

# ***Fear No More Household Enemies***

***Is *Eucalyptus citriodora* an effective insect repellent?***

Team 31

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## Abstract

When we were searching for possible topics for this project, we found *Eucalyptus citriodora*, Lemon-scented gum, so interesting that it has a special smell of lemon, and it was claimed to be effective in repelling insects.

After searching for information and field investigation, we confirmed a population of *Eucalyptus citriodora*, I Nam Sang Wai, Yuen Long.

After we have collected the samples, we examined the effectiveness of *Eucalyptus citriodora* in repelling different pests, such as silverfish, cockroach and ant, which can be commonly found in domestic residences.

At last, we suggested the use of *Eucalyptus citriodora* extract for anti-pest spray in household, libraries and book stores, which is more environmental friendly in order to conserve the environment.

### ➤ ***Eucalyptus citriodora* Facts**

*Eucalyptus citriodora* is a tall tree whose height can grow up to 51 metres. It is also known as lemon-scented gum, blue spotted gum and lemon eucalyptus. It has smooth, pale, uniform or slightly mottled bark. Its conspicuously narrow-leaved crown smells strongly of lemons and its pear-shaped fruit is formed in the corner of leaf and stem junctions.

This plant can produce a colourless to pale-yellow essential oil from the twigs and leaves of the plant. It can be used to produce nontoxic and low-cost soap perfumes, soap flakes, detergents, sprays, etc.



## **Reason for investigation**

We discovered *Eucalyptus citriodora* from books about trees in Hong Kong. We were interested in the strong lemon odour produced by the plant. Then, we did further searching on the lemon odour produced by *Eucalyptus citriodora*.

It was stated in some websites that the lemon odour from *Eucalyptus citriodora* could act as an insect repellent, particularly mosquitoes. Therefore, we wish to have an in-depth investigation on this odour's effect on species which we can find in our neighbourhood and find out whether it can relieve people from annoying pests.

## **Objective**

This investigation is to find out whether the extract from *Eucalyptus citriodora*'s leaves and fruit possess pest-repellent activity against various types of pests.

## Materials and method

### a. Outline of investigation process

20/1/2012	Field trip 1
25/2/2012	Field trip 2
29/2/2012	Experiment 1
2/3/1012	Experiment 2
7/3/2012	Experiment 3
9/3/2012	Experiment 4
10/3/2012	Field trip 3
14/3/2012	Experiment 5
16/3/2012	Experiment 6

### b. Field trips

	Field trip 1	Field trip 2	Field trip 3
Date	20/1/2012	25/2/2012	10/3/2012
Time	9:00am - 11:30am	9:00am -11:15am	9:00am -10:00am
Venue	Nam Sang Wai, Yuen Long		
Temperature	16.4°C -19.2°C	16.0°C	12.5°C -15.4°C
Weather	Sunny, Windy	Cloudy	Cloudy
Humidity	78%-94%	96%	71%-87%
Objective	Investigation of species Collection of samples <ul style="list-style-type: none"><li>• Fresh and fallen leaves</li><li>• Fresh and fallen fruit</li></ul>	Collection of samples <ul style="list-style-type: none"><li>• Fresh and fallen leaves</li></ul>	Collection of samples <ul style="list-style-type: none"><li>• Fresh leaves</li><li>• Fresh fruit</li></ul>

### c. Equipment

Field trips	Forceps x2 Plastic bags x5
Experiments	Forceps X2 Plastic boxes (without covers) X 3 Pestle and Mortar X 4 Electronic balance X 1 Glass bottle X8 Spatula X1 Dropper X2 Shovel ( for digging out earthworms) X1 Fruit (1.00g per experiment)

Leaves (0.536g per experiment)
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#### d. Experiments

##### ● Preliminary experiments

- i. Pieces of leaves  
0.536 g of fresh leaves was used for this experiment. We put the leaves on the side of the box and find out whether the organisms walked on them. If the organism walks on the leaves, there is no repulsion effect on that organism. If the organism walks away from the leaves, effect on that organism may exist.



Fig. 4.1 Experiment set up for pieces of leaves

- ii. Cut leaves  
0.536 g of cut fresh leaves was used for this experiment. We put the cut leaves on the side of the box and find out whether the organisms walked on them. Observe whether the organism passes through the cut leaves.



