

Application of Kaffir Lime (*Citrus hystrix*) Leaf Powder in Aromatic Candles to Repel *Musca domestica*

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ABSTRACT

The housefly (*Musca domestica*) is a vector that can spread diseases such as cholera, diarrhea, and dysentery by carrying various pathogenic bacteria. As a result, plant-based natural insecticides must be used in control operations. Citronellal, a compound found in the leaves of kaffir limes (*Citrus hystrix*), can repel a variety of insects and keep them away even after baiting. The goal of this study was to evaluate the efficacy of kaffir lime (*Citrus hystrix*) leaf powder in fragrant candle preparations as a natural repellent against house flies (*Musca domestica*). Twenty houseflies were used in each of the three treatments and two controls in this quasi-experimental study, which had five replications and a post-test-only controlled group design. For 60 minutes, the number of flies that landed on the shrimp shell bait was counted in order to make observations. A one-way ANOVA was then used to examine the data. The average number of flies repelled per dose, according to the results, was 10 at 4 grams (4 individuals), 20 at 20 grams (9 individuals), and 30 at 30 grams (14 individuals). The number of houseflies that landed on the bait was significantly impacted by the application of kaffir lime leaf aromatic candles, according to ANOVA results ($P < 0.05$). The number of flies landing between the 10-gram dose and the 20- and 30-gram doses differed significantly, according to the results of the LSD test. With a dosage of 22.667 grams, Kaffir lime leaf aromatic candles effectively repel 50% of the houseflies. A possible substitute for fly control is kaffir lime leaves, which can be used to make aromatic candles placed in areas flies frequently visit, such as dining tables.

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Introduction:

Vectors that are important in the spread of disease to humans must be considered to maintain a healthy environment. Flies are one type of insect that spreads illness. Supporting variables like humidity, temperature, and food sources affect their presence. As a result, the presence of flies can be used to determine the level of sanitation in a particular area [1].

Flies act as intermediate vectors in disease transmission due to their ability to carry pathogens on their bodies. They have fine hairs all over their bodies that serve as surfaces for pathogens such as bacteria and viruses to stick to. Flies frequently land on animal carcasses, trash, and excrement environments that are easily contaminated by pathogens. These pathogens can be spread by flies that subsequently land on unprotected food or food surfaces. Foodborne illnesses, including diarrhea, can therefore result from eating food contaminated by airborne bacteria [2].

The housefly (*Musca domestica*) is known as a mechanical vector for various diseases hazardous to human health such as cholera, typhoid, diarrhea, and dysentery by carrying

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bacteria commonly found in the human digestive tract, including *Salmonella*, *Shigella*, *Escherichia coli*, and *Staphylococcus* [3]. Therefore, to meet established standards for healthy environmental quality and health, control measures against these flies must be implemented. As a result, the risk of fly-borne disease transmission can be considerably decreased.

Repelling the vectors themselves is one method of controlling flies. Sticky traps and air fresheners are common public methods often considered ineffective at controlling flies. Consequently, different formulations are required to control these fly vectors [4].

The bioactive content of kaffir lime (*Citrus hystrix*) leaves, including flavonoids, saponins, tannins, alkaloids, and essential oils, makes it a plant with potential as an insect repellent [5]. One of the main constituents of kaffir lime leaf essential oil is citronellal, which has been shown in prior studies to be an effective insect repellent against *S. oryzae* insects [6]. Citronellal is thought to have a repellent effect because it acts as an antifeedant, suppressing the insects' appetite. As a result, even in the

presence of bait, insects are hesitant to approach the area surrounding the citronellal-containing substance [7].

American cockroaches (*Periplaneta americana*) can be effectively repelled by kaffir lime leaf powder. Citronellal, a substance with insect-repelling qualities, is thought to be responsible for its efficacy [8]. Aromatic candles offer an additional practical option for controlling houseflies, alongside sticky traps and spray air fresheners. Candles were once used only for lighting, but today they can also be used for other purposes, such as aromatherapy. The fragrance aromatic candles emit comes from plant-based essential oils that can repel insects. They are also known to repel flies [4]. When these candles burn, essential oil compounds are released into the air as microdroplets, which enter insects' respiratory systems and interfere with their sensory and nervous systems. As a result, even in the presence of bait, the insects swiftly flee and avoid the area [7].

