OP-065 [Bee Biology]
Influence of different diets on the growth and development of Eastern honey bee Apis cerana

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In recent years, honey bees are stressed with multiple factors, with malnutrition being a significant threat to the healthy development of honey bee colonies. To keep colony healthy and productive, the beekeepers supply their colonies with supplementary pollen or commercial pollen substitutes during periods of pollen dearth or insufficient pollen quantity or quality. Both Apis mellifera and Apis cerana are important pollinators in many natural ecosystems and agro-ecosystems. Apis cerana is an important indigenous species and is raised extensively in the mountainous regions of China. Currently, the research on effects of diets on honey bee growth and development is mainly focused on A. mellifera, with much fewer studies focused on A. cerana. In this study, we evaluated the effects of four natural pollen types (oilseed rape pollen, camellia pollen, lotus pollen and buckwheat pollen) and two pollen substitutes (Diet 1 and Diet 2) against a control group (sucrose solution) on A. cerana through cage experiments. The food consumption, live body weight, longevity, hypopharyngeal gland development and the midgut proteolytic enzyme activity of caged workers were measured. The food consumption rates of oilseed rape pollen and buckwheat pollen were greater than the other diets. Oilseed rape pollen and camellia pollen were recognized as excellent quality diet for hypopharyngeal gland development and midgut proteolytic enzyme activity. Over the entire experimental period, the caged workers fed with lotus pollen had similar diet consumption and body weight as those fed with pollen substitutes, while these bees had significant higher survival rate than those fed with other diets. The results indicated that the commercial pollen substitutes appeared to be less beneficial to caged A. cerana workers than the natural pollen resources.

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Influence of different diets on the growth and development of Eastern honey bee (*Apis cerana*)

GUILING DING

Institute of Apicultural Research, Chinese Academy of Agricultural Sciences

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Copenhagen

Introduction

Nectar is the main source of carbohydrate

Pollen is the primary source of protein

Introduction

Honey bees are exposed to many stressors that result in **pollen deficiencies**.

agricultural intensification

pollination service on monocultures

seasonal pollen dearth

Introduction

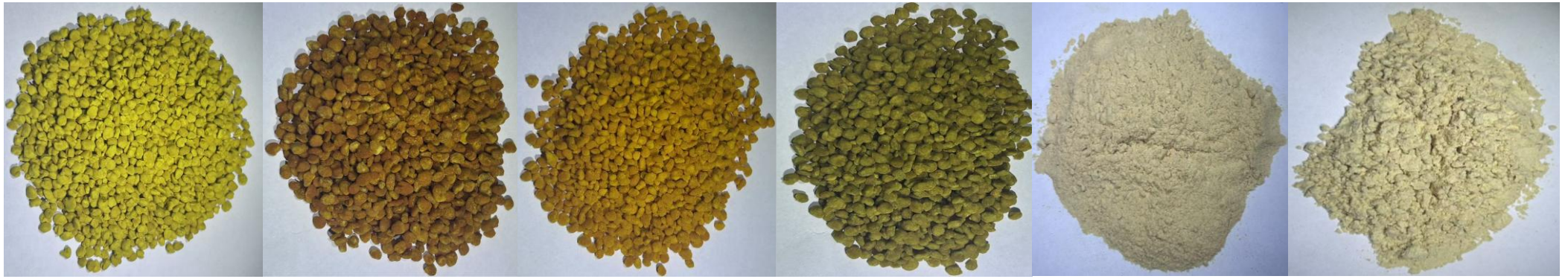
In China, there are approximately **9** million managed colonies (~ **6.8** million of *Apis mellifera* and **> 2** million of *Apis cerana* colonies)

Supplying colonies with pollen or pollen substitutes is a common practice in China, while **few data** are available concerning their effects on honey bees' health.

