

Final Report
*Investigating the management of
insects by using nanogels*
Group 01-32 (A.K.A Project Nano)

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Abstract

In this project, we investigated the management of insects using a citronella-infused nanogel by comparing its effectiveness with other other treatment groups (pure citronella oil and citronella oil dissolved in ethanol) and negative controls such as water. To attract the insects to the set-up box, equal masses of ripened bananas were placed in each box before they were left outside in the school garden for data collection over five days. This report includes the procedures in making the nanogel and the results of our field trials. The experiments were carried out three times to ensure the reproducibility of the results. The study found that the set-up with the citronella-infused nanogel had the least number of flies trapped, hence it was most effective at warding off insects and its management.

Introduction

2.1 Literature review

2.1.1 Bug problems

Since the dawn of human civilization, bugs have always been a source of annoyance to us. Nowadays it is even worse. Dengue and other diseases are known to be carried by pests, and the insects have ruined crops more times than humanity can count, hence, we have devised many ways to eradicate or ward them off, but to no avail until now...

2.1.2 Pesticides

We have decided to do this project because pesticides are not eco-friendly and can cause cancer to consumers of the plants and can also cause water pollution. Thus, we want to make a substitute for it.

2.1.3 Natural insect repellents

Natural insect-repellents can be extracted from plants and are environmentally friendly . It is a considerable substitute for pesticides.

2.1.4 Citronella

We chose to use citronella because it has a strong grassy scent that can ward off insects. Its oil extracted from it has citral and citronella in it which is also used as a plant-based insect repellent that has been used since ancient times (especially mosquitoes), and is still used to this very day

2.1.5 Nanogel

It is used to let the scent of the citronella release slowly instead of all at once. It is also-eco friendly as it is biodegradable.

2.2 Scope

The scope of this study is limited to the effects of citronella and nanogel against pests. The paper will only cover materials and methods used in the creation of nanogel. The study hopes that it can raise awareness of the dangers of pesticides and would also like to highlight the advantages of natural insect-repellents for the future.

2.3 Purpose & objectives

We wish to make a nanogel to manage fruit pests that can be an alternative to pesticides. This is because nanogel has high biocompatibility and drug loading capacity as well as biodegradability (low cytotoxicity). It also has good permeation capacities.

2.4 Hypothesis

Citronella extract entrapped in a nanogel is more effective in repelling insects than pure citronella extract.

Materials and methods

3.1 Materials and equipments

The materials and equipment required for making the nanogel and the field trials are listed in Table 1 below.

Table 1

Materials	Equipment
triethanolamine	Chopstick holder(makeshift box)
6 week-old bananas	Petri dishes
Citronella extract	Beakers
Ethanol	Knife(for cutting banana)
Nanogel infused with citronella extract	Weighing scale
Carbopol-940	Sonicator
Sticky yellow paper	Magnetic stirrer
Water	Homogenizer
Propylene glycol	Ultrasonic bath sonicator

3.2 Methods of extraction

3.2.1 Citronella

A 30ml of commercially-produced citronella oil was used.

3.2.2 Preparing the set-ups



Fig.1 Weighing the bananas for the set-ups of the third field trial

Preparing the set-ups for the three field trials are pretty general throughout. Putting in some yellow sticky paper on the bottom of each chopstick box after cutting the paper to a suitable size, then putting in 30g of rotting banana into the box (from the second field trial onwards, we put the banana in a petri dish first), then, we filled a petri dish full of liquid/nanogel, which will generally be 3ml/g. We then covered the box with the box's cover, which has holes in it, put the chopstick box into a cardboard box cover for the first field trial to maintain stability, but then used a metal tray for the next 2 field trials.

