

# Assessment of the impacts of microbial plant protection products on the health and development of the gut microbiome of honeybee (*Apis mellifera*, L.)

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Microbial plant protection products as substitutes for chemical PPPs enjoy an increasing popularity because of their compatibility with integrated pest management. Important are primarily PPPs with different strains of *Bacillus thuringiensis* (B.t.) as active substance due to selective effects on insects of the orders Lepidoptera, Coleoptera and Diptera. Despite the presumed safety for non-target insects, several studies with contrasting results show potential harms of some B.t.-products for insects of other orders like Hymenoptera. Due to the foraging activity of bees, they could be exposed to B.t.-products either acutely after spray application or chronically through ingestion of contaminated pollen and nectar. Recent studies suggest that the gut microbiome of honeybees is a crucial factor for bee health. The most studies were carried out under laboratory conditions and there is still no information about the plasticity of the core microbiome under colony field realistic conditions. Therefore, it is considered as an essential issue to clarify the contribution of the gut microbiome in the development of healthy bees and the relationship to applied microbial PPPs.

In the current study, we evaluated the effect of the product FlorBac<sup>®</sup> with the active substance *Bacillus thuringiensis* ssp.

*aizawai* (strain: ABTS-1857) on adults and larvae of honeybees (*Apis mellifera*) under laboratory and field conditions. Chronic oral toxicity tests on adult bees (OECD guideline 245) and larval chronic toxicity tests (OECD guidance document 239) were therefore conducted. Additionally, possible modifications of the chronic oral toxicity test like additional pollen feeding were assessed. Furthermore, an in-hive feeding experiment was performed to investigate the effects of B.t. on colony development and composition of the gut microbiome in individual bees.

Our results show that the survival of adult bees was affected after chronic exposure to FlorBac<sup>®</sup> depending on the tested concentrations. Moreover, the exposure duration seemed to play an important role. The mortality of bees arose only after 96 h at the highest concentration, so the acute test duration seems inappropriate for examining the effects of microbial PPPs. Moreover, the feeding with pollen had a significant effect on the survival of the treated bees. Our results demonstrated also a significantly reduced survival of treated larvae at all concentrations. The results of the field study are still pending.