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Effectiveness of *Ficus benjamina* "Vaditi" and *Artocarpus treculianus Elm.* "Tipuho" Sap Extracts as Non-Chemical Rodent Trap

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ABSTRACT

Pests are organisms that can cause economic damage or become threats to the health of humans and domestic animals. Rodents are pests and are considered to be essential reservoirs of numerous diseases that infect humans, domestic animals, and other wildlife species. Because of the threats, they have on humans and the environment, there is a need to employ an effective method to control rodent infestations that are inexpensive and non-chemical. The purpose of this study is to create a non-chemical and eco-friendly rodent trap from the sap extracts of *Ficus benjamina* and *Artocarpus trecalianus Elm.* Two different samples of rodent traps were prepared. The samples were tested in an area infested by rats within 24 hours. The sample sap extracts in both the controlled and experimental groups were observed within the first 0 to 8 hours and within the remaining time (9 to 24 hours). This procedure was replicated five times in both groups. Descriptive statistics and t-Test were then used to analyze and compare the data. Based on the study, the non-chemical rodent trap, mainly the decocted sap extracts from *Ficus benjamina* and *Artocarpus treculianus Elm.* mixed with pure honey extract were found to be a capable alternative rodent trap.

Keywords *— Ficus benjamina, Artocarpus trecalianus Elm.*, Experimental Design, Non-Chemical Rodent Trap, Batanes, Philippines

INTRODUCTION

Pests are organisms that spread disease, cause destruction, or are otherwise a nuisance. This population of relatively few species usually lives in close association with humans. Variety of pests are found in food handling premises, industrial sites, and private homes as well as in human service locations such as schools and hospitals that can sometimes cause economic damage or become threats to the health of humans and other domestic animals (MacFarlane, Benke, Goddard, & Sim, 2007).

One of the most common pests is rodents. Rodents make up the largest group of mammals. They comprised of 2,277 species, which account for 41% of the known mammals in the world and are a very diverse group in both size and habitat. Rodents are found on every continent except Antarctica. They live in a wide range of different habitats from snow-covered tundra to hot deserts. There are also some species of rodents that are considered to be the common invaders of the human environment (Rickel, 2005).

Furthermore, rodents are also one of the most interesting groups of mammals. They are essential components of virtually all the earth's terrestrial ecosystems and are important herbivores that aerate the soil by burrowing activities. They also assist in plant propagation by consuming and disseminating seeds. Rodents are often the essential food base for most predatory mammals and birds. They act as a medium to sustain the population of these species. However, it is important to note that rodents are also considered to be essential vectors or reservoirs of numerous diseases that infect humans, domestic animals, and other wildlife species (Tobin & Fall, 2004). Of the 41%, as stated earlier, the number of rodent species causing problems that require management is small. Only about 5% of rodent species worldwide pose a significant risk to humans (Singleton et al., 2007). These species include commensal rodents that are found in human-made infrastructure, such as Norway rats (*Rattus norvegicus*), black rats (*R. rattus*), and house mice (*Mus musculus*) (Buckle & Smith, 2015). In the Philippines, the more commonly found rodents that are detrimental to humans are either the black rat or brown rat.

With this, rodent presence can have serious implications for public and veterinary health and can amplify pathogens from the environment and form diseases (Brown et al., 2008). Rodents are also seen as pests because of their gnawing habit. This can cause economic losses, of food, and lead to structural damages. These rodents can directly transmit disease through feces, urine, saliva, or indirectly transmitted diseases through ticks, mites, or fleas (Bonnefoy, Kampen, & Sweeney, 2008). Additionally, the World Health Organization (2000) recognizes 31 common food-borne human pathogens (e.g., listeriosis, cholera, diarrhea (E. coli), and dysentery), and rodents have been associated in the transmission of many of them. Diseases like salmonellosis have also been implicated with a rodent infestation. Other important food-borne diseases in which rodents are associated are the enteric diseases caused by a wide range of diarrhoeal diseases. Often times, the main route of transmission of these diseases among humans is the consumption of food which has been in contact with infected feces of pests, including rodents, or human hands, or with contaminated water and soil (Battersby, 2002).

Another rodent impact is the economic and human hardships associated with devastating rodent-borne diseases (Meerburg et al., 2009). Such diseases include leptospirosis, murine typhus, and scrub typhus. These can be treated if diagnoses early. According to the Philippines Integrated Disease Surveillance, as cited by Jacob et al. (2010), in many Asian and Pacific countries, diagnosis is quite often too late, and death rates are higher than higher-profile illnesses such as HIV-AIDS. One particular development is the linkage of an outbreak of rodent zoonoses with an unusual weather event. Manila, Philippines, experienced equivalent to their monthly rainfall in September in just 18 hours on 26 September 2009. This weather event has led to large quantities of stagnant water over a month that resulted in an outbreak of leptospirosis. In Manila alone, from October 1 to 25, there were more than 2000 human cases that led to 192 deaths due to leptospirosis.

