

# LIFE TIME OF AFRICANIZED HONEYBEES *Apis mellifera* Linnaeus, 1758 (Hymenoptera: Apidae) FED BY DIETS WITH CITRIC ACID AND LEMON JUICE

BRIGHENTI, D. M.; CARVALHO, C. F.; BRIGHENTI, C. R. G.; CARVALHO, S. M.

Universidade Federal de Lavras - UFLA, Depto. de Entomologia, C.P. 3037, 37200-000, Lavras/MG – BRAZIL  
www.ufla.br - cfcvalho@ufla.br

## INTRODUCTION

The productive capacity of the honeybee *Apis mellifera* L. is linked to pollen and nectar sources, where the nectar is the major energetic source in natural conditions. With varied composition and dependence of botanical origin, in times where lack of nectar and pollen occurs honeybees need a food supplementation for their maintenance, avoiding the abandon of colonies and its migration to others regions where these resource is not missing.

Because the importance of supplementation, this work aimed to evaluate the survival of *A. mellifera* with different solutions of commercial sugar added with lemons juice "Galego", "Tahiti", "Cravo" and citric acid.

## MATERIAL AND METHODS

Forager africanized honeybees were obtained at a colony in the Central Apiary of UFLA, anesthetized with CO<sub>2</sub> for 120s, individualized in number of ten (and ten replicate for treatment) and placed into cylindrical cages of 15 cm x 10 cm, covered with tulle in top and bottom. All cages were maintained in climatic chamber at 28±2°C, RH 70±10% and 12-hour photophase. The survival of honey bees were evaluated in two assays: first - diets with different concentrations of citric acid; second - diets (juices) with different variety of lemon and concentration. For all assays, the diet is formulated using one solution (1:1) of commercial sucrose (sugar cane) and water.

➡ Citric acid (concentration employed - w/v):

- 0.7; 0.5; 0.3; 0.16; 0.1 and 0 (control).

➡ Juice of lemon:

- In this assay, the juice of lemons "Galego"; "Tahiti" and "Cravo" (Figure 3) were employed in different concentration to prepare the diet, being the volume (mL; v/v) of each juice 20; 15; 10; 5; 1 and 0 (control). The fruits were collected in the UFLA orchard at the correct maturation point, being processed and filtered in 2,0mm mesh at 10°C.

- In both experiments, the number of honeybees dead was counted at regular 12-hour interval, even when the death of the last bee occurred. The survival rate was performed using the adjustment of the curves done by the Weibull distribution. With the adjustment, the effect of each diet was investigated by the maximum likelihood estimate and the lethal time (LT) for the intervals 10; 50 and 99% were determined.

## RESULTS

➡ Citric acid – the mortality of honeybees is affected by the citric acid concentration in diet. When fed with the diet + citric acid at 0.1; 0.16 and 0.3 g, the greater longevity of honeybees was observed (TL<sub>99</sub> of 475.57 h) and the less mortality 192 h after start the assay was found at 0.1 and 0.16g of citric acid. The largest concentration and the control induces the greater mortality at 192 h (Table 1). By the comparison between the survival curves, we found the formation of three groups with similar behavior, being first by control, second by 0.1; 0.16 and 0.3 g; and third with 0.5 and 0.7 g of citric acid (Figure 1). We verified that the weight of honeybees was affected when 0.5 or 0.7 g of citric acid was added in the diet, causing abnormal growth of abdomen. In the lower concentration, the mean of weight of honeybees was 139.25 mg, being 2.01 times more that the mean found in less concentration, 81.30 mg (Figure 2).

➡ Juice lemon - Using the different concentrations of lemon juices, the reduction in the mortality of the honeybees was found relative to the control. Only with the sucrose solution, the mortality observed at eight days was of 94.0%. For "Galego" juice, less mortalities were verified with 5 and 10 mL (mean of 74% at 192 h); "Tahiti" no difference was found, but the largest mortalities was with the short volume of juice; and "Cravo", the largest survival was with 5 mL of juice. To maintenance of honeybees long time in laboratory condition, we found that for all variety of lemon, the best volume is 10 mL, however, in short times each lemon has distinct behavior. "Cravo" and "Galego" at 5 mL of juice added in the food, induce the best values of survival and for "Tahiti", the volume which showed the best results is 20 mL in the food (Table 2 and Figure 4).

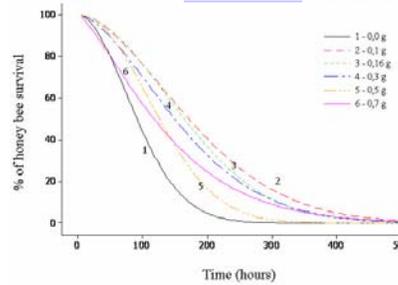


Figure 1. Survival of *Apis mellifera* feeding with aqueous solution of commercial sugar + citric acid.

Table 1. Lethal time of *A. mellifera* fed with aqueous solution of commercial sugar + citric acid, and mortality at the last time of assay.

