IMPACT OF SUGAR SYRUPS ON LIFESPAN AND AGE RELATED PHYSIOLOGICAL CONDITION IN CAGED HONEYBEES

30. September 2013 Dr. Maja Smodič Škerl

VARIOUS CARBOHYDRATE SUPPLEMENTS

Fructose-glucose syrup
Saccharose-fructose-glucose syrup
Saccharose syrup (white sugar + water)
Sugar candies

FIELD TRIALS, FEEDING WITH SYRUPS

At the same time we made lab experiments with caged bees to find out the effect of syrups on the bees.

We conducted a series of experiments using caged bees and commercially available syrups:

1. GLUCOSE – FRUCTOSE SYRUP (GF)
2. SACCHAROSE – GLUCOSE – FRUCTOSE SYRUP (SGF)
3. FRUCTOSE – GLUCOSE – SACCHAROSE SYRUP (FGS)
4. SACCHAROSE SYRUP (SS).

Impact of sugar syrups on lifespan and age related physiological condition in caged honeybees

- The transition from nursing to foraging is known to be associated with food perception, consumption etc.
- Bees infected with Nosema ceranae have higher hunger level leading to a lower survival. Infected bees fed ad libitum and non-infected bees had similar lifespan.
- It is not known how substitute energy sources, such as sugar syrups, affect worker metabolism including possible influence of Nosema spp. in the midgut, and shorten the honeybee lifespan according to season.

METHODOLOGY

Newly-emerged honey bees (A. m. carnica, Pol.)

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Season</th>
<th>Feeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Spring bees (April-May 2012)</td>
<td>GF syrup</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FGS syrup</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80, 60 %</td>
</tr>
<tr>
<td>2.</td>
<td>Summer bees (June-July 2012)</td>
<td>Floral honey, bee bread (1 cap)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 repetitions, 100 bees</td>
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<tr>
<td>3.</td>
<td>Winter bees (October-November 2012)</td>
<td>GF syrup, diluted 1:1</td>
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<tr>
<td></td>
<td></td>
<td>FGS syrup, diluted 1:1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65, 60 %</td>
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<tr>
<td></td>
<td></td>
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</tbody>
</table>

And non-infected bees had higher hunger level leading to a lower survival. Infected bees fed ad libitum and non-infected bees had similar lifespan.

It is not known how substitute energy sources, such as sugar syrups, affect worker metabolism including possible influence of Nosema spp. in the midgut, and shorten the honeybee lifespan according to season.
METHODOLOGY

a) SURVIVAL – daily counted dead bees
b) NOSEMA SPORES – abdomens of dead bees, spores were counted using hemocytometer
c) TOTAL PROTEIN CONTENT IN HEMOLYMPH (according to Bradford)
d) VITELLOGENIN (SDS-PAGE electrophoresis)
e) GLUCOSE/FRUCTOSE TITRE IN HEMOLYMPH (HPLC)
f) VENTRICULUS (cell death – apoptosis)

I. RESULTS:

Effect of feeding with sugar syrups on honeybee (Apis mellifera carnica) longevity

SGF. Murska Sobota, p 99-104.

ANOVA, LSD, P < 0,001

SS

Vitellogenin

Vitellogenin slightly present at newly-emerged and 2 day-old workers

SDS-PAGE electrophoresis gel, Comassie blue

PROTEINS IN BEE HEMOLYMPH

6 days bees (lab test 120 bees):

- Beebread 27,57 µg protein / µl, 68,76 % vitellogenin
- Soya/yeast 24,08 µg protein / µl, 47,40 % vitellogenin
- Pollen 11,36 µg protein / µl, 28,85 % vitellogenin
- Corn 3,98 µg protein / µl, 10,96 % vitellogenin
- Sugar 2,17 µg protein / µl, 5,48 % vitellogenin

I. RESULTS: SUGAR CONCENTRATION IN HEMOLYMHP

<table>
<thead>
<tr>
<th>AGE (days)</th>
<th>GLUCOSE (mg/dL, x 100)</th>
<th>SD</th>
<th>AGE (days)</th>
<th>FRUCTOSE (mg/dL, x 100)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>30.56</td>
<td>0.54</td>
<td>2</td>
<td>30.56</td>
<td>0.54</td>
</tr>
<tr>
<td>8</td>
<td>30.56</td>
<td>0.54</td>
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<td>30.56</td>
<td>0.54</td>
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<tr>
<td>16</td>
<td>30.56</td>
<td>0.54</td>
<td>16</td>
<td>30.56</td>
<td>0.54</td>
</tr>
</tbody>
</table>

II. RESULTS: SUMMER BEES - Survival

![Graph showing survival rates of summer bees across different concentrations.]

II. RESULTS: Nosema spores

![Graph showing Nosema spores across different conditions.]

II. RESULTS: TOTAL PROTEIN CONTENT IN HEMOLYMHP

![Graph showing total protein content in hemolymph across different conditions.]

II. RESULTS: SUGAR CONCENTRATION IN HEMOLYMHP

![Graph showing sugar concentration in hemolymph across different conditions.]

Vitellogenin

![Image of Vitellogenin in hemolymph with SDS-PAGE electrophoresis gel and Comassie blue.]

II. RESULTS: SUMMER BEES - Survival

![Graph showing survival rates of summer bees across different conditions.]

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![Graph showing sugar concentration in hemolymph across different conditions.]

Vitellogenin

![Image of Vitellogenin in hemolymph with SDS-PAGE electrophoresis gel and Comassie blue.]

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II. RESULTS: 

**Nosema spores**

**SUMMER BEES: floral honey + bee bread**

![Bar chart showing the average number of Nosema spores per day for floral honey and bee bread](chart.png)

- Day 1: 0.00 spores
- Day 10: 0.05 spores
- Day 16: 0.30 spores
- Day 20: 0.35 spores
- Day 22: 0.40 spores
- Day 23: 0.45 spores
- Day 31: 0.50 spores

**SUMMER BEES: Floral honey + bee bread**

![SDS-PAGE electrophoresis gel, Commassie blue](gel.png)

![Appl+1 and Appl+2 proteins](proteins.png)

III. RESULTS: WINTER BEES - Survival

![Graph showing survival rates for different diets](survival-graph.png)

- GF (green feeding): 0.00 survival
- SGF (sugar feeding): 0.05 survival
- FGS (flower syrup feeding): 0.30 survival
- SS (sugar syrup): 0.35 survival

III. RESULTS: Ventricleus and apoptosis

- 9 days old worker: Negative nuclei
- 15 days old worker: Positive nuclei (Brown reaction product)

- Apoptosis in cell nuclei

III. RESULTS: 

**Nosema spores**

![Graph showing Nosema spores over time](spores-graph.png)

CONCLUSIONS

- Bees from all three seasons survived best on GF syrup and SS (except winter bees).
- Nosema mostly infected older bees (16-35 days) fed SS or GF (winter bees).
- Vitellogenic was not detected in capped bees fed sugar syrup. The highest protein titre was found in GF/SGF groups in younger spring bees and in FGS group in younger summer bees.
- Fructose content was high in younger spring bees (SGF) and in all 4 groups in summer bees. Fructose was sig, different between the groups in spring bees.
- Cell nuclei in ventricleus of winter bees were apoptotic in older bees (15 days).
- Our results indicate that sugar syrups have several impacts on honeybees.
ACKNOWLEDGEMENTS

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