Optimizing drone fertility with nutritional supplements to honey bee colonies during spring

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Introduction

Commercial queen breeding requires large numbers of fertile drones to insure optimal queen mating. The nutritional needs of honeybee colonies and workers have been the subject of extensive research while a limited number of study have investigated the impact of colony nutrition on drones[1]. Drone rearing occurs only within colonies with abundant food resources[2]. Previous studies have shown that protein deprivation after drone emergence did not affect drone fertility[3]. However limited access of pollen during drone larval development resulted in lower body mass, less semen and less eversion of the endophallus[4].

Objectives

The aim of this study was to determine if supplemental feeding of honeybee colonies in spring prior the drone production timing in Quebec will influence drone body size and reproductive qualities (semen volume, number and viability of sperm).

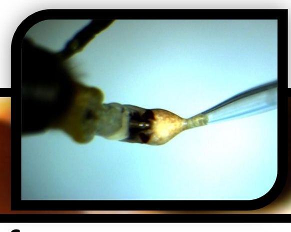
Methods

This study was conducted at the Centre de Recherche en Sciences Animales de Deschambault (CRSAD, Quebec, Canada) in spring and summer 2013. 20 honeybee packages with young open-mated Carniolian queens were introduced in standard 10-frames Langstroth hives and sitributed in 4 experimental group :

5 control colonies (C: without supplemental feeding)
5 pollen colonies (P: 15% pollen patties, 2x 500g)
5 syrup colonies (S: syrup 1:1, 2L per week)
5 pollen and syrup colonies (PS : both supplements)

* Supplement feeding for 5 consecutive weeks
** Drone frame foundation added on week 2
*** Drone evaluation at age 21-25 days old:

- **Weight** (mg), **thorax width** (mm), **abdominal index** (abdominal
- **Semen volume :** evaluated with an Instrumental Insemination device fitted with a Harbo micrometer syringe to the nearest 0.2 µl.
- **Sperm number :** number of sperm present in 5 square of a Neubaer haemocytometer.
- **Sperm viability :** sperm viability Live/Dead Kit was used for viability assessment (SYBR 14 for live sperm and propidium iodide for dead sperm).



Results

Drone measurements

917 drones were evaluated for weight, thorax and abdomen measurements .

Table 1. Mean weight, thorax width, and abdominal index (width × length) of *A. mellifera* drones reared in various experimental groups

Variable	Treatment				*F*	df	*P*
	Control (C)	Syrup (S)	Protein (P)	Syrup + protein (PS)			
Weight (mg)	240.5 ± 1.1ab	240.8 ± 1.3ab	237.7 ± 1.3a	243.0 ± 1.4b	2.83	3, 913	0.0375
Thorax width (mm)	5.45 ± 0.014c	5.32 ± 0.011a	5.29 ± 0.021a	5.39 ± 0.010b	11.27	3, 909	<0.0001
Abdominal index	42.49 ± 0.26a	44.17 ± 0.24b	43.82 ± 0.26b	43.89 ± 0.23b	8.50	3, 904	<0.0001

Values are means of all drones for each treatment ± standard errors; different letters within a line indicate significant difference (Tukey's honestly significant difference test at level 0.05).

Drones supplemented with pollen and syrup weight significantly more than drones only fed with pollen. Drones from control group had a wider thorax but a lower abdominal index than all groups receiving supplements.

Semen Production and Quality

124 pooled semen evaluated (7 pools of 5 drones/colony, 18 colonies)

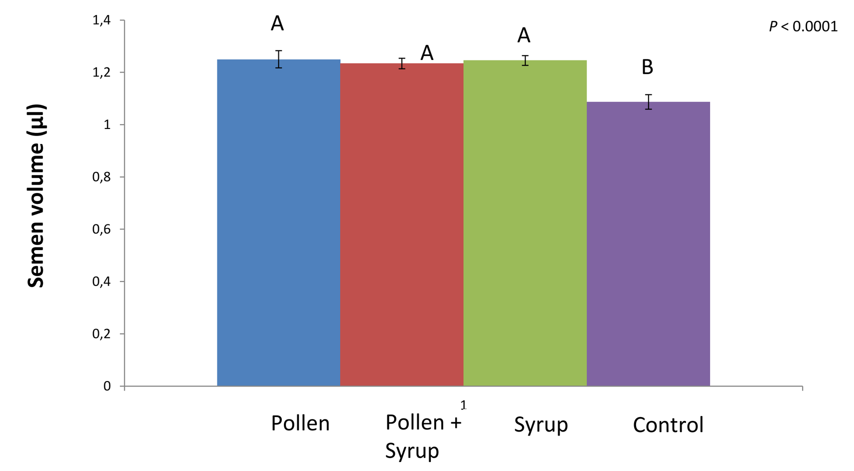


Figure 1. Mean semen volume produced by drones in various experimental groups

Table 2. Mean semen volume, sperm count per ml, sperm count per drone, and percentage of sperm viability of *A. mellifera* drones in various experimental groups

Variable	Treatment				*F*	df	*P*
	Control	Syrup	Protein	Syrup + protein			
Semen volume (µl)	1.09 ± 0.03a	1.25 ± 0.02b	1.25 ± 0.03b	1.23 ± 0.02b	6.26	3, 112	<0.0001
Sperm count/ml ($\times 10^9$)	2.77 ± 0.20	2.55 ± 0.16	2.31 ± 0.32	2.48 ± 0.25	0.68	3, 112	ns
Sperm count per drone ($\times 10^6$)	3.05 ± 1.5	3.09 ± 1.75	3.01 ± 1.83	3.08 ± 1.74	0.41	3, 112	ns
Viability %	79.73 ± 0.95a	80.63 ± 0.40ab	81.33 ± 0.55ab	82.93 ± 0.45b	3.68	3, 112	0.01432

Values are means of all semen pools (five drones) for each treatment ± standard errors; different letters within a line indicate significant difference (Tukey's honestly significant difference test at level 0.05).

Discussion

This study showed that many of the variables measured in drones were significantly affected by supplemental feeding. In summary, pollen and syrup supplements together have contributed to increase drone weight and sperm viability, while all types of supplements administered to colonies increased abdominal index and semen volume but decreased thorax width. In our study, the abdominal index of drone was positively correlated with all variables except sperm viability. Drones with a greater abdomen index produce more semen and have greater cell concentration.

An increase of 3% in sperm viability (pollen and syrup group compared to non-fed group) of a three million sperm drone means 90 000 more viable sperm. This increase could improve fertility of early bred queen in northern climates.

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