Not only do rodents infestations cause serious problems to humans, but they also pose threats to agriculture. In Asia, rodents cause pre-harvest losses of 5–10% in rice crops (Singleton, 2003). However, in upland environments, occasional rodent infestations can lead to severe major crop losses and shortages (Aplin et al., 2006; Normile, 2010). Throughout history, there have been serious rodent outbreaks and infestations. One example is bamboo-masting in countries such as Bangladesh, India, Myanmar, and Lao PDR. This led to massive population rodent outbreaks causing severe famine (Schiller et al., 1999).

Therefore, rodents cause a variety of problems such as loss and contamination of foodstuffs, destruction of property, rat bites, gnawed electrical wiring resulting in fires, and transmission of a variety of diseases in different parts of the world especially in close association with people in dense settlements.

Because of the threats that rodent pests have on humans and the environment, there is a need to employ an effective method to control rodent infestations that are relatively easy, inexpensive, and effective under most conditions. According to Smith and Meyer (2015), the most obvious way to control and deal with a pest is to remove the pest, which usually means killing it. However, this kind of approach to pest control may not be the most useful or most economical in practice. Others counter pests by using chemical pesticides or rodenticides (Kudagamage & Nugaliyadde, 1995). This leads to several undesirable health consequences and serious environmental pollution, hence, causing toxicity to non-target organisms. Nearly two decades ago, Buckle (1994) reported that the use of rodenticides was the primary approach of rodent control in urban and agricultural environments. In Manhattan, it was recorded in 2012 that 60 to 80% of all forms of rodenticides and control products are being purchased (the United States Environmental Protection Agency, 2006). Households purchase about 40 to 50 million household-use containers of rodent baits each year (Kaukeinen, Spragins, & Hobson, 2000). The use of rodenticides to target mammals has raised concerns about their use in urban environments. These are also being purchased over the counter. With all the toxicants, it may cause accidental poisonings to dogs, cats, other wildlife, and humans (Stone, Okoniewski, & Stedelin, 2003).

Most of the time, it is challenging to control a pest ('target') using chemicals without causing collateral damage to other species ('non-target'). Non-target damage should, of course, be minimized.

In this regard, the objective of this study is to create a non-chemical and eco-friendly rodent trap that has the potential to lower the use of rodenticides and reduce the risk of human poisoning and other dangers in the environment. Sap extract from *Ficus benjamina* commonly known in the province of Batanes as "Vaditi" (Ivasayen), "Vadichi" (Isamurungen), or "Valiti" (Itbayaten) and sap from *Artocarpus treculianus Elm.* which is locally known as "Tipuho" (Ivasayen), "Chipuho" (Isamurungen), or "Atipuxo" (Itbayaten), were used as adhesive to make a rodent trap.

Ficus benjamina, also known as weeping fig, is a multipurpose tree found in various parts of Pakistan. *Ficus benjamina* is native to a large area, including India, Southern China, Southeast Asia, Malaysia, the Philippines, Northern Australia, and the islands of the South Pacific. It grows as a large evergreen shrub, up to 8 meters tall, with nearly 10 meters wide-spreading crown and drooping shoots with slender young twigs (Imran et al., 2014). According to Frohne and

Pfander (2005), the milky sap of *Ficus benjamina* species contains 'heart poisons' that are used as dart poisons in some cultures. It has also been reported to cause allergic and toxic reactions in livestock. Additionally, the sap from the plant contains furocoumarins, psoralens, and ficin. Frequent contact can cause itching of the eyes, cough, and wheezing; contact and exposure to sunlight can cause skin irritation with itching, redness, and stinging (Fern, 2014). This makes the sap extract from *Ficus benjamina* an excellent ingredient in creating a non-chemical rodent trap.

Artocarpus treculianus is a tree that is 15 meters or taller. The leaves are broadly elliptical or oval with an acute apex. Its leaves are dark green and light green below with midrib and veins prominent underneath. Its fruit is irregular in shape, around 7 to 12 cm in diameter, and orange to yellow when mature. The *Artocarpus treculianus Elm.* is endemic in the Philippines. It is usually found in Batanes Islands, Babuyan Islands, Northern and Southern Luzon, Palawan, Sibuyan Island, Samar, Leyte, and parts of Mindanao. In these places, the white sap coming from the tree is cooked and used as a trap for birds and other organisms (Madulid & Agoo, 2006).

