The effects of *Cecropia obtusifolia* and *Cecropia polyphlebia* on lung capacity in relation to alkaloid concentration

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**ABSTRACT**

For centuries, people have depended on nature to alleviate their ailments. A popular natural remedy for asthma is the use of *Cecropia adenopus* (Rivero 2008). In this study, I looked at two *Cecropia* spp., *C. obtusifolia* and *C. polyphlebia*, found in Monteverde, Costa Rica. *Cecropia obtusifolia* is found at lower elevation and has a mutualism with *Azteca* ants while *C. polyphlebia* is found at higher elevation in the Cloud Forest with no ant mutualism. A previous study by Ross (2003) found that ingestion of *C. obtusifolia* leaf decoction increased lung capacity by three to four percent compared to a placebo group. A possible reason is the presence of alkaloids (Schmeller & Wink 1998) in leaves of *Cecropiaceae* (Morton 1981). I predicted that since *C. obtusifolia* has a mutualism with ants, it would have less alkaloids compared to *C. polyphlebia*, thus rendering it less effective as an anti-asthmatic agent. I followed the protocols from Ross (2003) for tea preparation and lung capacity measurement and Gottheiner (1998) for alkaloid extraction. I found no increase in lung capacity from drinking *Cecropia* decoctions. The mean rate of change, which is the final lung capacity measurement minus the initial divided by the number of samples in a group, for the control is 0.136 L with a standard error of 0.066; *C. obtusifolia*, 0.180 L and 0.090; and *C. polyphlebia*, 0.172 L and 0.100 (one-way ANOVA; F$_{2,52}$ = 0.056, p = 0.946). Further, while *C. polyphlebia* may have more alkaloids, this was not significant enough to make a difference in lung capacity.

**RESUMEN**

Por centurias los seres humanos han dependido de la naturaleza para aliviar sus males. Un remedio popular para el asma es el uso de *Cecropia adenopus*. Estudie *Cecropia obtusifolia* y *Cecropia polyphlebia*, en Monteverde, Costa Rica. *Cecropia obtusifolia* se encuentra a elevaciones más bajas y tiene un mutualismo con hormigas *Azteca*, mientras que *C. polyphlebia* se encuentra a mayores alturas sin mutualismo con las hormigas. Un estudio previo encontró que las infusiones de *C. obtusifolia* incrementan la capacidad pulmonar entre un tres y cuatro por ciento comparado con un placebo, probablemente por la presencia de alcaloides. Debido a que *C. polyphlebia* no tiene un mutualismo con hormigas debería tener una mayor concentración de alcaloides, por lo tanto un mayor efecto antiasmático. A pesar de que se encontró una mayor concentración de alcaloides en *C. polyphlebia*, no se encontraron diferencias en el efecto de los tratamientos en la capacidad pulmonar.

**INTRODUCTION**

The World Health Organization (WHO 2008) estimated that 80% of the population in some Asian and African countries depends on traditional medicine, probably due to the fact that more than one billion people do not have access to health care services and modern medicine (Carr 2004). In Belize, at least 75% of its population receives primary health care from traditional practitioners (Balick & Mendelsohn 1992), and this may well be true for most developing countries. For ailments, like asthma, where there are an estimated 300 million people suffering, and is the most common chronic disease for children (WHO 2008)—a cheap, readily available traditional cure is important for people in the developing world.
For centuries, humans have used the *Cecropia* trees as herbal remedies to alleviate asthma (Raintree Nutrition 2007). *Cecropia* trees are prevalent in the Neotropics, growing in disturbed areas such as roadside, forest edge, and landslide—easily accessible for humans to use. Of particular interest are the two *Cecropia* species in the Monteverde area, *C. obtusifolia* and *C. polyphlebia*. *Cecropia obtusifolia* has been shown to control hypertension (Salas et al. 1987; Lima-Landman et al. 2007), hypoglycemia (Roman-Ramos et al. 1991; Andrade-Cetto & Wiedenfeld 2001), and act as a diuretic (Vargas and Montero 1996), as well as an analgesic depressor (Perez-Guerrero et al. 2001). Ross (2003) found that consuming *C. obtusifolia* leaf decoctions increased lung capacity by three to four percent compared to a placebo group. This is the first clinical demonstration of the pharmacological potential of *Cecropia* spp. for asthma, bronchitis, and other respiratory diseases.

A set of important compounds shown to have medicinal value are alkaloids. Schmeller and Wink (1998) reported on the different uses of alkaloid compounds as painkillers, stimulants and hallucinogens by humans. In nature, alkaloids are secondary compounds, known to be produced by plants as a chemical defense against herbivores, microorganism, viruses, and other plants (Schmeller & Wink, 1998). Although *C. obtusifolia* contains alkaloid, flavonoids, tannins (Morton 1981) and other compounds, its main defense against herbivores is a mutualistic relationship with *Azteca* ants. *C. polyphlebia*, growing at higher altitudes, has lost its ant partner and should have a higher concentration of alkaloids and other secondary compounds in its leaves to compensate (Scalley 1993).

Because *Cecropia spp.* has been used traditionally to control asthma and Ross (2003) found *C. obtusifolia* to increase lung capacity, it is likely that the more chemically protected *C. polyphlebia* would do an even better job. Therefore, this study examines if ingestion of leaf decoction of *Cecropia polyphlebia* will have a higher increase in lung capacity compare to *C. obtusifolia* and determines if *C. polyphlebia* contains higher level of alkaloids.

