Sci-Journal

Kava Decreases the Heart Rate of Daphnia

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Abstract

Kava, which grows throughout the Pacific Islands, was used by Polynesians in ceremonies and is now used as a recreational drug. Because of its current popularity, concern is rising about the health effects of kava when taken with other drugs. Results of the few studies done on the effects of kava on the heart are unclear; this study was conducted to see the effect of kava on heart rate. Kava, alcohol and water were administered to three groups of daphnia. Heart rates of the subjects were monitored for 10 seconds before and after the substances were administered. The research design used for this study was a mixed factorial and the data were analyzed using a statistical test called two-way analysis of variance with repeated measures on one variable. A significant interaction [$F(2,57)=10.76$, $p<0.001$] was found, and further analyses showed that only kava decreased heart rate. This study was the first to test the effects of kava on the heart rate of daphnia and suggests that it could have an effect on the health of humans.

Introduction

The leaves and roots of kava are used for drinks and medicinal purposes. Although very few scientific studies have been done on Kava, it has been shown to affect human physiological processes, including body temperature, and the nervous system (Felter and Lloyd, 1889; Kava Kava, 2002). Studies have shown that kava is as effective as prescription drugs for treating stress and anxiety, and causes sleepiness and relaxation of the muscles (Alexander, Watson, and Fleming, 1987; Lebot, Merlin, and Lindstrom, 1992; Kilham, 2002). Because kava is a recreational drug that

affects physiology, there is current concern about this drug being taken with alcohol and tranquilizers (FDA: diet drugs pose health risks, 1998; Govt. list of risky supplements, 1998; Tips on supplement safety, 1998; Zoltan, 1998; McCarthy and Jacobus, 1999). The reported effects from kava appear to be similar to affects from these other substances: they appear to calm physiological functions. Although tranquilizers and alcohol have been shown to decrease heart rate, the effects of kava on the heart are unclear. Most references to the effects of kava on heart rate are based on anecdotal evidence and not on scientific studies. Some of these references and a few studies suggest that kava increases heart rate; some suggest that it decreases heart rate, while others do not indicate any effects for kava on heart rate in humans (Ohnuma, 1999; Cropley, Cave, Ellis, and Middleton, 2002; Watkins, Connor, and Davidson, 2002; Cheryl, 2002; Tudor, 2002).

Research Question
Does kava have an effect on heart rate?

Hypothesis
It was hypothesized that if the heart is exposed to kava, then the heart rate should decrease because kava has been shown to affect the human physiological processes causing sleepiness and relaxation of the muscles. Sleepiness and relaxation shows that the body's nervous system is affected, which can, in turn, affect the heart rate.

Method

Subjects
Because using humans in a study to test the effects of kava on heart rate would not be ethical, *Daphnia sp*. was chosen as subjects to test the hypothesis. Daphnia is a microscopic organism approximately one millimeter long, commonly known as the water flea (see Figure 1). Studies have used daphnia to investigate the effects of painkillers, alcohol, and other substances (Jacobs, 1998; Carlson, 1999; Cheramy, 2002).

Sixty *Daphnia sp*., obtained from Petland (Kahala), were selected from a large stock aquarium. They were divided into three equal groups of 20

organisms each: Group 1: kava (experimental group); Group 2: alcohol, to control for the effects of the alcohol in the kava solution; and Group 3: water, to control for the effects of adding a drop of solution to the daphnia.