Apis cerana

Apis mellifera

In this study, we compared the effects of **four** common species of bee pollen and **two** widely used commercial pollen substitutes (Diet 1 and Diet 2) against the control group on caged *A. cerana* workers.



oilseed rape pollen | camellia pollen | lotus pollen | buckwheat pollen | pollen substitute #1 (Diet 1) | pollen substitute #2 (Diet 2)

Protein content of the pollen and pollen substitutes

The detailed information about the bee pollen

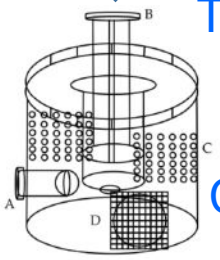
Pollen	Producing Region	Time of Collection	Protein Content (g/100g)
oilseed rape pollen	Huzhu County, Haidong City, Qinghai Province	July	24.53 ± 0.40
camellia pollen	Yuncheng District, Ya'an City, Sichuan Province	March	21.50 ± 0.36
lotus pollen	Dingbian County, Yulin City, Shaanxi Province	August	18.03 ± 0.42
buckwheat pollen	Guangchang County, Fuzhou City, Jiangxi Province	October	13.43 ± 0.31

The detailed information about the pollen substitutes

Pollen Substitutes	Ingredients	Protein Content (g/100g)
Diet 1	vegetable germ, vegetable proteins, yeast powder, lysine, methionine, etc.	23.45 ± 0.01
Diet 2	vegetable proteins, carrot powder, yeast powder, lactic acid bacteria, amino acid, mineral, trace element, multivitamins, etc.	38.16 ± 0.02

The laboratory experiment

workers emerged within 24 h



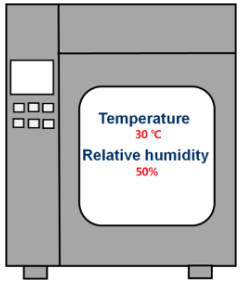
Treatment

- 50% (*w*/*w*) sucrose solution
- one /all the six protein pastes

Control

- 50% (*w*/*w*) sucrose solution

30 workers per cage



3 or 4 cages for each treatment and the control

Diet preference

- each protein diet's consumption was calculated daily
- the number of workers consuming each diet was recorded

Diet consumption, body weight, survival probability, hypopharyngeal gland (HPG) development and total midgut proteolytic enzyme activity

- the surviving workers were counted
- each bee's daily consumption was calculated
- the body weight of individual worker was recorded
- the acinus size and the protein concentration of the HPG was measured
- the total midgut proteolytic enzyme activity was assessed