Fig. 4.2 Experiment set up for cut leaves

- iii. Ground leaves  
0.536 g of ground fresh leaves was used for this experiment. We put the ground leaves in circle with a diameter of 4.5 cm. Then, we put the organisms inside the circle. Observe whether the organism left the grinded leaf circle.



Fig. 4.3 Experiment set up for ground leaves arranged in a ring at the centre



- iv. Ground fruit  
1.00 g of ground fruit was used for the experiment. We put the fruit around a corner. Then, we put the organism in the corner. Observe whether the organism left the corner surrounded with the ground fruit.



Fig. 4.4 Experiment set up for ground fruit arranged around the corner

Procedures:

1. Container washed and dried
2. The following samples were prepared in bulk:
  - Pieces of leaves
  - Cut leaves 0.536g
  - Ground leaves 0.536g
  - Ground fruit 1.00g
3. The samples were put in different arrangements in the container, one at a time:
4. one at a time:
  - At the side
  - Ring around the centre
  - Around a corner
5. The following organisms were put into the container, one at a time without touching the sample.

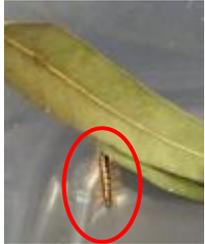
Phylum	Organism
Annelida	Earthworm 
	Millipede 
Mollusca	Slug 
	Snail 
Arthropoda	Ant 
	Cockroach 



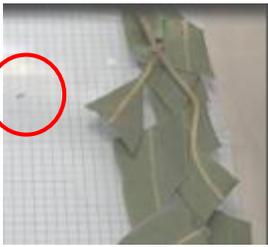
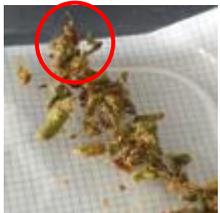
	Silverfish		
	Spider		

6. Movement of the organisms were observed.

## Results

	Pieces of leaves	Cut leaves	Ground leaves	Ground fruit
Earthworm	☆ • Touched the extract with its mouth	☆ • Touched the extract with its mouth • Stuck some of the extract on its body	-- Died before experiment	✗
Millipede	✗ 	✗ 	✗ 	✗ 
Slug	✗ 	✗ 	☆ • Touched the extract with its mouth 	✗ 
Snail	☆ ● Climbed on the leaves after a while.	☆ • avoid the leaves at first • Started to investigate the leaves and pick up some leaves afterwards	-- Died before the experiment	-- Died before the experiment



Ant	x	x 	x 	x
Cockroach	-- • died during the experiment	-- • died during the experiment	x 	✓ • Ran to the opposite side of the box when its palps touch the extract 
Silverfish	x 	✓ • Moved away when it sense the extract 	✓ • Wanted to escape when it sense the extract 	✓ 
Spider	x	x	x	x 

Key:

✓	Have effect (organism turned away from the extract soon after they sensed it)
x	No effect (organism were able to touch or walk on the extract)
☆	Show interest to extract (organism grabbed the extract)
--	No data

## Further experiments

### a. Silverfish

Due to the effects of the extracts of leaves and fruit on silverfishes in the preliminary experiments, we decided to carry out some special experiments for silverfishes to prove the effectiveness of the extracts on silverfishes. They might have turned away from the sample because of the presence of obstacles, some other attraction and so on.

In the pre-experiment observation, we found that the silverfish preferred to stay in the gap at the side of the container. As a result, we tried to put ground leaves and fruit in the gap in order to observe the movement of silverfish, and found out whether the silverfish would still prefer staying in the gap. The duration for all the experiments was 5 minutes. Sand was put in another set up as control.