The purpose of this research is to promote the use of a chemical-free rodent trap in regulating health hazards caused by both rodent pests and pesticides. There is a need to advocate for the accessibility and cost reduction of non-chemical rat traps, especially in impoverished urban communities, as well as restricting residential use of hazardous pesticides.

Additionally, the use of non-toxic alternatives such as plant-based traps requires a shift in intentions for people to accept that such options can be as effective and feasible as rodenticides or chemical-based traps. Non-chemical rodent control methods are needed, especially in risk communities, as there is an overuse of pesticides for rodent control (Kirsten & Maltitz, 2006).

Promoting an alternative non-chemical rodent control method decreases the double health burden caused by exposure to toxic pesticides and rodent-borne diseases (Roomaney, Ehrlich, & Rother, 2012).

MATERIALS AND METHODS

Research Design

The research design involved the utilization of experimental methods in addressing the research objectives. Generally, the experimental method is a scientific and systematic approach to research in which "experiments are carried out to explore the relationship between variables" (Nunan & David, 1992). It uncovers causal links as it seeks to discover the results when a set of variables are kept constant and manipulated. In contrast, the other set of variables are measured, calculated, and compared (DonYei, 2007).

Materials

The materials needed to collect the sap extracts from the trees include a sharp bolo to create an opening in the trunk and to induce the production of sap. Two vials for the sap extract from each tree were also used. Since the sap extracts can cause irritation or allergic reactions, surgical gloves were used.

A pan, stirring rod, measuring cup, and a spoon was utilized for the process of decoction. A decoction is an extraction process that requires that the plant material be boiled (Daswani, Ghadge, & Birdi, 2011). This process is done to dissolve the chemicals of the plant material, which may include stems, roots, and barks. The decocted sap from both trees was placed on two sheets of paper (8.5" x 11"). The spoon was used to spread the decocted sap on the sheets of paper evenly. The study also used 3-4 tablespoons of pure honey extract to compare the controlled group and the experimental group.

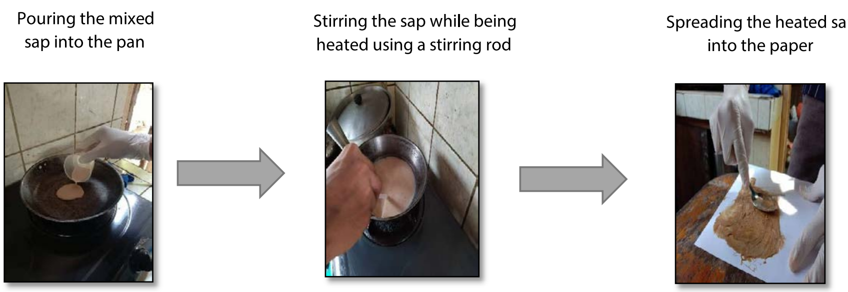
Procedure

Before conducting the procedure, the researchers asked for a permit (BPLS-PAMB PERMIT No. 20-01-021) from the Department of Environment and Natural Resources (DENR) in the province of Batanes to avoid any environmental violation. The sharp bolo was used to make a deep hole to extract sap from both trees. The researchers were able to collect 40 to 70 ml of sap extract from each of the trees. Sap extracts were then placed on separate vials. It took the researchers 25-35 minutes to collect and extract the saps of the trees.

Collecting Sap Extracts
from Tipuho and Vaditi

Tipuho and Vaditi Sap
Extracts

The first step to the process of decoction was to pour the extracted sap from each of the trees into a saucepan together with the honey extract. The mixture was stirred while being heated in low fire for no more than 6 minutes. It was then stirred continuously until the consistency of the mixture becomes thick and sticky. The decocted mixture was then placed on the two sheets of paper. It was spread evenly on the parts of the papers using a spoon. The sheets of paper with the decocted mixture were put together to prevent its exposure to air so that its sticky texture will be preserved.



Data Analysis

Before the researchers started with the observation, they prepared two different samples of rodent traps – controlled and experimental groups. The controlled group consists of the sap extracts from *Ficus benjamina* and *Artocarpus treculianus Elm.* while the experimental group consists of sap extracts from both trees mixed with the pure honey extract. The samples were placed and left for approximately 24 hours within an area in a farm infested by rats. Each of the samples in both groups was observed within the first 0 to 8 hours and then within the remaining time (9 to 24 hours). This procedure was replicated five times, both in the controlled and experimental groups. The researchers used descriptive statistics and t-Test, then Microsoft Excel Version 2016 application was used to analyze the data.