**METHODS**

*Cecropia obtusifolia* and *C. polyphlebia* were identified by location (altitude), number of leaflets, length of inflorescences, and the presence (or absence) of ant mutualism, following guidelines by Zuchowski (2007) and Longino (2005). *Cecropia obtusifolia*, an ant-mutualistic plant, occurs in disturbed areas of moist to wet forest from 1000 to 1500 m elevation, and has 10 - 13 long leaflets with inflorescence spikes to more than 50 cm long. In contrast, *C. polyphlebia* has no mutualism with ants; short inflorescence spikes less than 6 cm long, 10 - 11 leaflets, and occurs above 1500 m in the Cloud Forest.

**Study sites**

The leaves of *C. obtusifolia* were gathered from four individual plants on roadsides near Centro Panamecano de Idiomas (CPI) – Monteverde and El Hotel de Montana (1350 m). *Cecropia polyphlebia* leaves were collected in the Monteverde Cloud Forest near the Biological Station of Monteverde (1550 m).
Cecropia Tea and Lung Capacity Experiment

I collected one young leaf per individual plant for a total of four individuals for each species. The leaves were boiled and made into tea according to Ross (2003) with the exception that I increased the amount of leave tissue per one liter of water from two grams to four grams. The placebo tea was made from diluted chamomile (Matricaria recutita: Asteraceae) tea. I made the teas in bulk and assigned treatments randomly to participants on the same day—each participant to one treatment. A total of 55 volunteers participated, 18 for each of the treatment groups and 19 for the control. The average participant was a 21 year old college female who exercised at least twice a week and had no pre-existing respiratory diseases. The participants were instructed to refrigerate the tea and drink 100 mL of tea after breakfast for five days. I measured the lung capacity of an individual by having the person blow a balloon in one breath, and this was completed before the individual had consumed the tea as the initial lung capacity measurement. Another lung capacity measurement was taken after the fifth day as the final lung capacity. The volume of the balloon, and thus the lung capacity of the participant, was determined through water displacement.

Alkaloid Extraction from C. obtusifolia and C. polyphlebia

I completed the same leaf collection for my alkaloid extraction. The species were collected and dried in a drying box for a day. Then, the dried leaves were ground and soaked in methanol overnight. The rest of the alkaloid extraction procedures were from Gottheiner (1998). All the samples were analyzed with a MRC Spectrophotometer, Model UV-200-RS at 540 nm, and measured in percent transmittance (% T).

RESULTS

There was no statistical significant between the treatment groups and placebo group even though the alkaloid concentration of C. polyphlebia was slightly higher than C. obtusifolia.

Cecropia Tea-Lung Capacity Experiment

Comparing measurements of the initial and final lung capacity, I found no difference between Cecropia teas and the placebo chamomile tea (one-way ANOVA; F_{2,52} = 0.056, p = 0.946). Figure one shows the mean rate of change (L)—which is the final lung capacity measurement minus the initial divided by the number of samples in each group—for each treatment with the standard errors. The rate of change for the control is 0.136 L with a standard error of 0.066; C. obtusifolia, 0.180 L and 0.090; and C. polyphlebia, 0.172 L and 0.100. Although Cecropia obtusifolia and C. polyphlebia have a slightly higher rate of change compared to the control, the overlap of the standard errors indicates that there is no statistical difference between the two treatment groups and the placebo group.
Alkaloid Extraction of C. obtusifolia and C. polyphlebia

The percent transmittance (% T) for *Cecropia obtusifolia* was 97 and for *C. polyphlebia*, 95. This shows that *C. polyphlebia* have a slightly higher concentration of alkaloid because the *C. polyphlebia* sample absorbed more light. However, the exact alkaloid concentration is not known because a standard curve was not generated.

**DISCUSSION**

My experiment examined the effects of ingestion of *Cecropia obtusifolia* and *C. polyphlebia* leaf decoction on lung capacity. I expected to find that *C. polyphlebia* would have a higher increase in lung capacity due to the fact that it lacks ants, and thus, it likely increases its synthesis of alkaloids and other secondary compounds for protection against herbivores and pathogens. My results indicated that while *C. polyphlebia* contained a slightly higher concentration of alkaloid than *C. obtusifolia*, there was no difference in its impact on lung capacity. In fact, neither *Cecropia* species increased lung capacity compared to the control. This was a surprising result since a previous student investigator found a three to four percent lung capacity increase using *C. obtusifolia* both in short-time effectiveness (measured one minute after leaf ingestion) and long-term effectiveness (measured after five days), respectively (Ross

Figure 1. The average rate of change for each treatment group. *Cecropia obtusifolia* and *C. polyphlebia* have a slightly higher rate of change compared to the control group but it is not statistically significant.
2003). I even doubled the strength of the decoction by doubling the grams of leaves per liter of water from two grams (Ross 2003) to four grams, expecting to find a subsequent increase in lung capacity. While I cannot explain why Ross (2003) found different result, an herbal medicine website (Rivero 2008) and a scientific paper (Alonso 1998) recommend Cecropia leaves decoction to be 20 - 40 grams per one liter of water for the treatment of asthma. The expected effect is one hour after tea consumption and should be consumed two to four times daily. Clearly, this is an area that needs to be explored in more depth.

For future studies, it is pertinent to have better lung capacity measuring equipment as this will insure increased accuracy. Any decoction of Cecropia leaves should follow the recommended amount of 20 – 40 grams per one liter of water and should be taken at least twice a day. In addition, a standard curve should be generated to calculate the alkaloid concentration of Cecropia obtusifolia and C. polyphlebia. This may validate the need to decoct more leaves per one liter of water.

Lastly, the importance of Cecropia trees and its effect on asthma cannot be ignored. The discovery of such treatment would mean that millions of sufferers of asthma or other respiratory diseases would benefit tremendously, especially when access to health care services is limited.

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