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

(Einflüsse von teilentfettetem Insektenmehl (Hermetia illucens) oder Mikroalgen (Spirulina platensis) im Mischfutter auf Schleimhautoberfläche und Muzinsekretion im Dünndarm von Masthähnchen.)

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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 of the small intestine.

Methods: 180 one-day-old male growing chickens (Ross 308) were randomly allotted to 30 pens (6 birds per pen) for a growth study (34d) with three diets and feed/water supply on free choice level. The control starter/grower diet contained 39/32% SBM which was replaced in the experimental diets by HM and SM at 50% level with a basic AA fortification (AA added: Lys, Met) according to the control diet (1). After finishing the growth study, 8 birds per diet were slaughtered after 12 hours fastening and the small intestine was removed for stereological morphometry and histological analysis of the mucosa. A systematic uniform random (SUR) sampling scheme (2) was applied to 3 intestinal sections (I1: duodenum, I2: proximal jejunum I3: distal jejunum and ileum). From each section, length and weight was determined and 5 equal SUR sub-segments were collected after measuring their circumferences. All samples were formalin-fixed (4%), paraffin-embedded and cut into 4 µm vertical sections serially stained with hematoxylin eosin (HE) and Periodic acid-Schiff (PAS) reaction. The primary mucosal surface area (S_{pm}) was calculated by length x mean circumference of each intestinal section. For stereological estimation of the villus surface area (S_v), a villus amplification factor ($Ss_{(v,pm)}$) was determined in SUR generated visual fields from digitalized HE-stained slides with a stereological software tool (STEPanizer©). Mucin volume ($Vv_{(muc)}$) of the intestinal epithelium related to its basement membrane surface ($Ss_{(bm)}$) was stereologically estimated in SUR visual fields from digitalized PAS-stained slides. Statistical analysis utilized one-way ANOVA with Kruskal-Wallis multiple comparisons test (GraphPad Prism V5).

Results: Final body mass (BM) differed significantly ($p \leq 0.01$) between treatments (Control: 2439.7^{c} ±317g; HM: 1597.5^{b} ±105g; SM: 1195.2^{a} ±186g). Compared to control diet, the relative S_{pm} was significantly increased in all gut sections with diet SM and in I1 with diet HM (Tab.). However, due to balancing effects by the villus amplification factor ($Ss_{(v,pm)}$) significant differences of relative S_v data were only observed between control and SM diet in I1. The mucin volume to surface ratio tended to be generally lower with diet HM.

	Control (n=8)			HM (n=8)			SM (n=8)		
	I1	I2	I3	I1	I2	I3	I1	I2	I3
relative S_{pm} (cm^2/g BM)	0.03^{a} (12%)	0.06^{a} (6%)	0.04^{a} (14%)	0.04^{b} (16%)	$0.07^{a,b}$ (13%)	$0.05^{a,b}$ (8%)	0.05^{b} (16%)	0.09^{b} (13%)	0.06^{b} (8%)
$Ss_{(v, pm)}$	19.1 (38%)	36.8 (30%)	23.1 (27%)	19.1 (19%)	29.1 (38%)	18.5 (46%)	17.7 (21%)	27.3 (27%)	20.2 (34%)
relative S_v (cm^2/g BM)	0.48^{a} (49%)	2.1 (31%)	0.95 (35%)	$0.69^{a,b}$ (31%)	2.06 (39%)	0.96 (46%)	0.80^{b} (20%)	2.5 (30%)	1.22 (35%)
$Vv_{(muc)}/Ss_{(bm)}$	3.75 (33%)	4.36 (32%)	7.44 (22%)	2.61 (37%)	3.85 (39%)	6.98 (31%)	3.33 (24%)	4.48 (43%)	8.32 (21%)

Mean values and coefficients of variation (CV) in %; means in the same row with different superscript letters are significantly different ($p \leq 0.05$).

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

(1) Velten et al.: Proc. Soc. Nutr. Physiol. 26, 2017, 89

(2) Makanya et al: J. Anat. 187, 1995, 361-368

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