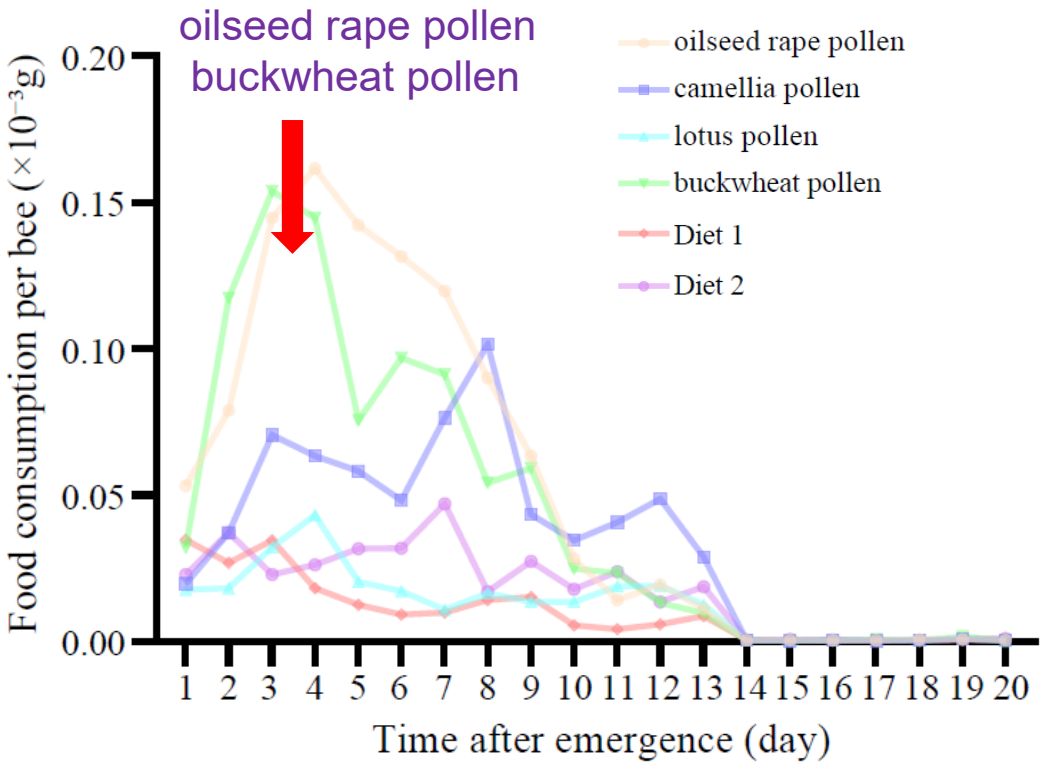
Diet preference of workers in the cage

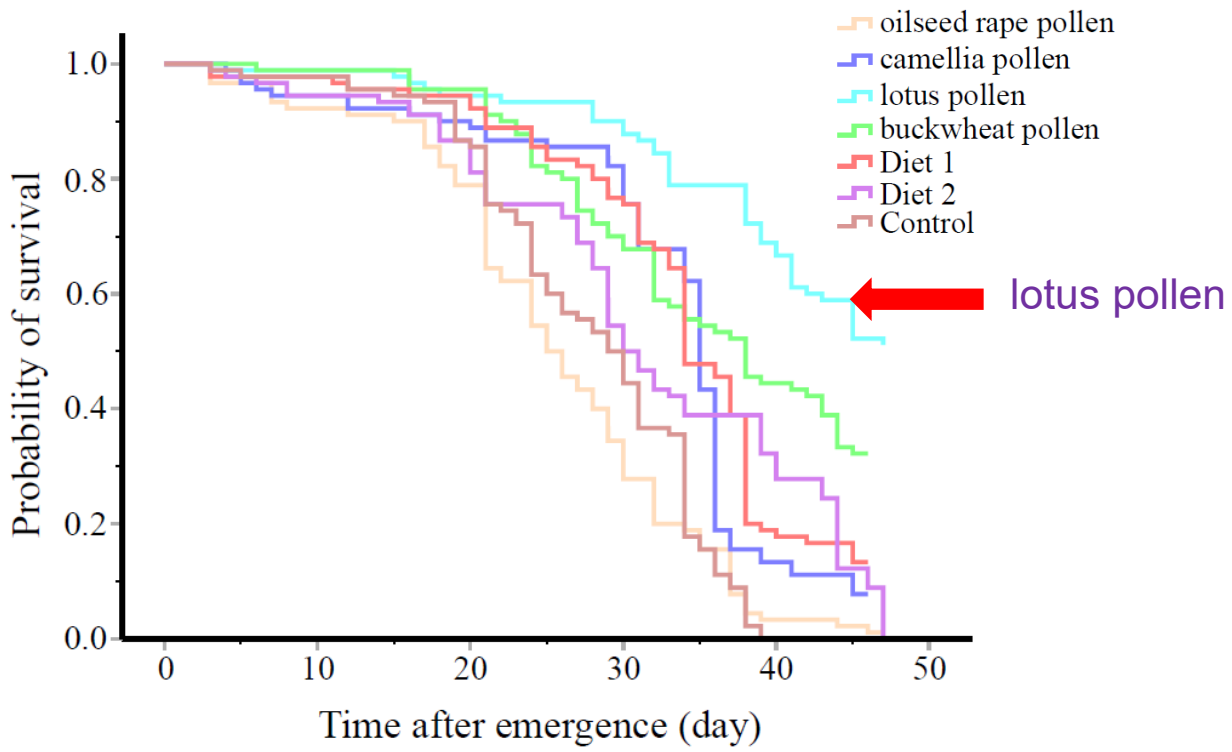
The total diet consumption and the number of workers consuming each diet

Diet	Total Diet Consumed (g)	Number of Workers
oilseed rape pollen	0.257 ± 0.096 ^{ab}	3.3 ± 1.5 ^{c}
camellia pollen	0.228 ± 0.034 ^{ab}	2.8 ± 0.3 ^{c}
lotus pollen	0.117 ± 0.008 ^{b}	0.5 ± 0.9 ^{c}
buckwheat pollen	0.357 ± 0.092 ^{a}	13.0 ± 3.4 ^{a}
Diet 1	0.135 ± 0.002 ^{b}	7.8 ± 1.8 ^{b}
Diet 2	0.210 ± 0.018 ^{ab}	0.8 ± 0.2 ^{c}

