

# Honey Bees<sup>1</sup>: Response to Galactose and Lactose Incorporated into Sucrose Syrup<sup>2,3</sup>

H. ALLEN SYLVESTER<sup>4</sup>

Bee Breeding and Stock Center Laboratory, Federal Research, SEA, USDA, Baton Rouge, LA 70808

## ABSTRACT

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The addition of 10% lactose or galactose to 50% (wt/wt) sucrose solution reduced the amount of solution hoarded by *Apis mellifera* L. held in cages with comb pieces. Thus, bees are able to detect lactose and galactose. Lactose and galactose were toxic in a hoarding test. Oxytetracycline and sulfathiazole had no effect on the toxicity of lactose.

Previous experiments on the effects of various sugars on the feeding behavior and mortality of honey bees, *Apis mellifera* L., have used bees in cages without comb available for food storage (Barker and Lehner 1976, Barker 1977). Also, Barker and Lehner (1974) reported that artifacts in a variety of added sugars altered syrup uptake by combless cages of bees. I used the external food storage behavior (hoarding; Kulinčević and Rothenbuhler 1973) of honey bees in cages provided with comb pieces to determine the effects of the incorporation of lactose or galactose in sucrose syrup on syrup uptake and storage by caged honey bees and to measure the relative longevity of the bees fed treated and untreated syrups. In addition, the effects of sodium sulfathiazole or oxytetracycline added to lactose-sucrose syrup were measured.

## Materials and Methods

The 8 colonies with the best rates of survival out of 35 colonies previously surveyed for hoarding behavior were chosen as source colonies. Brood combs containing emerging adult worker bees were removed from each of these colonies and placed in emergence cages in a 35° C incubator. Newly emerged worker bees, ages 0-24 h, were then collected from the combs of each source colony and placed in groups of 30 in hoarding cages similar to those of Kulinčević and Rothenbuhler (1973). Each cage was fitted with a 20-ml water vial and a 20-ml syrup vial, but no pollen substitute was provided. Within each replicate group of cages, the different syrup treatments were randomly assigned. The cages were placed in incubators held at 35° C and 50% RH.

For the lactose and galactose tests, sucrose syrup (50% wt/wt) was used as the control solution and as the base for the 4 test solutions. Lactose (Sigma Chemical Co. L-3625) or galactose (Sigma G-0625) was individually added to aliquots of sucrose syrup at 4 and 10% (wt/vol) rates. Each source colony was represented by 3-6 replicate groups of 5 cages, for a total of 27 cages/treatment. Evaluations were made in July 1977. For the drug test, sucrose and 10% lactose syrups were made as mentioned previously. Sodium sulfathiazole (Walter T. Kelley Co.) at 0.15 and 0.25 mg/ml and oxytetracycline (TM 50, Walter T. Kelley Co.) at 0.7 and 1.4 mg/ml

were added to aliquots of 10% lactose syrup. Of the aforementioned 8 colonies, 5 were chosen as source colonies, and 3 replicate groups of 6 cages were tested per colony. The evaluations were made in Sept. and Oct. 1977.

The amounts of sugar syrup removed from the feeders were recorded daily. The quantity of syrup taken was calculated as the sum of the total amounts removed during the 3rd, 4th, and 5th complete days of the tests (converted to ml/bee/day) to reduce the effects of daily fluctuations. Bees that died in each cage were removed and counted daily until ½ or more had died. Mortality was calculated by converting the total numbers of bees that had died after 8 and 16 complete days of testing to percentages of the initial cage populations to yield % dead at day 8 and % dead at day 16, respectively. Days to median mortality were calculated as the number of complete test days until at least ½ of the bees in the cage had died. Analyses of variance and least significant difference tests were performed on data cast as ml/bee/day of syrup taken, days to median mortality, and % dead at 8 and at 16 days.

## Results and Discussion

### Syrup Consumption

The mean quantities of 10% lactose and 10% galactose syrups taken from the feeder vials were significantly different ( $P < 0.01$ ) relative to the 4% syrups and the control (Table 1). Thus, in these experiments, both lactose and galactose at 10% concentrations reduced the uptake of sugar syrup by bees. Von Frisch (1967) stated that galactose curtailed the life of bees and that "Here the sense of taste fails to caution against dangerous food." Dietz (1975) stated "... that bees with their ability to differentiate between sweet and unsweet sugars are, however, unable to use their sense of taste to differentiate between toxic and nontoxic sugars." When the bees are able to obtain and store syrup beyond the amount they are able to consume, it becomes clear that the addition of 10% lactose or galactose reduces the removal of sugar syrup from the feeder.