The general public can use aromatic candles as fly repellents because they are environmentally friendly and suitable for use in public areas, especially dining establishments. Restaurants often attract flies seeking food and shelter, as they typically contain abundant food sources—ranging from meals served to patrons to organic waste generated during food preparation. Flies are attracted to the establishment's humid atmosphere and the smell of available food. As a result, using aromatic candles in restaurants to deter these fly vectors is highly recommended [9]. The purpose of this study is to ascertain how well different amounts of kaffir lime (*Citrus hystrix*) leaves added to fragrant candles work as a natural insect repellent against house flies (*Musca domestica*).

Material and Methods

In order to assess the impact of the treatment by comparing the two groups, this study uses an experimental design, specifically a *Post-test Only Controlled Group Design*, in which participants are randomly assigned to either an experimental group or a control group. The study focuses on the ability of fragrant candles made from kaffir lime (*Citrus hystrix*) leaves to repel houseflies. The houseflies (*Musca domestica*) used in the study were obtained through laboratory breeding, which entails putting fresh shrimp and wet rice—which serve as an egg-laying medium—into a cage with houseflies that were previously caught at the Lambaro Market waste collection point in Aceh Besar. The adult houseflies used in the samples range in age from two to five days.

The control and experimental groups undergo repeated trials in order to obtain more precise data about the treatment's impact; the number of repetitions that result is as follows:

$$\begin{aligned}(t-1)(r-1) &\geq 15 \\ (5-1)(r-1) &\geq 15 \\ 4r - 4 &\geq 15 \\ 4r &\geq 19 \\ r &\geq 4,75\end{aligned}$$

Description:

t = treatment (number of treatments)
r = replication (number of replicates)
15 = general degrees of freedom

Five replicates were needed for every test, according to the calculations. A total of 500 houseflies were needed as the sample size, with 20 flies per treatment group. In terms of the dosage of kaffir lime leaf powder in the aromatic candle formulation—using variations of 10, 20, and 30 grams—60 grams were needed for a single treatment run, meaning that 300 grams were needed overall for the five replicates.

Table 1. Test Wax Formulation

Wax Code	Parafin Wax	Kaffir lime (<i>Citrus hystrix</i>) leaf powder
A1	100 grams	10 grams
A2	100 grams	20 grams
A3	100 grams	30 grams
Negative control	100 grams	0 gram
Positive control	Household candle (white candle)	

The methodical process of condensing and presenting data as information, known as data analysis, entails applying statistical methods to investigate patterns and relationships within the data. Following the collection of data on the quantity of fly landings, data processing and analysis are carried out.

The following formula is used to determine how well aromatic candles made from kaffir lime (*Citrus hystrix*) leaves repel house flies (*Musca domestica*) based on how many flies land on the bait.

$$\text{Repellence (\%)} = \frac{\sum \text{early flies} - \sum \text{flies that land on bait}}{\sum \text{early flies}} \times 100\%$$

The level of repellency can be determined using a scale:[10] : Strong : 80% - 100%, Moderate 60% - 79%, Weak 40% - 59% and no effect : 0% - 39%

An LSD (*Least Significant Difference*) test was used to find differences between different dosages of kaffir lime leaf powder in the aromatic candle formulation after data analysis using a *one-way ANOVA* to determine the effect of kaffir lime leaf aromatic candles on the number of houseflies repelled. The effective dose of the aromatic candle for keeping houseflies away was then determined using a probit regression analysis.

Result:

The number of flies repelled and the percentage of housefly mortality at various dose of Kaffir Lime Leaf Aromatic Candles for each hour of treatment can be seen in Table 1.

Table 2. Mean Number of Houseflies Repelled After Exposure to Kaffir Lime Leaf Aromatic Candles

Powder Dosage	Number of Flies	Number of Flies Landing and Repelling Over 60 Minutes										Average Number of Repelled Flies
		P1		P2		P3		P4		P5		
		L	R	L	R	L	R	L	R	L	R	
K (-)	20	19	1	20	0	20	0	20	0	21	0	0
K (+)	20	18	2	17	3	17	3	17	3	18	2	3
10 gr	20	15	5	17	3	16	4	17	3	17	3	4
20 gr	20	9	11	10	10	13	7	12	8	12	8	9
30 gr	20	9	11	5	15	5	15	5	15	7	13	14

Description :

K (-) = negative control (0 gram of powder)

K (+) = positive control (white candle)