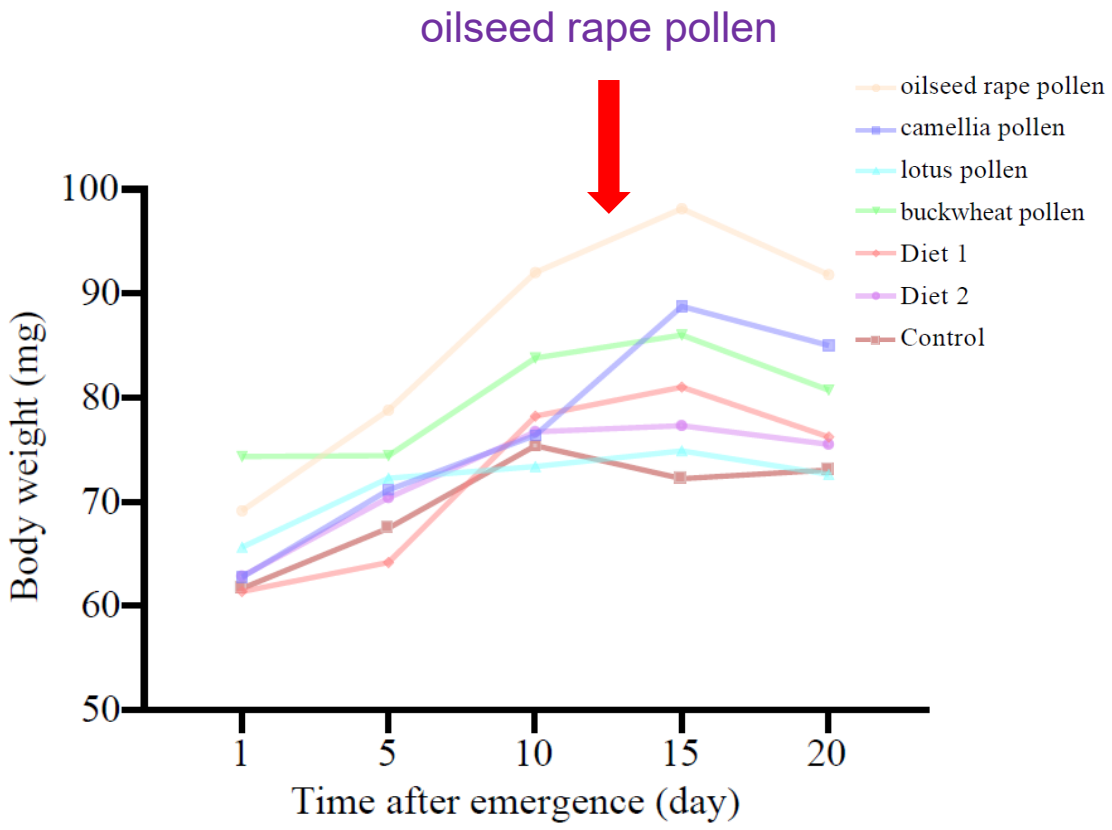
The data are mean ± SE. Means in the same column with different letters are significantly different at $p < 0.05$.

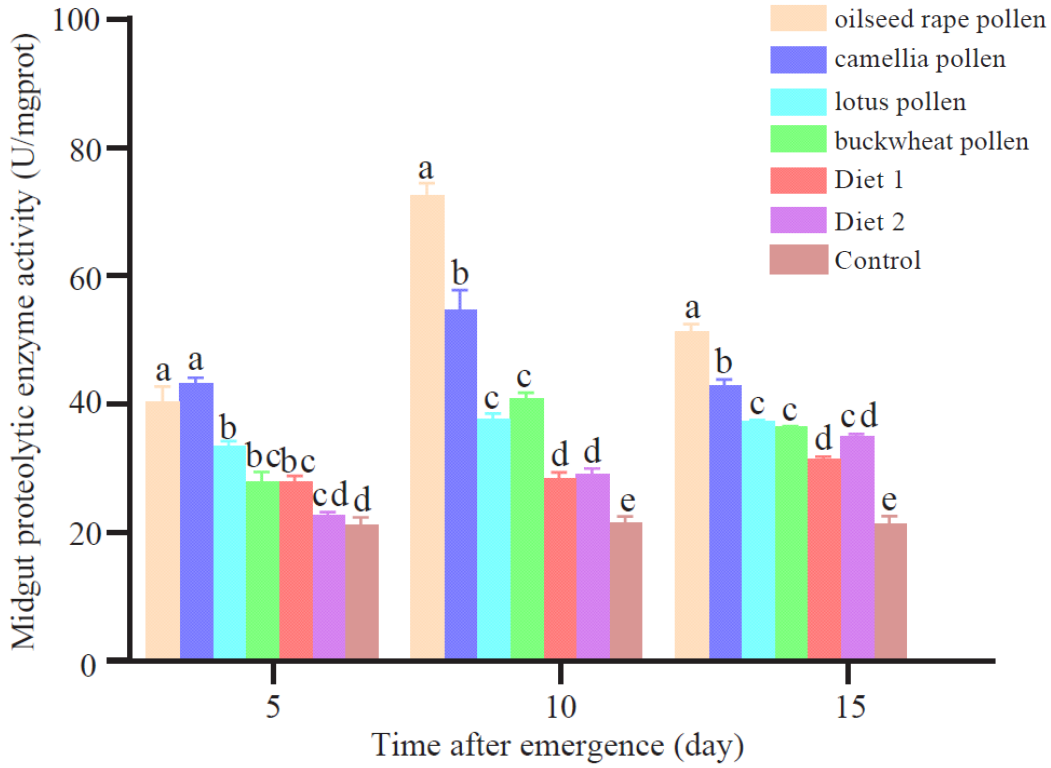
Diet consumption and survival probability of workers



