Effect of *Cecropia polyphlebia*, *Cecropia obtusifolia*, and *Bidens pilosa* on Human Lung Capacity

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Abstract

Traditional medicine is used by 80% of the world population as their primary care. Monteverde, Costa Rica houses a rich flora including *Cecropia polyphlebia* (Cecropiaceae), *Cecropia obtusifolia* (Cecropiaceae), and *Bidens pilosa* (Asteraceae) that have been identified as medicinal plants to reduce the symptoms of asthma and other respiratory ailments. Fifty-eight human subjects were divided into four groups of tea treatments, including Chamomile *Chamaemelum nobile* (Asteraceae) as a control. Lung capacity was measured using the amount of air blown into a balloon in a single breath. Initial (pre-treatment) as well as the immediate and long-term effects of plant extracts on lung capacity were measured for the four tea treatments. Results showed no statistically significant difference between the immediate and long-term effects of any of the treatments. However, there was a statistically significant difference between *B. pilosa* and *C. obtusifolia*; *B. Pilosa* and *C. nobile*; and *C. polyphlebia* and *C. nobile. B. Pilosa* and *C. polyphlebia* are most effective to increase one's lung capacity and, therefore, most likely to lessen asthma symptoms.

Resumen

Medicina tradicional esta usada por 80% del mundo para mejorar la salud. Monteverde, Costa Rica tiene una flora con una riqueza alta que contiene plantas medicinales, incluyendo plantas como *Cecropia polyphlebia* (Cecropiaceae), *Cecropia obtusifolia* (Cecropiaceae), y *Bidens pilosa* (Asteraceae) que reduzcan las síntomas de asma y otros enfermedades respiratorios. Para este estudio, cincuenta y ocho personas estaban divididas en cuatro grupos de tratamientos de te diferentes, incluyendo manzanillo, *Chamaemelum nobile* (Asteraceae), como un control. La capacidad de los pulmones estaba medida usando una sopla de aire por un globo por cada persona. Efectos iniciales, inmediatos, y largo plazo de la capacidad de los pulmones estaban medidas por los cuatro tratamientos de té. Los resultados mostraron no diferencia entre los efectos inmediatos y de largo plazo. Sin embargo, era una diferencia entre *B. pilosa* y *C. obtusifolia*; *B. Pilosa* y *C. nobile*; y *C. polyphlebia* y *C. nobile. Bidens pilosa* y *C. polyphlebia* son lo más eficientes para mejorar la capacidad de los pulmones y bajar las síntomas de asma.

Introduction

Approximately 300 million people worldwide are affected by asthma, disproportionately affecting people living in lower-income, inner city environments (Fauci 2009). Unfortunately, there is no cure for this chronic lung disease that often begins in the first year of life and causes chest tightness, shortness of breath, coughing, and wheezing (Castro-Rodríguez 2000).

It has also been shown that 80% of the world population relies on traditional medicine for primary care (Farnsworth 1985). Part of this is because a number of countries naturally have medicinal plants present (Farnsworth 1985). This may also be accounted to tradition as well as the high costs of medical procedures, drugs, and vaccines. Further, in developed countries, there is also a lack of access to health care as well as the issues of poor-quality and counterfeit drugs,

lack of availability of essential drugs due to fluctuating production or prohibitive cost, and the need to develop field-based drug research to determine optimum utilization (Pécoul et al. 1999). Also, it has been shown that many who are afflicted by asthma do not have access to basic asthmatic medication or medical care (Masoli 2003). Therefore, this shows the importance of medicinal plants and knowledge about their uses for the people's well-being that do not have access to healthcare.

In Costa Rica, plants such as *Cecropia polyphlebia* (Cecropiaceae), *Cecropia obtusifolia* (Cecropiaceae), and *Bidens pilosa* (Asteraceae) are abundant and have been identified as medicinal plants to relieve asthma (Raintree 2007). For respiratory problems like asthma, making a tea from these plants could be cost-effective for many in the developing world, compared to high-tech, expensive pharmaceuticals (McCaleb 1997).

Two grams of *C. obtusifolia* leaves per liter of water produced a significant short-term but not long term change in lung capacity (Ross, 2003). A similar concentration of *C. polyphlebia* was also tested and showed a higher level of alkaloids than *C. obtusifolia*. This was because of the mutualistic relationship between *C. obtusifolia* and ants that help with protecting the plant. Therefore, *C. polyphlebia* would require higher alkaloid levels to protect itself. The study found no statistically significant increase in lung capacity with either tea (Xiong 2009).

