What is the ideal honeybee diet ?

Introduction

Commercial beekeepers use pollen supplements to optimise the condition of their colonies. These supplements have little scientific credibility and the proteins used are often indigestible .

Here, we applied the Geometric Framework for nutrition[1] to compare how diets of different protein source affect the regulatory feeding behaviour of honeybees.

Aim

The aim of this study is to find ways to improve artificial pollen substitutes that are fed to honeybees in terms of performance and pricing

Methods

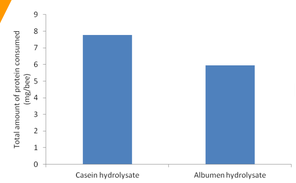
Groups of 30 honeybees were fed diets based on the composition of the 10 essential amino acids found in the proteins of existing artificial pollen substitutes.
Bees were fed liquid diets with access to a tube providing the treatment (protein + 1M sucrose) or sucrose-only. Consumption was measured over 14 days by weighing and replacing feeding tubes every 24 hours

Housing box where honeybees were kept for 14 days with access to feeding tubes

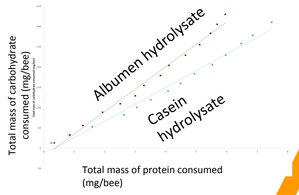
Results

Total consumption of protein and carbohydrate was calculated per bee and compared between diets. The protein:carbohydrate (P:C) ratio was recorded

1. Different protein sources



Total consumption of the two protein sources, casein hydrolysate and albumin hydrolysate. Each bee ate nearly 2 mg less albumin lysate in comparison to casein lysate



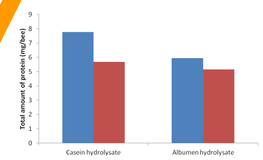
Protein consumption and carbohydrate consumption (mg/bee) for casein hydrolysate and albumin hydrolysate

The ratio of P:C differs greatly between the proteins. Albumin = **1:55 P:C while** casein hydrolysate = **1:41 P:C**

2. State of protein

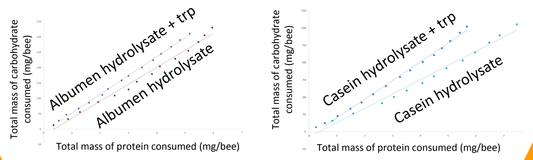
Casein was provided in 3 digestion states; complete protein, partially digested (peptopro) and fully hydrolysed (casein hydrolysate). We found that bees were able to maintain the same intake target for all all three treatments, suggesting that the efficiency of the digestion of casein and casein peptides does not differ significantly

3. Adding tryptophan



Total consumption of protein between diets with (red) and without tryptophan (blue) for casein hydrolysate and albumin hydrolysate Adding tryptophan significantly reduced total consumption of protein

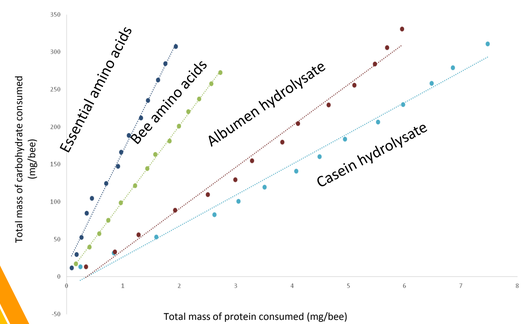
The addition of tryptophan reduced the ratio of P:C in both albumin hydrolysate and casein hydrolysate



Protein and carbohydrate consumption (mg/bee) for casein hydrolysate and albumin hydrolysate with and without tryptophan.

4. Free amino acid distribution

Feeding a diet that was more similar to the intrinsic amino acid profile of bees resulted in lower consumption of protein compared to feeding on the profile of amino acids of other proteins (albumin hydrolysate and casein hydrolysate



Discussion

By changing the protein or changing the composition of the diet by the addition of another essential amino acid, **consumption can be reduced**.
This is beneficial to producers of pollen substitutes as it means that they may be able to use cheaper, alternative proteins in their feed. **This benefits the bees as the feed would be more digestible, leading to less wastage**.

As shown by feeding different forms of casein, protein digestibility does not affect how the honeybees regulate their carbohydrate intake.

This means that **undigested versions of the protein can be used in the effective production of new artificial substitutes.**

Future work

The digestibility of the proteins needs to be determined using analysis of the bee gut contents to ensure that the most effective proteins are used in pollen substitutes.

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References – Raubenheimer D, Simpson SJ (1993) The geometry of compensatory feeding in the locust. Animal Behaviour 45:953-964

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