I concluded that this reduced uptake occurs because 10% lactose or galactose reduces the acceptability of sugar solutions to bees. However, this reduced acceptability is only manifested when the bees are able to store removed syrup. Thus, more information can indeed be obtained about the acceptability of sugar solutions to bees when hoarding is made a part of an experiment than when it is not. Since the bees in any given cage were not

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Table 1.—Effects of lactose or galactose in sucrose syrup on bees caged with comb available for syrup storage.<sup>a</sup>

Treatment	ml syrup taken/bee on days 3 + 4 + 5 $\bar{X} \pm SE$	Days to median mortality $\bar{X} \pm SE$	% dead, day 8 $\bar{X} \pm SE$	% dead, day 16 $\bar{X} \pm SE$
Sucrose 50% wt/wt	0.113±0.006a		4.9±1.1ab	14.6±1.8a
Sucrose + 4% galactose wt/vol	0.109±0.007a	20.4±0.3a	2.6±0.5a	23.3±2.1b
Sucrose + 4% lactose wt/vol	0.112±0.006a	12.9±0.2b	13.6±1.4c	78.4±2.0c
Sucrose + 10% galactose wt/vol	0.076±0.005b	11.9±0.2c	11.4±1.4bc	94.9±0.7d
Sucrose + 10% lactose wt/vol	0.072±0.004b	8.1±0.1d	64.6±2.6d	99.4±0.2d

<sup>a</sup> Means with same letters are not significantly different at the 0.05 level of probability as determined by LSD test.

allowed a choice, the present experiment demonstrates nothing about preference.

The decrease in syrup uptake of ±33% for 10% galactose and ±36% for 10% lactose cannot be accounted for by the increase in total sugar concentration from 50% in the controls to 60% in the 10% treatments. In another experiment (Sylvester 1978) in which I compared syrup uptake in a hoarding test, there was an increase as sucrose concentration increased from 10–50% but a decrease of ±5.5% when the concentration increased from 50–60%. However, this decrease was not statistically significant ( $P < 0.05$ ) and at most could account for only a small part of the decreases that resulted when 10% lactose or 10% galactose was added.

Since in nature, bees collect amounts of nectar that are beyond their immediate needs and store the excess as honey, bees may, in fact, be able to differentiate between at least some toxic and nontoxic sugars. However, if their immediate needs are not satisfied, they may still collect the toxic sugars.

#### Mortality

Median mortality was not calculated for bees in the control cages since most had not died when the test was terminated. Mean days to median mortality were significantly different ( $P < 0.05$ ) for all treatments (Table 1). The fact that the median mortality in cages with solutions of 4% lactose ( $\bar{X} \pm SE = 12.9 \pm 0.2$ ) was almost as high as that in cages with 10% galactose ( $\bar{X} \pm SE = 11.9 \pm 0.2$ ) further supports the statement of Barker and Lehner (1976) that “. . . the galactose unit per se fails to account for the toxicity of lactose.” The mean % bees dead at both days 8 and 16 (Table 1) is generally in close agreement with the figures of Barker and Lehner

(1976) and confirm that lactose and galactose are toxic to bees.

#### Drugs

Neither level of drugs had a statistically significant ( $P < 0.05$ ) effect on mean days to median mortality. For syrup containing the high level of oxytetracycline, 1.4 mg/ml, the hoarding rate was significantly different ( $P < 0.05$ ) from syrup containing only lactose and sucrose ( $\bar{X} \pm SE = 3.4 \pm 0.3$  ml vs.  $5.3 \pm 0.4$  ml, respectively) but was not significantly different from the other drug treatments, i.e., 0.15 mg/ml sulfa  $5.0 \pm 0.3$  ml, 0.25 mg/ml sulfa  $4.6 \pm 0.4$  ml, and 0.7 mg/ml oxytetracycline  $3.9 \pm 0.3$  ml. Thus a solution of 1.4 mg/ml of TM 50 oxytetracycline may be repellent to bees.

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