#### i. Ground leaves



Fig. 5.1 Experiment set up of ground leaves

Procedures:

1. A container was washed and dried
2. Leaves were ground with pestle and mortar
3. Mass of ground sample was measured
4. Resulting mixture was placed in the gaps at the sides as shown in fig. 5.1
5. Organisms were put in the middle of the container at a time
6. Movement of the organism was observed

- ii. Ground fruit with water  
Fruit : water = 1:3 w/w

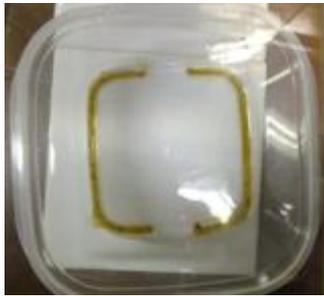


Fig. 5.2 Experiment set up of ground fruit with water

- iii. Ground fruit with hexane  
Fruit : hexane ( $C_6H_{14}$ ) = 1:3 w/w



Fig. 5.3 Experiment set up of ground fruit with hexane

Procedures:

1. A container was washed and dried
2. Fruit was ground with pestle and mortar
3. Mass of ground sample was measured
4. Ground sample was mixed with water/hexane by using dropper
5. The mixture was placed in the gaps at the sides as shown in fig. 5.2 and 5.3  
Organism was put in the middle of the container at a time
6. Movement of the organism was observed

● Results for further experiments for silverfish

- i. Ground leaves

At first, the silverfish was placed in the midst of the container. At 15", the silverfish in the control experiment (Sand set up experiment) moved to the gap as its usual behavior, whereas it did not move. At 2'35", the silverfish in the ground leaves set up moved. The silverfish moved to the gap and onto the ground leaves for a few times as fig. 5.4 has shown. At the end of the experiment, the silver fish in the control experiment stayed in the sand, whereas another silverfish stayed on the edge of the box which did not have *Eucalyptus citriodora*.

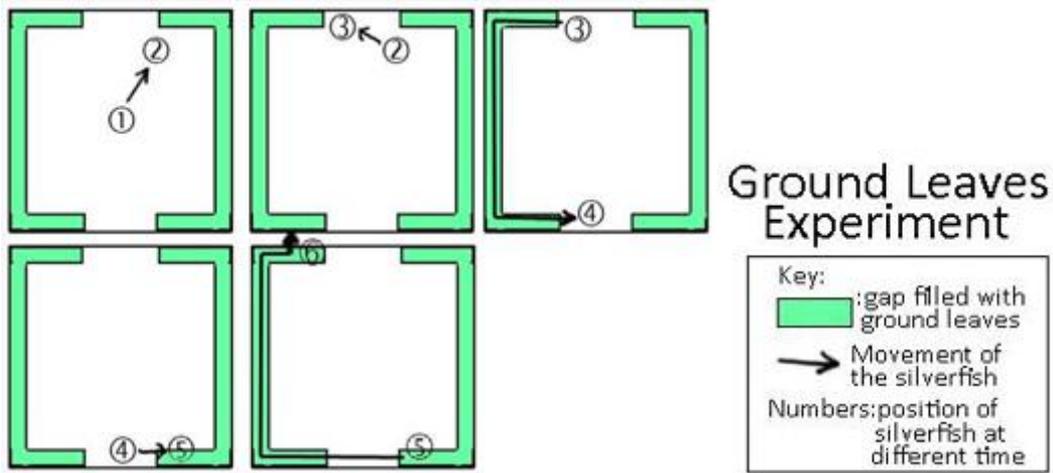


Fig. 5.4 The movement of silverfish throughout the experiment with ground leaves

ii. Ground fruit with water

At the beginning the silver fish was placed in the midst of the container. It moved at once and started to move to the gap as its usual behavior. During the experiment, it had tried to move to the gap of the sides of the container for 5 times (Figure 5.5, points 2,3,5,6,7) . However, once it reached the gap, it turned back immediately. At last, the silverfish stayed out of the gaps and faced the midst.