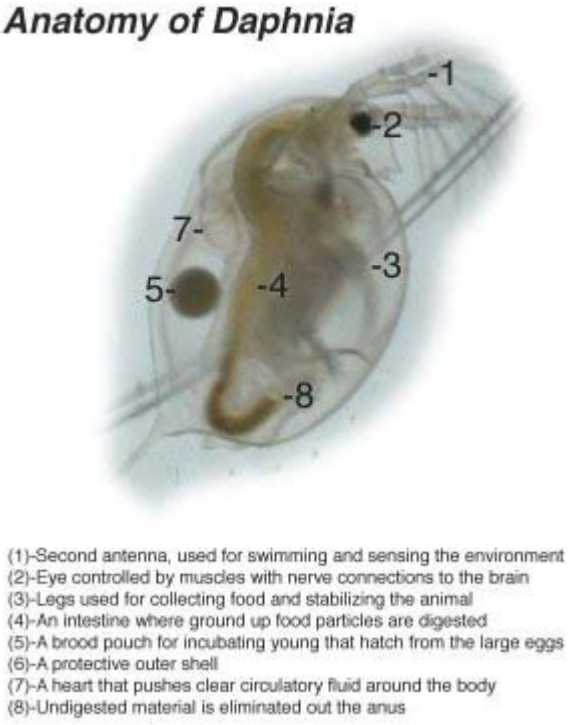

Figure 1. A *Daphnia sp.* Numbers and key indicate anatomy

Materials

The materials used for this study were a dissecting microscope to magnify the daphnia, 60% kava in 60% alcohol solution (Down to Earth brand), 95% ethyl alcohol, distilled water, a stopwatch for timing heart rate, a 4-liter stock aquarium, three counters for counting heart rate, a TV monitor for viewing the daphnia, a video camera to attach to the microscope, transfer pipettes for transferring the daphnia, three small petri dishes for holding the microorganisms, pH paper (Universal) to get the pH of each substance, data collection sheets, and Kleenex tissue for absorbing excess liquid.

Procedures

A pilot study was conducted to see what dosage of kava should be used in

the study. One drop of a 15% kava solution was determined to be an ideal dose for this study because it appeared to affect the heart rate with no other apparent affects to the daphnia. To prepare the solution used for this dose, 40 drops of water were added to 10 drops of 60% kava solution to get a 15% kava in 15% alcohol solution. Ten drops of 95% ethyl alcohol were diluted with 62 drops of water to get 15% ethyl alcohol for the alcohol control group solution.

A daphnia was placed on a petri dish in a drop of water. Tissue (approximately one centimeter square) was then placed on the drop of water next to the subject. The petri dish with the daphnia was then placed under the microscope with the light off. The light was turned on and the microscope was focused on the heart of the subject to take a 10-second before-treatment heart rate. Three experimenters used the counters to count the heart beats by viewing the daphnia enlarged on a TV monitor. After the data were recorded, the light was again turned off and a drop of kava, alcohol, or water was placed on the tissue in the petri dish. The daphnia was given 30 seconds to adjust to the solution. The light was then turned on and after-treatment heart beats were counted for 10 seconds.

The same procedure was used for all subjects. After the first ten subjects (Block 1) in each condition were studied, assistants began to add the solution to the second ten daphnia (Block 2) so that the experimenters did not know which subject received kava, alcohol, or water. The subjects were run in groups of three subjects: Kava, Alcohol and Water. The mean number of heart beats taken by the three experimenters for each subject before and after treatment was calculated. Means were then calculated for the mean heart rates before and after adding the experimental solutions for all subjects in each group and separately for Blocks 1 and 2. The temperature of the laboratory was held at a constant 25°C throughout the experiment. The kava, alcohol, and water had pH concentrations of near neutral (6.8 to 7.0).

Design and Analysis

This study had two independent variables. The first variable,

TREATMENT, involved three separate groups (kava, alcohol and water) of subjects. The second variable, TREATMENT PERIOD involved measuring data from the same subjects at two different times (before-treatment and after-treatment). This research design is called a mixed factorial and is analyzed using a statistical test called two-way analysis of variance (ANOVA) with repeated measures on one variable (Fox, Kuo, Tilling, and Ulrich, 1994). Tests for Simple Main Effects were run after a significant interaction and, where significant, were followed by Tukey's test to determine differences between means. The criterion used for statistical significance (α) was 0.05 for all tests.

Results

Figure 2 presents the mean heart rates for the three groups. As can be seen in the figure, after the substances were given, the daphnia heart rates appeared to dramatically decrease only in the kava group. The two-way ANOVA revealed a significant TREATMENT X TREATMENT PERIOD interaction effect. Tests for Simple Main Effects showed that there were differences between the means before and after treatments and differences between the means of the three groups after their treatment with kava, alcohol, or water. Kava significantly decreased heart rate. Tukey's tests indicated that the kava-treated daphnia heart rates were significantly lower than both the alcohol and water controls' heart rates.

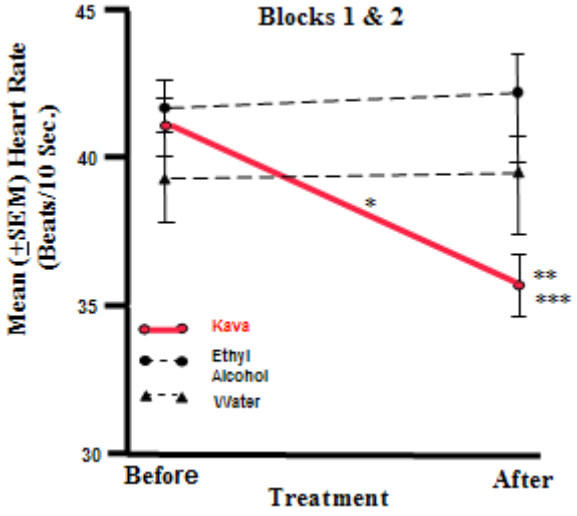

Figure 2. Mean (± standard error of the mean) heart rate in beats per 10 seconds before and after daphnia were exposed to kava, ethyl alcohol, or water.