The purpose of this study is to determine which of the three species, *C. polyphlebia, C. obtusifolia*, and *B. pilosa*, tea will most increase one's lung capacity. I hypothesize that *B. pilosa* would be least effective because it was placed in the tier three category of medicinal plants to use for respiratory problems. The *Cecropia* family was listed in the tier one category (Raintree 2007). I also predict that *C. polyphlebia* will be more effective than *C. obtusifolia* because of its higher alkaloid levels (Xiong 2009). Furthermore, short-term and long-term effects will be measured to determine if the herbal tea derived from *C. polyphlebia*, *C. obtusifolia*, and *B. pilosa* is best used on a by-need basis or a regular basis.

Methods

C. polyphlebia tea and *C. obtusifolia* tea were made following a standard leaf infusion process. *C. obtusifolia* leaveswere collected along roadsides near Centro Panamericano de Idiomas (CPI) at 1430 m. *C. polyphlebia* leaves were collected at 1550 m around the Estación Biologica de Monteverde. Once dried in a dry box, they were torn into smaller pieces, and soaked for 15 minutes in boiling water (Herbs 2009). *B. pilosa*, a common weed, was collected along the roadsides between Santa Elena (1370 m) and CPI (1430 m). It also went through the same process to create a third tea sample. The fourth tea sample was dried *Chamaemelum nobile* (Asteraceae), produced commercially as Chamomile tea and bought from a local supermarket. This was meant to be the control for lung capacity because it is not reported to increase lung capacity, unlike the others. The teas were made in mass quantity, 10 grams of dried material per liter of water, then refrigerated for no more than 6 days (Schulte 2009).

Fifty-eight human subjects, with a 16:42 ratio of males to females, were randomly divided into the four sample groups. Subjects ranged from 20 – 51 years old, the majority aged between 20 and 21 years old. There were no smokers, though there was one 20 year old female with exercised induced asthma. Each subject measured their lung capacity by blowing a full breath of air into a balloon. This represented each subject's initial lung capacity. For five consecutive days, subjects drank 200 mL each day of their respective assigned treatment for a total of 1 liter (Raintree 2007). On day one, within 2 minutes of drinking the tea, subjects

measured their lung capacity in the same manner. This showed the immediate effects of the medicinal properties of the tea. On day five, at least thirty minutes after the final dose of treatment, a final measurement was taken of subjects' lung capacity. This showed the long-term effects of the tea.

Throughout the experiment, as soon as balloons were collected, volume levels were determined through water displacement. Each balloon was completely submerged using a thin piece of plastic into a plastic bucket filled to the brim with water. The excess water spilled into a second, larger container which represented the volume inside the balloon. The volume was measured with a graduated cylinder to the nearest 5 mL.

To ensure consistent results amongst all subjects, the following actions were taken. All subjects had to have a resting heart beat by sitting for at least 20 minutes before blowing up a balloon. All balloons were the same brand and size, and none were stretched out before a subject expelled into them.

Results

Subjects' immediate lung capacity was measured on day one and compared to the initial lung capacity before treatment began to calculate the percent of change. The long-term effects were found by comparing the fifth day's lung capacity to the initial lung capacity to also find the percent of change. There was no statistically significant difference in immediate reaction to tea compared to the long-term reaction to tea for any of the four treatments (two-way ANOVA test; $F_{1,99} = 2.13$, $p = 0.14$). However, trends were present within each treatment. *B. pilosa* had an initial mean percent increase of 10% which then further increased to 23% after five days of treatment. *C. obtusifolia* showed a slight increase from the initial and final treatment starting at 2% and increasing to a 4% change. *C. polyphlebia* also had a slight increase from 12% to 13% rate of change in lung capacity from the initial lung capacity. Lastly, *C. nobile*, the control, had a 2% decrease in lung capacity after the initial and final dose of treatment (Fig. 1 and Fig. 2).