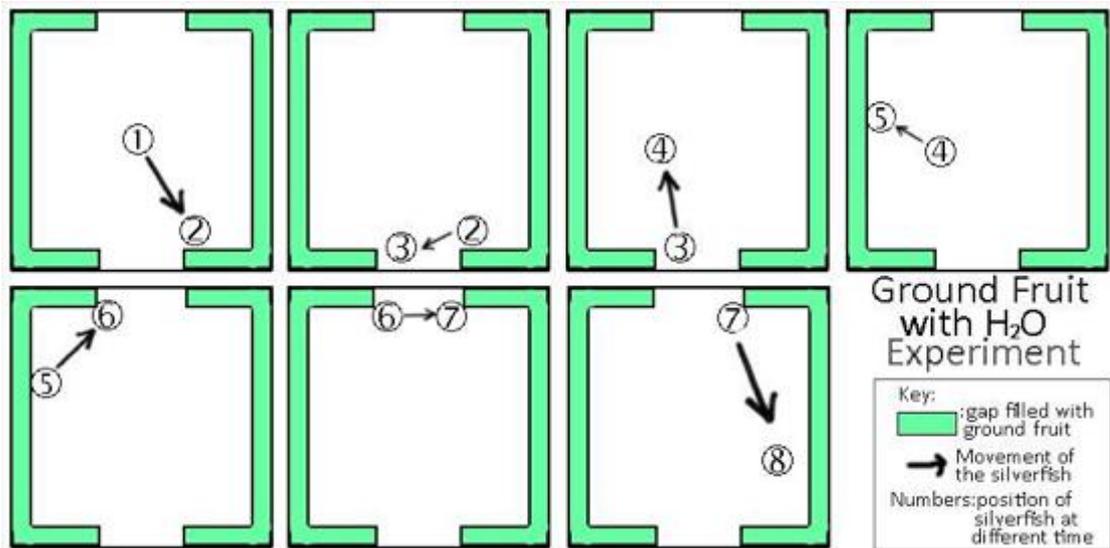


Fig. 5.5 The movement of silverfish throughout the experiment with ground fruit with water

iii. Ground fruit with hexane

There is no effect on the silverfish by the mixture of hexane and fruit. For the first 2 minutes, the silverfish did not move at all. It moved until we tried to use forceps to touch it. However, it finally stayed in the gap of the container.

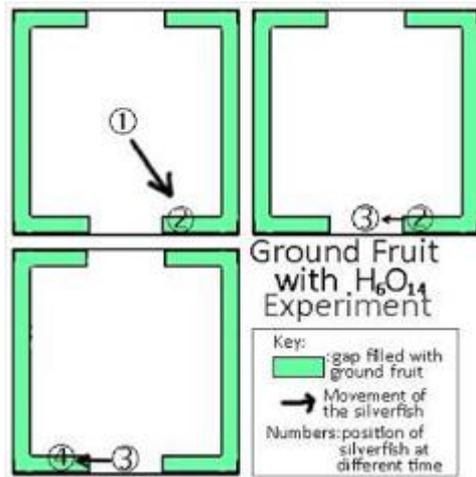


Fig. 5.6 The movement of silverfish throughout the experiment with ground fruit with hexane

## b. Cockroach

As cockroach also showed that it can be repelled by the ground fruit extract in the preliminary experiment, we also did further experiments for cockroach to prove the effectiveness of *Eucalyptus citriodora* in repelling cockroaches.

In the pre-experiment observation, we found that the cockroach preferred to crawl to the top of the upper container. As a result, we tried to put dried ground leaves and fruit extract in the gap of the upper container in order to observe the movement of cockroach, and found out whether the cockroach would still prefer staying in the gap. Dried water was put in another setup as control.

### i. Ground fruit with water

Fruit : water = 1:3



Fig. 5.7 Experiment set up of ground fruit with water (bird-eye view and side view)

### Procedures:

1. Two containers were washed and dried.
2. Fruit was ground with pestle and mortar.
3. Mass of ground sample was measured.
4. Ground sample was mixed with water by using dropper.
5. Resulting mixture was placed in the gaps at the sides of a container as fig. 5.7 has shown. Another container is empty.

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6. Organism was put in the lower container at a time. The upper container is the container with the extract. The two containers were combined with their openings facing each other.
  7. Movement of the organism was observed

- Results for further experiments for cockroach

- i. Ground fruit with water

The cockroach initially started to climb to the top of the box. But when it detect the extract, it stopped its action and stayed in its position. After a period of time, we reversed the set up. The container with the extract became the lower container. The cockroach moved again towards the top of the upper container.



## Analysis

From the experiment, we find out that the extract of *Eucalyptus citriodora* showed some repellent effect on silverfishes and cockroaches, especially silverfishes, but not spiders, millipedes, ants, slugs, snails and earthworms.

