM, respectively, with basic AA fortification (Lys, Met) according to control diet

Preparation of the small intestine: I1: duodenum, I2: proximal jejunum (up to Meckel's diverticulum), I3: distal jejunum/ileum

Systematic uniform random sampling (SURS)^2: for stereological analysis of the intestinal sections and calculation of the primary mucosal surface area

\[ S_{pm} = \text{length} \times \text{mean circumference} \]

Histology: 5 SURS sub-segments (U) per section (S) were formalin-fixed (4%) and from each, 3 biopsies (Ø 5mm) were punched out/ divided at random position/orientation, paraffin-embedded for serial vertical sections (4 µm) and stained with hematoxylin eosin (HE) or Periodic acid-Schiff (PAS) reaction

Results
The final body mass (BM) differed significantly (p≤0.01) between treatments (control: 2439.7c ±317g; HM: 1597.5b ±105g; SM: 1195.2a ±186g). Compared to control diet, the relative \( S_{pm} \) was significantly enlarged in all intestinal sections with diet SM, and in I1 with diet HM. However, due to balancing effects by the villus amplification factor \( S_{s(v,pm)} \) significant differences of relative \( S_{v} \) data were only observed in I1 between control and SM diet.

Mucin volume to surface ratios tended to be lower in all intestinal sections with diet HM.

Results indicate that 50% algae meal based diets induce an increase in intestinal absorption surface, especially in the duodenum, possibly due to rather inefficient protein digestibility. The observed trend to lower mucosal mucin volume with insect meal based diets might point to improved intestinal health. Further modifications of intestinal microstructure are under investigation in ongoing experiments.

Mean values and coefficients of variation (CV) in %; means in the same row of the corresponding column (I1, I2, I3) with different superscript letters are significantly different (p≤0.05; *p≤0.005; **p≤0.001).

\[ \text{Vv/Ss} = \frac{\text{P(mucin)} \times l}{2 \times l(BM)} \]

Statistical analysis: one-way ANOVA with Kruskal-Wallis multiple comparisons test (GraphPad Prism V5).

Conclusion
Results indicate that 50% algae meal based diets induce an increase in intestinal absorption surface, especially in the duodenum, possibly due to rather inefficient protein digestibility. The observed trend to lower mucosal mucin volume with insect meal based diets might point to improved intestinal health. Further modifications of intestinal microstructure are under investigation in ongoing experiments.