RESULTS AND DISCUSSION

Table 1. Comparison of the Controlled Group and Experimental Group

Time Duration	Trial 1		Trial 2		Trial 3		Trial 4		Trial 5	
	A	B	A	B	A	B	A	B	A	B
0-8 hours	0	1	1	3	1	2	0	3	1	1
9-24 hours	0	(1)+1	(1)+1	(3)+2	(1)+1	(2)+2	(0)+1	(3)+3	(1)+0	(1)+2
Total	0	2	2	5	2	4	1	6	1	3

**A – No. of Rat/s in the Controlled Group*
**B – No. of Rat/s in the Experimental Group*

Table 1 shows the number of rats trapped in the controlled and experimental group in each trial within the 24-hour observation. Within 0-8 hours, the controlled group did not catch any rat for trial 1 and 4 and one rat each for trial 2, 3 and 5. For the experimental group, one rat each was caught for trial 1 and 5, three rats each for trial 2 and 4, and 2 rats for trial 3. For the succeeding hours, no rat was caught for trial 1 and 5 and an additional of 1 rat each for trial 2, 3 and 4 under the control group. The experimental group, on the other hand, caught 1 rat for trial 1, 2 rats each for trial 2, 3 and 5, and 3 rats for trial 4.

Table 2. Total Number of Rats Caught in the Controlled and Experimental Group

Trial	Controlled Group	Experimental Group
1	0	2
2	2	5
3	2	4
4	1	6
5	1	3

Within the 24-hour observation, there was a total of six rats that were caught under the controlled group and 20 rats for the experimental group. An independent samples t-Test was conducted to compare the controlled group and the experimental group. Based on table 2, there was a significant difference between the controlled group (M = 1.20, SD = 0.84) and the experimental group

(M = 4.00, SD = 1.58), t (8) = -3.50, $p < 0.05$. These results suggest that the experimental group is a better rat trap.

The experimental group has a higher potential to trap rats due to the added content of the pure honey extract. Based on the observation, it is common knowledge that rats are attracted to sweet foods. Honey can be one of the most effective baits to catch rats and mice. Aside from the sweet taste of the honey, honey extract mixed with the sap extracts from *Ficus benjamina* and *Artocarpus treculianus Elm.* makes the trap sticky.

According to Shin et al. (2019), what makes honey extract become an adhesive is the bee's salivary secretions. It coats the pollen grains and allows them to stick better. The bees produce the sugary secretions from the nectar they drink from the flowers. This is the main ingredient in honey. Another component in honey is a plant-based oil that coats the pollen grains called *pollenkitt*. This helps stabilize the adhesive properties of the nectar and protect it from the impact of too much or sometimes too little humidity.

These components in honey make the experimental group more effective. The sweet aroma of honey makes rats attracted to it but would not be able to devour honey. When rats are engrossed, the honey's waxy texture combined with the trees' sticky sap extracts makes rats unaware of being trapped.

This is similar to the method employed by Cowan & Brown (2015). According to them, one of the advantages of using adhesive traps is that they are non-toxic and non-contaminating. Additionally, they hold the carcass in one place and require no license for their use and are inexpensive.

Furthermore, rodent infestation is considered as one of the health hazards both to humans and other livestock. Because of this, numerous methods have already been adopted, such as the use of chemical traps, rodenticides, or repellents. However, there are limitations to these methods, and that is chemical toxicities. This is as well supported by the study conducted by Kalandakanond-Thongsong et al. (2010), stating that the significant factors that limit the usage of chemical pesticides are possibly handling hazards and food contamination. Therefore, due to possible chemical toxicity, using natural plant extracts may be a better and more promising alternative rodent trap (Gabr, 2005).

CONCLUSIONS

The non-chemical rodent trap, mainly the decocted sap extracts from *Ficus benjamina* and *Artocarpus treculianus Elm.* mixed with pure honey extract was found to be a capable and effective alternative rodent trap.

TRANSLATIONAL RESEARCH

Since rodent infestations will continue to pose severe challenges to landowners, community producers, and homeowners, this research can be used to provide public education and awareness on the effects of rodenticides and other chemical rodent traps about their toxicity content and how they affect humans and the environment. With this, workshops can be offered to the public, especially to rodent control industries, to consider a serious alternative to chemical rodent control. This research can also be given more attention by concerned organizations such as the Department of Health to foster new technologies that will help not only modernize the pest control industry but can also present a better means of toxic free pest control. Furthermore, continued technology development can also be considered to improve the effectiveness and safety of pest controls and create alternative methods to eradicate rodents, particularly those that cause damage.

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