Silverfishes, *Lepisma saccharina*, are wingless insects with a silvery light grey and blue body. They inhabit moist areas and can be found in bathrooms, closets and attics. They consume matter that contains polysaccharides such as books, glue, paper, photos, clothing, sugar and hair. They and cockroaches both are considered as household pests.

Therefore, we think that ground leaves and fruits of *Eucalyptus citriodora* is good to use at home to repel silverfishes and cockroaches, which are common household pests in Hong Kong and are undesirable by most people. By putting those extracts of *Eucalyptus citriodora* at home, it would be effective in preventing those pests appear and damage things at people's homes.

It is a natural insect repellent which is cheap, easy to produce and environmentally friendly. However, there are possible drawbacks as not everyone likes the smell and it may stain paper and books when we use it to repel silverfishes.



## Discussion

### a. Limitations and sources of error

#### i. Temperature and weather

Experiments were done on different dates in 3 weeks. As the temperature and weather varies in the project period, experiment may not be done at the same temperature which maybe possible source of error. Thus, our experiments were conducted at room temperature so that the temperature did not fluctuate as much.

#### ii. Freshness of leaves and fruit

There were only two field trips for collecting leaf and fruit samples for experiment but our experiments lasted for three weeks. Thus, there may be differences in freshness of leaves. Moreover due to law, we could only pick up leaves from the ground instead of directly from the trees. It was difficult to determine the freshness of the leaves.

#### iii. Period of time for project

The season and the weather of the period of time for the project may not be suitable for organisms' activities. We proposed to do the experiment for mosquitoes but it was difficult for us to catch one for experiment as they are mainly active in summer. It was also difficult for us to collect a large number of the organisms.

#### iv. Experiment organisms

The organisms for experiment were randomly collected on the school campus and at our homes. Therefore, it was difficult to identify the exact species and sex of the animals collected. Moreover, some of them died during the experiment due to accidents or other factors and some were too small to be observed. Therefore, some experiments of some organisms cannot be completed. In addition, since cockroaches can fly, closed container was used in its experiments that may alter experiment process and results by introducing another variable.

#### v. Experiment extracts

There were different sizes of leaves we used for the experiment which were whole pieces of leaves, cut leaves and ground leaves. Although we tried to arrange the leaves extract in the same way, the pieces of leaves and cut leaves could not be arranged into a ring in the middle just like the ground leaf extract. That may affect the movement of the organisms.

vi. Volatility of Hexane( $C_6H_{14}$ )

Hexane is highly volatile as it has low carbon content. During the experiment of the mixture of ground fruit and hexane, some of the hexane evaporated and the mass of hexane may become smaller and the result may be less accurate.

b. **Suggestions for improvement**

- i. Experiment dates can be arranged within a week to shorten the divergence of temperature, weather and freshness of leaves and fruit for experiments.
- ii. Closed containers can be used for all the experiments to keep controlled variables constant for all experiment organisms and lower chance for hexane to evaporate.

c. **Further investigation**

- i. In the experiment, we can only show the effect of the lemon odour on animals' movement. Therefore, we would like to have a further investigation on the leaves so as to find out which chemical or organelle produced the odour and the mechanism of repelling insects.
- ii. *Eucalyptus citriodora* is present in different places in Hong Kong such as Chinese University of Hong Kong and Tai Lam Kap Lung Forest Trail. We would like to investigate the difference in effect of repelling insects of *Eucalyptus citriodora* in different parts of Hong Kong, where soil conditions and local community may be different.
- iii. We would like to use the commercial essence of *Eucalyptus citriodora* to repeat the experiments. This may yield a more obvious result as the essence may have stronger odour and may be a better insect repellent. However, commercial essence is not natural.



## Summary

From our investigation, it is proved that the effect of extract from *Eucalyptus citriodora*'s leaves and fruit to different organisms is different. It may not be effective to some insects like ants despite the fact that the websites claimed it is an insect repellent. Nevertheless, it is effective in repelling some household pests such as silverfishes and cockroaches.

We also find out that the effect of the extract of *Eucalyptus citriodora*'s fruit is better than that of leaves. We suggest that it can be further processed to become natural pest-repellent.

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