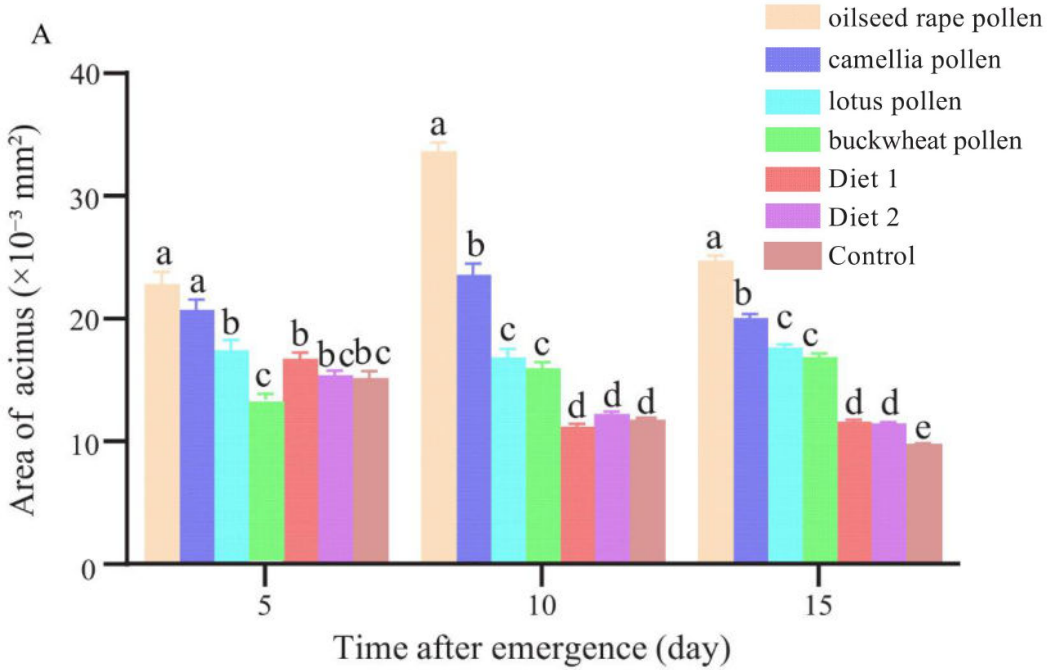


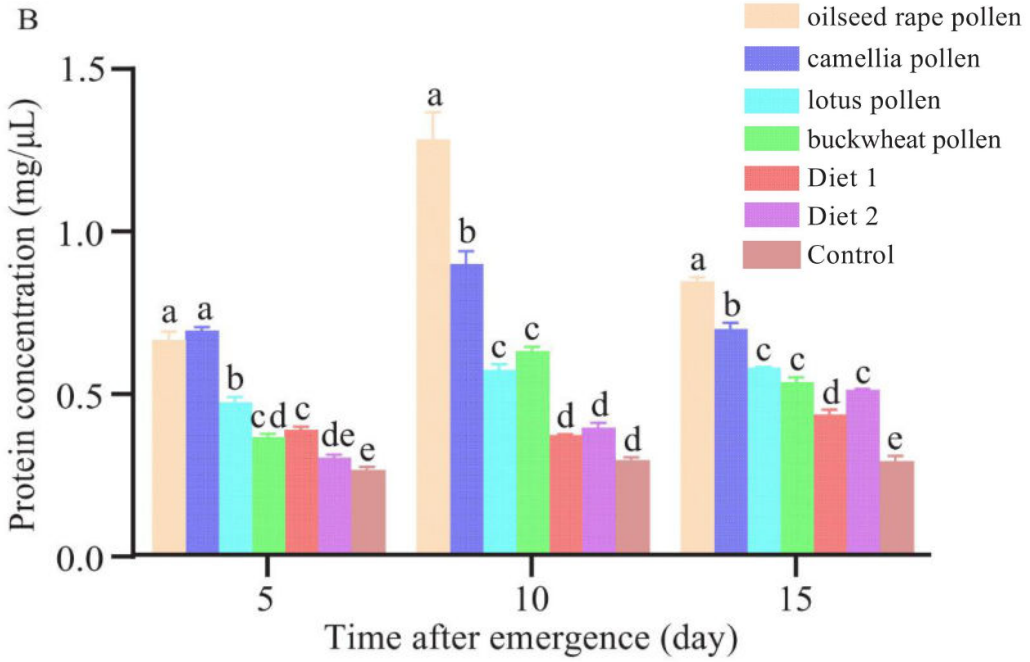
Body weight and total midgut proteolytic enzyme activity of workers

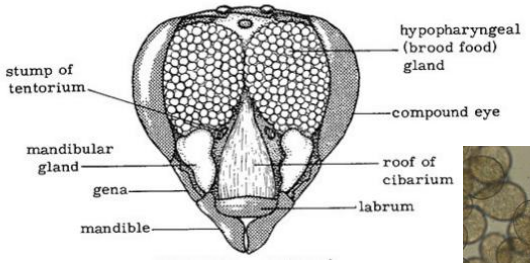




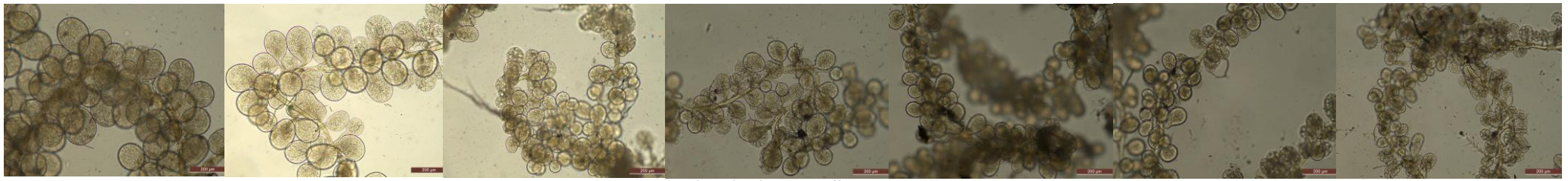
Hypopharyngeal gland development of workers







Carreck *et al*. (2013)



oilseed rape pollen | camellia pollen | lotus pollen | buckwheat pollen | Diet 1 | Diet 2 | control

Ranking of the natural pollen pellets and pollen substitutes

Diets	Diet Consumption	Number of Workers	Daily Consumption per Bee	Body Weight	Survival Probability	Area of Acinus of HPG	Protein Concentration of HPG	Midgut Proteolytic Enzyme Activity	Comprehensive Ranking
oilseed rape pollen	2	3	1	1	7	1	1	1	1
camellia pollen	3	4	3	3	5	2	2	2	3
lotus pollen	6	6	5	7	1	3	3	3	4
buckwheat pollen	1	1	2	2	2	4	4	4	2
Diet 1	5	2	6	4	4	6	6	6	6
Diet 2	4	5	4	5	3	5	5	5	5

Summary

- The diets showed different effects on caged *A. cerana* workers, which might be due to the differences in their nutritional components;
- Further field experiments are needed to understand the impacts of these diets on the health of honey bee colonies;
- Our study indicates that the natural pollen resources are more beneficial to caged workers than the pollen substitutes;
- More efforts are needed to develop effective pollen substitutes for *A. cerana*.

Acknowledgements

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