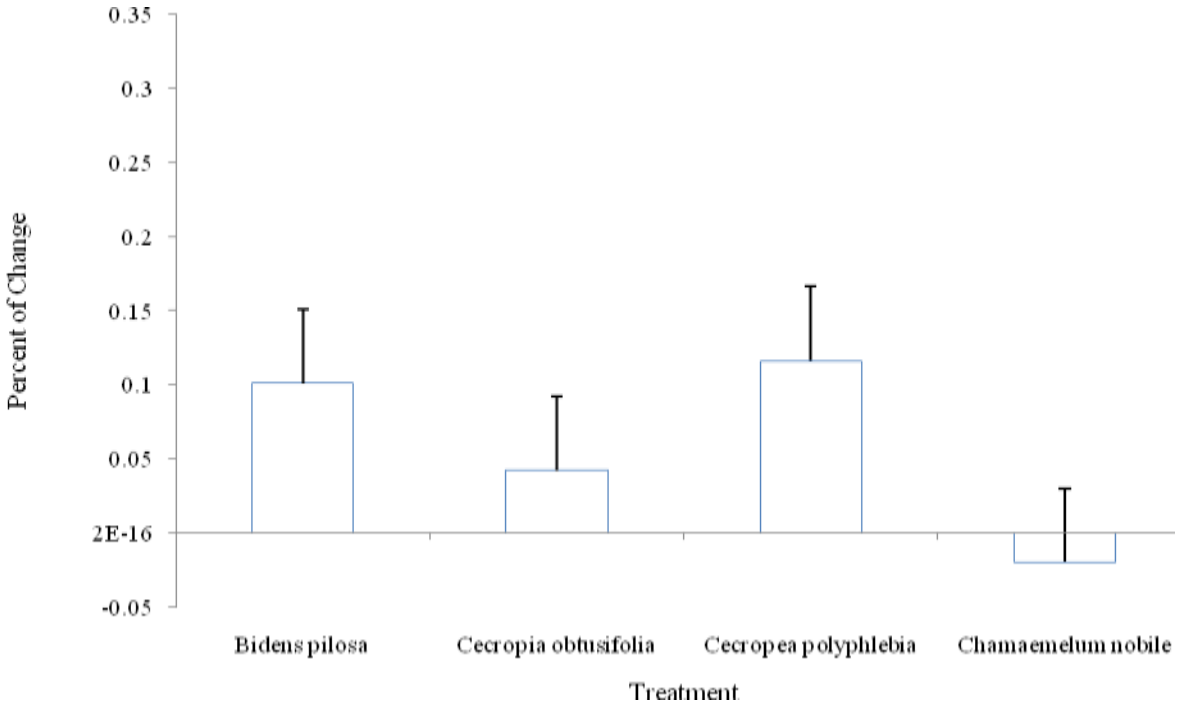

FIGURE 1. Percent of change in mean volume (mL) between *B. pilosa, C. obtusifolia , C. polyphlebia,* and *C. nobile* immediately after the first dose.