* Indicates mean heart rate after treatment is significantly different than the heart rate before treatment.
** Significantly different from the Ethyl Alcohol group's mean heart rate.
*** Significantly different from the Water group's mean heart rate.
Two-way ANOVA results:
TREATMENT EFFECT: $F(2,57) = 2.16$, $p = 0.12$.
TREATMENT PERIOD EFFECT: $F(1,57) = 4.68$, $p < 0.04$.
TREATMENT X TREATMENT PERIOD EFFECT: $F(2,57) = 10.76$, $p < 0.001$.

The data for the first ten subjects from each group (Block 1) and the second ten subjects from each group (Block 2) are shown in Figures 3 and 4. Regardless of whether the experimenters knew (Block 1) or were blind (Block 2) to which organism received kava, alcohol, or water, the results stayed the same: kava caused a decrease in daphnia heart rate.

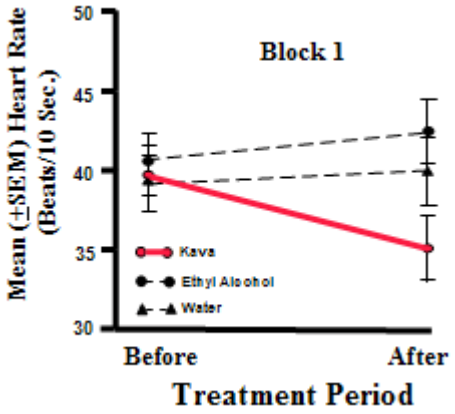

Figure 3. Mean (± standard error of the mean) heart rate in beats per ten seconds for Block 1 before and after daphnia were exposed to kava, ethyl alcohol, or water.

Note: For Block 1, the experimenters administered the treatment to the subjects and *KNEW* which treatment each subject received.

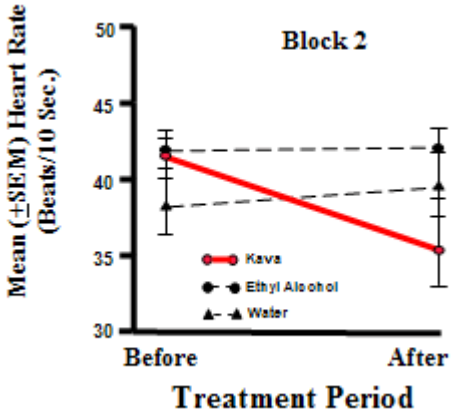

Figure 4. Mean (± standard error of the mean) heart rate in beats per ten seconds for Block 2 before and after daphnia were exposed to kava, ethyl alcohol, or water.

Note: For Block 2, the experimenters administered the treatment to the subjects and *DID NOT KNOW* which treatment each subject received.

Discussion

The results showed that kava decreased daphnia heart rate, while neither alcohol nor water had any effect. These findings support this study's hypothesis and agree with reports of others that kava decreases human heart rates (Cheryl, 2002). Some of these reports are based upon findings that kava's effects include sleepiness, numbing, and loss of muscle control--all of which are signs of decrease in central nervous system activity typically accompanied by slower heart rate (Baum, Hill, and Ropmmelspacher, 1998).

Prescription drugs such as tranquilizers and alcohol calm down physiology and decrease heart rate (McCarthy and Jacobus, 1999). The results of the present study show that kava also decreases heart rate. When kava is taken

with one of these prescription drugs, the combined effects on the heart could be dangerous and affect one's health.

Few studies have attempted to investigate the effects of kava on heart rate. To this author's knowledge, this study is the first to test the effects of kava on the heart rate of daphnia. Substances that affect the heart of daphnia may not have the same effects on the heart of humans (Cheramy, 2002). If kava has the same effects on humans as it does on this microorganism, the mechanisms responsible for its effect on the human heart may not be the same (Jacobs, 1998).

Studies have found that alcohol disrupts normal regulation of heart beat, causing a decrease in heart rate (Herbert, 1999). In contrast, the present study indicated that alcohol does not affect heart rate, at least for daphnia. The alcohol control concentration used in this study was only 15% and it is possible that a higher concentration may have had an effect.

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