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Ethanol levels in honeybee hemolymph resulting from alcohol ingestion

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Abstract

Our previous work on a social insect model of ethanol-induced behavior focused on behavioral studies of honeybees (*Apis mellifera* L.). We now investigate the dependence of honeybee blood ethanol concentration on both the amount of ethanol consumed and time elapsed since ingestion. Blood ethanol level was determined using gas chromatograph using hemolymph taken from harnessed bees. Significantly increased levels of ethanol in honeybee hemolymph were detected within 15 min of feeding bees alcohol. Within 30 min, ethanol concentration increased 2.7 times. The concentration of ethanol ingested also had a significant effect on blood ethanol level. However, postfeeding times greater than 30 min did not significantly increase ethanol concentration in bee hemolymph. This study integrates with our behavioral data on the effect of ethanol on honeybees. Our laboratory and field experiments show a correlation between the time frame for behavioral changes and significant increases of blood ethanol levels shown in this study.

Keywords: Honeybee; *Apis mellifera*; Gas chromatograph; Ethanol; Hemolymph

Introduction

Investigations of social insect models of induced ethanol behavior have concentrated on the behavioral effects of ethanol on honeybees (*Apis mellifera* L.). Previous results from this laboratory have shown several effects that are common among humans and bees. These include the ability to self-administer ethanol and disruptions in both locomotion and Pavlovian conditioning (see Abramson et al., 2007 for a review). Our most recent work has extended the behavioral analysis to more complicated aspects of honeybee behavior. Drinking ethanol will disrupt, for example, both complex decision processes in free-flying forager bees and social communication within the hive (Abramson et al., 2005; Bozic et al., 2006).

We now turn our attention to the physiology of ethanol consumption in the honeybee. The present paper provides some physiological background for the possible action of ethanol through the blood on the central nervous system. We investigate the dependence of blood ethanol concentration on postingestion time and on concentration of ethanol consumed.

In the phylum Arthropoda, some data exist on how ethanol is metabolized in insects. Alcohol dehydrogenize in the fruit fly *Drosophila* is from the type II short-chain dehydrogenises (Benach et al., 2005). It can bind both ethanol and acetaldehyde. Other studies using *Drosophila* suggest that there also exists acetaldehyde dehydrogenize (Fry et al., 2004). However, it remains controversial whether this enzyme contributes to the metabolism of ingested ethanol in fruit flies.

The majority of data on blood ethanol levels and its physiological influence is available from studies using mammals and humans (Grant et al., 2000; Jones et al., 1991; Norberg et al., 2000). Blood concentration of ethanol depends on transport from the digestive track to the blood and catabolism of ethanol in the body. Ethanol conversion to acetaldehyde is catalyzed by alcohol dehydrogenize in these organisms (Sherman et al., 1994; Umulis et al., 2005). Acetaldehyde is then oxidized to acetate by acetaldehyde dehydrogenize.

Materials and methods

Bees preparation and hemolymph sampling

Honeybees (*Apis mellifera* L.) were collected at random as they departed the hive 1 day before an experiment. Each

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