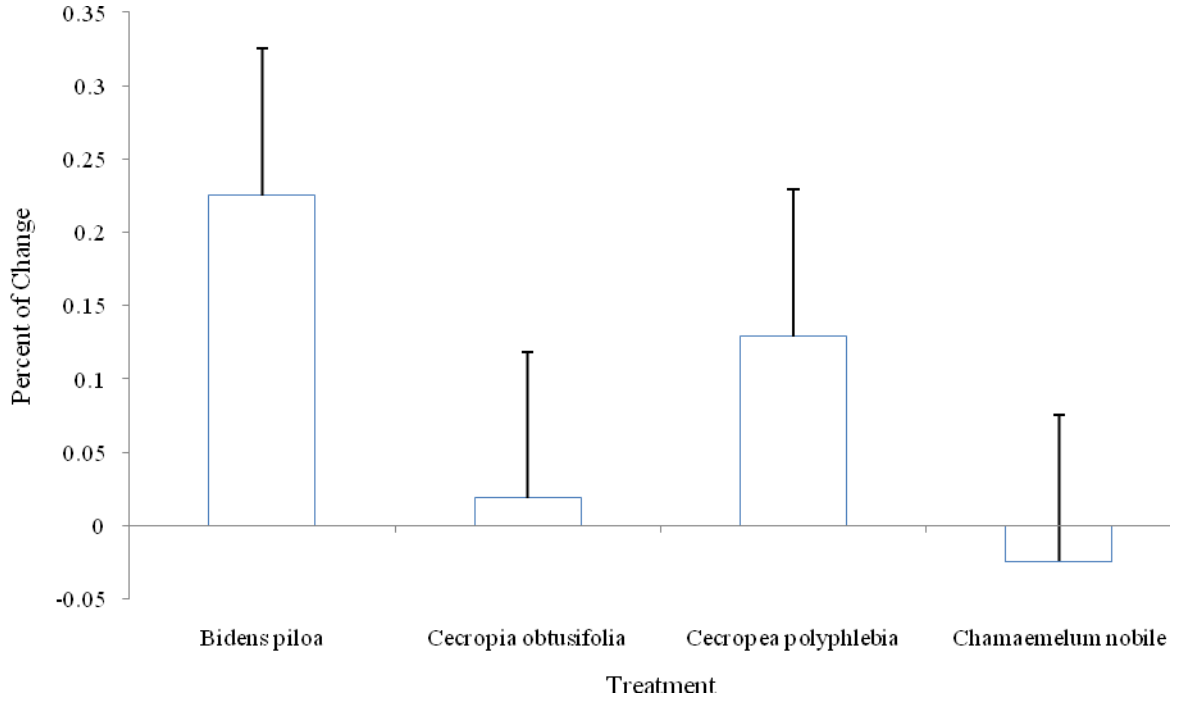

FIGURE 2. Percent of change in mean volume (mL) between *B. pilosa, C. obtusifolia, C. polyphlebia,* and *C. nobile* after fifth day.

Though there was not a statistically significant difference within each treatment, there was a statistically significant difference between the four treatments (two-way ANOVA test; $F_{3,99} = 7.8$, $p = 0.001$). Using the Tukey test, significant differences were seen between the treatments (Table 1).

TABLE 1. Tukey test result for comparisons between treatments categories.

	B. pilosa	*C. polyphlebia*	*C. obtusifolia*	*C. nobile*
B. pilosa	------	$p > 0.05$	**$p < 0.05$**	**$p < 0.05$**
C. polyphlebia	------	------	$p > 0.05$	**$p < 0.05$**
C. obtusifolia	------	------	-------	$p > 0.05$
C. nobile	------	------	-------	------

Discussion

As there is no statistically significant difference on lung capacity from drinking one cup of tea compared to a cup a day for five days, it is unnecessary to drink an herbal tea derived from *B. pilosa, C. obtusifolia,* or *C. polyphlebia* for the long-term. However, the results have shown that the two most effective teas are *B. pilosa* and *C. polyphlebia.* This is because they were significantly different from *C. nobile*, the control that did not influence subjects' lung capacity. *C. obtusifolia* was significantly different from *B. pilosa*, but not significantly different from *C. nobile*. Therefore, it does not significantly change one's lung capacity. This may explain why studies differ in their ability to demonstrate a difference. Out of the four teas presented in this experiment *B. pilosa* and *C. polyphlebia* would be most beneficial for a person to drink to subdue the effects of asthma.

My results contradicted both prior studies. In 2003, it was found that *C. obtusifolia* significantly increased human lung capacity, but did not in this study. Earlier this year, significant differences in alkaloid levels were confirmed. This was due to the mutualism of ants with *C. obtusifolia*. It was shown that *C. polyphlebia* would require higher alkaloid levels because it did not have the additional protection by ants like *C. obtusifolia.* Though, the study did not show a significant difference on lung capacity between the two *Cecropia* species. However, this study hypothesized that significant alkaloid levels would affect lung capacity and results proved accurate. The reasons for differences between the spring 2009 study and this is that there may have been due to Xiong's study using inaccurate tea leaves to water ratio.

The results of *B. pilosa* and *C. polyphlebia* are very important for those living with asthma as well as other similar respiratory ailments. These plants are widely available in Monteverde. However, *C. obtusifolia* and *C. polyphlebia* may be difficult to differentiate unless if one knows which has a mutualistic ant relationship or at which elevations they are found. Once locals can identify and locate these valuable plats, they can take advantage of this natural remedy and save their money on medication from a pharmacy. Those who cannot afford healthcare or live in a remote area with limited healthcare access can greatly benefit from these natural remedies. The effectiveness of these medicinal plants is important for the 80% of the world's population that relies on traditional medicine as their primary care (Farnsworth 1985).

The next step is education. The knowledge gained through this experiment is valuable, especially for Monteverde locals who have direct access to these plants. However, the information and results are limited to whoever reads this report which is unlikely to be the disparate population in Monteverde. Though, it is unknown if the Monteverde population is already aware of the natural remedies that can easily be found on roadsides like *B. pilosa*. Therefore, I suggest that future studies should poll locals on their knowledge of local medicinal plants including *B. pilosa*, *C. obtusifolia*, and *C. polyphlebia*. Another study may look into the biological reasons for why *B. pilosa* was as effective when stated otherwise. Lastly, one more future study could resolve the conflicting data found between the three independent studies involving *C. obtusifolia*, and *C. polyphlebia*.

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