Percentage of citric acid (w/v)	Lethal time (LT±SE) in hours			Mortality (%) at 192 h <sup>a</sup>
	TL <sub>10</sub>	TL <sub>50</sub>	TL <sub>99</sub>	
0.00	33.63 ± 6.58	91.25 ± 8.28	248.92 ± 28.11	94.0 ± 4.0 a
0.10	57.95 ± 14.49	171.61 ± 18.19	511.10 ± 127.90	58.0 ± 11.6 c
0.16	60.91 ± 12.54	164.68 ± 15.85	447.56 ± 94.81	64.0 ± 8.12 c
0.30	48.26 ± 12.65	149.86 ± 15.34	468.06 ± 124.51	82.0 ± 5.83 b
0.50	50.37 ± 8.96	125.86 ± 10.34	315.99 ± 38.29	82.0 ± 5.83 b
0.70	28.58 ± 8.90	117.79 ± 15.23	488.93 ± 118.48	74.0 ± 2.45 b

Means followed of the same letter in the column do not differ from each other by the Scott-Knott test at 5%.



Figure 2. Abnormal growth of abdomen after ingestion of more than 0.5g (w/v) of citric acid (A); Normal abdomen after ingestion until 0.3g (w/v) of citric acid (B).

Table 2. Lethal time of *A. mellifera* fed with aqueous solution of commercial sugar + lemon juice.

Lemon variety	Volume of juice lemon in solutions (mL)	Lethal time (LT±SE) in hours		
		TL <sub>10</sub>	TL <sub>50</sub>	TL <sub>99</sub>
Control	0	33.63 ± 6.58	91.25 ± 8.28	248.92 ± 28.11
Galego	1	70.50 ± 11.86	143.90 ± 9.09	294.80 ± 44.90
	5	<b>77.39 ± 10.23</b>	<b>150.31 ± 9.10</b>	292.94 ± 29.88
	10	42.52 ± 11.10	140.27 ± 15.24	<b>465.55 ± 114.43</b>
	15	54.75 ± 10.02	131.59 ± 10.24	317.74 ± 44.87
	20	65.99 ± 8.90	128.09 ± 7.59	249.47 ± 22.01
Tahiti	1	57.70 ± 9.08	125.42 ± 8.71	273.72 ± 28.86
	5	57.90 ± 10.48	133.32 ± 9.88	308.28 ± 44.72
	10	41.93 ± 11.56	128.40 ± 13.10	<b>395.51 ± 80.55</b>
	15	41.89 ± 10.38	127.70 ± 12.82	391.51 ± 75.65
	20	<b>68.40 ± 11.29</b>	<b>145.09 ± 9.91</b>	308.95 ± 38.61
Cravo	1	57.70 ± 9.08	146.64 ± 11.13	339.95 ± 49.85
	5	<b>69.81 ± 12.36</b>	<b>155.78 ± 11.55</b>	349.05 ± 52.72
	10	46.19 ± 10.39	139.20 ± 14.03	<b>421.85 ± 81.53</b>
	15	52.72 ± 9.63	111.21 ± 10.04	314.46 ± 40.90
	20	58.57 ± 10.30	140.54 ± 11.07	337.80 ± 49.54

Values in bold are the largest estimated for each lemon.

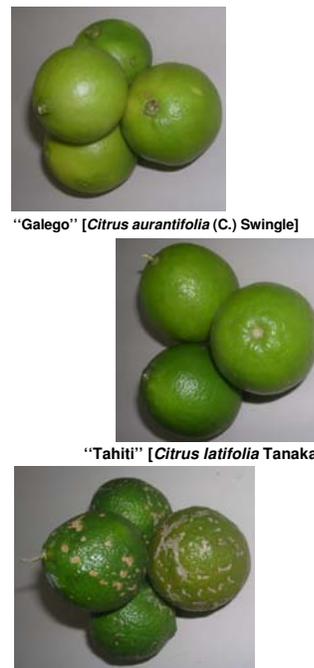


Figure 3. Lemons variety found in Brazil.

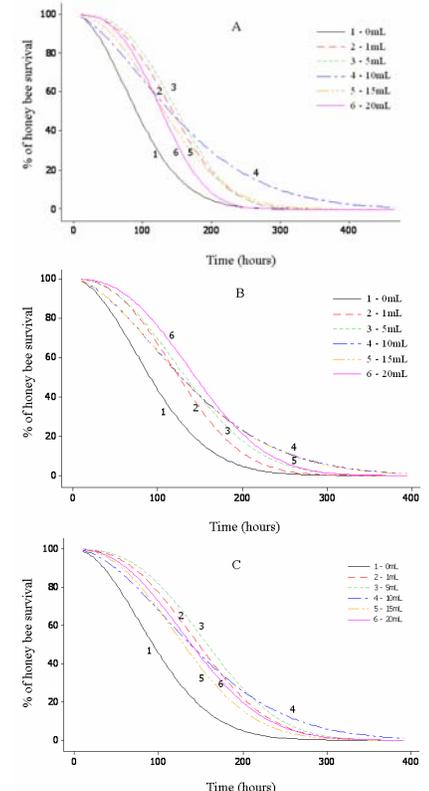


Figure 4. Effect of lemons juice in diet on honeybee survival: A - "Galego"; B - "Tahiti" and C - "Cravo".

## CONCLUSIONS

- Amounts less than 0.3g of citric acid in diet increases the survival of honeybees.
- Amounts greater than 0.3g of citric acid in diet, decreases the survival of honeybees and induces abnormal growth abdominal.
- 10 mL of juice from "Galego", "Tahiti" or "Cravo" lemons in saccharose:water solution (1:1) can replace the use of citric acid (or tartaric acid), increasing the survival rate of *Apis mellifera* when maintained in laboratory.