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Effect of dietary insect protein from *Tenebrio molitor L.* on lipid metabolism in an obese rat model (Einfluss von Insektenprotein von *Tenebrio molitotr L*. auf den Lipidstoffwechsel in einem obesen Rattenmodell). Denise K. Gessner*, A. Schwarz, E. Most, R. Ringseis, K. Eder – Gießen

Insect protein is a novel source of protein which might become more important in the nutrition of livestock and humans in future due to the limitation of plant and animal protein resources. Studies in pigs, poultry and fish have already shown that proteins from various insect species represent a source of protein with a high biological value for growth performance. However, effects of insect protein on metabolism in animals have not yet been investigated. As the amino acid composition of insect protein shows some similarities with soy protein, a protein known for its hypolipidemic effects, we investigated the hypothesis that insect protein could beneficially influence the lipid metabolism in an obese animal model.

Methods: As an obese animal model, we used 36 male (*fa/fa*) Zucker rats which were allotted to three groups: (1) control group which received a diet with 20% casein as source of protein (OC group), (2) a treatment group which received a diet in which 50 % of casein was replaced by insect protein (OI50 group), and (3) a treatment group which received a diet in which 100 % of casein was replaced by insect protein (OI100 group). The basal semisynthetic diet was composed of corn starch, saccharose, oil mixture, cellulose and a mineral and vitamin premix. As a source of insect protein, the product TMP-Y465 (Ynsect, Paris) isolated from ground yellow mealworms (*Tenebrio molitor L*.) was used. The product consisted of 70 % of protein and additionally contained 13 % of fat. Amount of fat and fatty acid composition of the diets were equalized between the three groups by supplementing the diets with individual mixtures of various fats (soybean oil, rapeseed oil, linseed oil, butter). Diets were fed for four weeks. Liver and plasma samples were analysed for triacylglycerol (TAG) and cholesterol (Chol) concentrations. Moreover, a microarray analysis of hepatic gene expression was performed (n = 5/group) and metabolomics analysis of plasma samples was applied (n = 12/group). Results were analysed by one-way ANOVA and Fisher´s multiple range test.

Results: OI50 and OI100 rats had a higher feed intake than OC rats ($P < 0.05$); final body weight was higher in OI50 rats than in OC rats ($P < 0.05$); final body weight of OI100 rats did not differ from that of OC rats. Replacement of casein by insect protein caused a dose-dependent reduction of Chol in plasma and liver and of TAG in the liver ($P < 0.05$). TAG concentration in plasma, however, was higher in OI50 and OI100 rats than in OC rats. Metabolomics analysis revealed increased concentrations of free and acetyl carnitine, increased concentrations of phosphatidylcholine (PC) species with 2 or 3 double bonds (C34:2, C36:2, C36:3) and decreased concentrations of PC species with 4, 5 or 6 double bonds (C36:4, C38:4, C38:5, C38:6) in plasma ($P < 0.05$). The microarray analysis revealed a number of 84/224 of genes which were down-regulated and a number of 254/449 genes which were up-regulated in the liver of the OI50/OI100 rats in comparison to OC rats (fold change ≥ 1.3 and ≤ -1.3, $P < 0.05$). Among the down-regulated genes, there were a number of genes of SREBP-1 pathway (involved in fatty acid and TAG synthesis), SREBP-2 pathway (involved in Chol synthesis pathway) and fatty acid desaturation. mRNA concentration of *CYP7A1*, the key enzyme of bile acid synthesis was upregulated in the liver of OI50/OI100 rats compared to OC rats.

Conclusion: The results of this study show that insect protein lowers Chol concentrations in liver and plasma and TAG concentration in liver. Data from the microarray analysis indicate that these effects might be due to a down regulation of genes involved in fatty acid, TAG and Chol synthesis and to an upregulation of genes involved in bile acid synthesis. Combination of transcriptomics and metabolomics analyses moreover shows that insect protein causes an inhibition of desaturation of linoleic- and α-linolenic acid, effects which might influence TAG and Chol metabolism in a secondary way.

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