Disentangling metabolic functions of bacteria in the honey bee gut

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Gut microbiota carry out diverse metabolic activities, which are critical for establishing mutualistic interactions with the host and among community members. However, due to the complexity of the gut microbiota, it is challenging to identify the contribution of individual members to the overall metabolic activity of the community. To address this question, we focused on the honey bee gut microbiota, a relatively simple community having a long evolutionary association with its host. Using untargeted metabolomics, we first characterized overall metabolic changes between microbiota-depleted bees and bees colonized with a reconstituted community resembling the native honey bee gut microbiota. We then carried out mono?colonizations to determine the contribution of individual members to the overall metabolic changes in the gut. We identified 372 metabolic changes between microbiota-depleted and colonized bees, 299 of which could be explained by mono-colonizations. Most of the identified bacterial substrates originated from the pollen-diet of bees, including flavonoids, phenolamides, and omega hydroxy acids which are all major constituents of the recalcitrant outer pollen wall. Strikingly, distinct community members contributed to the conversion of these plant-derived compounds indicating substrate specificity and possible cross-feeding interactions. Fermentation seemed to be the major bacterial metabolism, as several organic acids accumulated in the presence of the microbiota. Moreover, we discovered that a specific gut symbiont, Bifidobacterium asteroides, stimulates the production of host signaling molecules involved in regulation of hormonal and immune system suggesting a direct impact on bee physiology and development. Overall, our study provides new insights into the metabolic functions of the bee gut microbiota and highlights the usefulness of high?throughput untargeted metabolomics to study symbiotic interactions within microbial communities and with their host.