3.2.3 Preparation of the nanogel



Fig. 2 Homogenizing the organic phase

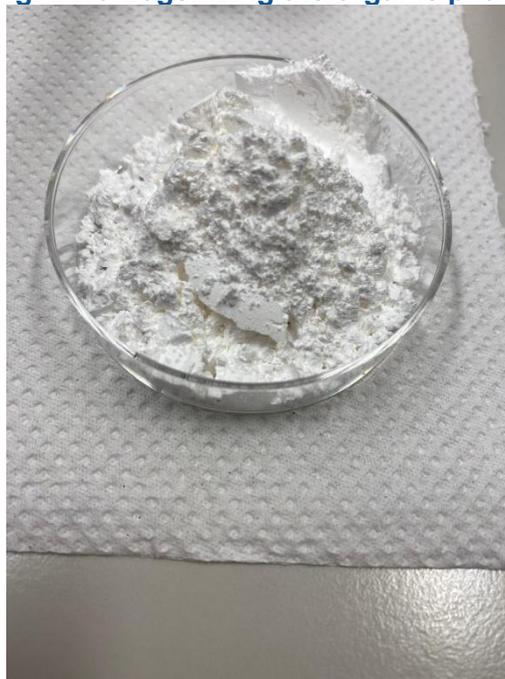


Fig. 3 6g of Carbopol-940



Fig. 4 Ultrasonic bath sonicator

1. Dissolve 6g of Carbopol -940 (Fig. 2) in 250 ml of deionised water. Stir continuously.
2. Heat the mixture for 20 min in a magnetic stirrer and sonicate the mixture in an ultrasonic bath Sonicator for 10 min to make an organic phase.
3. Dissolve 3 ml of citronella extract in 15 ml of 95% ethanol and 15 ml of propylene glycol. Stir to mix.

4. Add the mixture from step 3 drop by drop into the mixture in step 2 during high speed homogenization (Fig. 1) for 30 min at 2000 rpm to form an emulsion. The emulsion, converted into nanodroplets by the homogenizer, results in an oil-in-water (o/w) emulsion.

5. The o/w emulsion is then homogenized for 15 min at 2000 rpm and 5 ml of triethanolamine is added dropwise with continuous stirring to form the nanogel.

Results and discussion

4.1 Raw data

Table 2

Treatment	Number of insects trapped on the yellow sticky tape			
	First trial	Second trial	Third trial	Average
Ethanol	2	4	0	2
Water	7	14	12	11
Citronella dissolved in ethanol	2	2	0	1.3
Pure citronella oil	3	2	0	1.6
Citronella nanogels	0	3	1	1.3

4.2 Discussion

According to the results shown in Table 2, the use of citronella nanogels were as effective as using citronella oil dissolved in ethanol. The nanogel was effective at warding off insects due to its slow-release properties of the citronella oil.

4.3 Sources of error and weaknesses

For the first field trial, the citronella oil set up, for some reason, had more flies than ethanol.

4.4 Field trial log

-4.4.1 Summary

Our project has gone exactly the way we have expected it to go. We have extracted the results of every set-up in the 3 field trials, and we have come up with a suitable conclusion for our experiment.

-4.4.2 First field trials



Fig.5 The unsuccessful first field trials for citronella oil

Our field trials began at 26 July, when we first put together the set-ups, which comprised of chopstick holders that James bought in Daiso, yellow sticky tape and citronella oil that was bought from Amazon by our mentor, the rotting bananas, and ethanol, petri dishes, and other apparatus from the biology research lab, the four set ups

comprised of 3ml of citronella oil, 3ml of water, 3ml of ethanol and 3ml of a mixture of citronella oil and ethanol. We put them outside with the protection of a cardboard box cover so as to prevent the box from shaking , getting snatched away by monkeys or being eaten by bats. The first set up wasn't much of a success, as when we checked our set-ups on 30 July, there weren't many flies in any of the boxes. For your information, in the first trial, there were 3 flies in the dish with ethanol, 4 for that of citronella, 2 for citronella and ethanol and approximately 7 for water. Hence, we decided to do the first trial again for the sake of ensuring consistency, and we didn't really trust the first results.

-4.4.3 Second field trials



Fig.6 The more successful second trials for citronella oil

The second trial began on the day we checked the boxes, 30 July, and when we checked the boxes again on the 2nd of August, we received results that were more like it. This time, there were 2 flies in the set up with citronella, 4 for pure ethanol, 2 for citronella and ethanol, and 13 for water,

this proves that citronella can repel insects (flies, in this case), and we decided to go with the nanogel making process.

-4.4.4 Final (nanogel) trials



Fig.7 One of the three citronella nanogel set-ups

We have finished our final field trials including set-ups with nanogels, which are 3 set ups of 10g of citronella nanogel each, as well as 10ml of regular water as control. The results are that the nanogel had a total of 1 fly on average, while there were 12 flies in the set up with water, hence, proving that the citronella nanogel is even more efficient in warding off flies, and lasts longer as the nanogel has yet to be fully sublimed, but the pure citronella oil has totally evaporated in a much shorter time.

5 Application

5.1 Future application and research

In the future, studies can further test if nanogels can also make other natural insect-repellent scents' release

slower, such as lemongrass, and successfully create an eco-friendly and cheap alternative to pesticides for all, which was the main aim of our project in the first place.

6 Conclusion

The study found that citronella infused with nanogel is effective at warding off fruit flies. Future studies can show whether nanogel infused with other natural insect-repellents are also effective.

7 References

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