P(1,2,3,4,5) = repetition

L = landed (number of flies that landed)

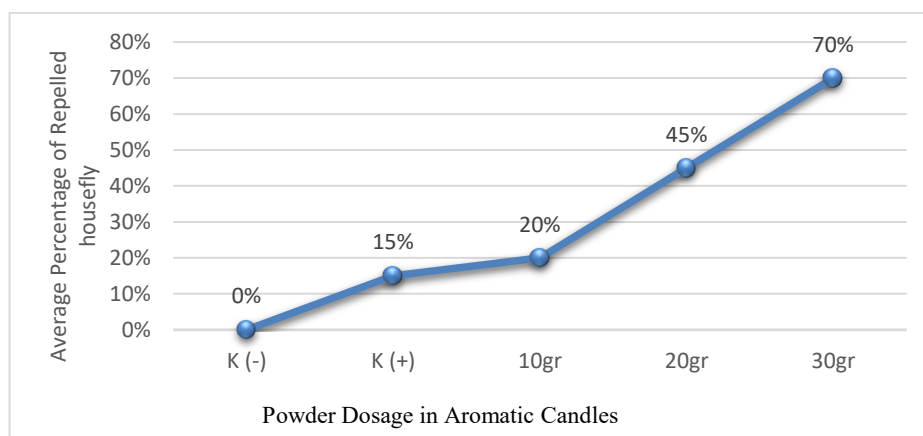
R = repelled (number of flies that were repelled)

The average number of house flies (*Musca domestica*) repelled following exposure to kaffir lime (*Citrus hystrix*) leaf aromatic candles is displayed in Table 2 above. Four flies were repelled by the 10gr dosage, nine by the 20gr dosage, and fourteen by the 30-gram. The percentage of flies that did not land with the use of aromatic candles is presented in Figure 1.

The average percentage of houseflies that stayed away with various doses of Kaffir Lime Leaf (*Citrus hystrix*) Aromatic Candles. The higher the dosage, the more

houseflies stayed away. At a 10gr dosage, only 10% stayed away, and at a 30gr dosage, 70% of the flies did not land.

Bivariate analysis was employed to examine the relationship between two variables and to obtain statistical data on their influence or cause-and-effect relationship. The following table presents the findings of the data analysis from the study conducted.

**Figure 1** Graph of the Repellency Average Percentage of Kaffir Lime Leaf Scented Candles**Table 3.** Results of One-Way ANOVA Test for Kaffir Lime Leaf (*Citrus hystrix*) Aromatic Candles as a Natural Repellent for Houseflies (*Musca domestica*)

Treatment Dose	Mean	Std. Deviasi	95% Confidence Interval		P value
			Lower Limit	Upper Limit	
K (-)	20,00	0,707	19,12	20,88	0,000
K (+)	17,40	0,548	16,72	18,08	
10 grams	16,40	0,894	15,29	17,51	
20 grams	11,20	1,643	9,16	13,24	
30 grams	6,20	1,789	3,98	8,42	
Total	14,24	5,158	12,11	16,37	

The application of kaffir lime leaf aromatic candles has an impact on house fly repellency, as demonstrated by the comparison of mean values across the various dosages of kaffir lime leaf powder used in the aromatic candles, according to Table 3 ANOVA results, which show a significance value of 0.00 ($p < 0.05$). Additionally, a

follow up test the LSD (*Least Significant Difference*) test was carried out to identify which particular treatments differed significantly from one another. The following table displays the test's results.

Table 4 LSD Test Results for Kaffir Lime Leaf (*Citrus hystrix*) Aromatic Candles as a Natural Repellent for House Flies (*Musca domestica*)

(I) Dosage	(J) Dosage	Significant Difference (I-J)	P	95% Confidence Interval	
				Lower Limit	Upper Limit
K (-)	K(+)	2,600*	0,003	0,98	4,22
	10 grams	3,600*	0,000	1,98	5,22
	20 grams	8,800*	0,000	7,18	10,42
	30 grams	13,800*	0,000	12,18	15,42
K (+)	K(-)	-2,600*	0,003	-4,22	-0,98
	10 grams	1,000	0,211	-0,62	2,62
	20 grams	6,200*	0,000	4,58	7,82
	30 grams	11,200*	0,000	9,58	12,82
10 grams	20 grams	5,200*	0,000	3,58	6,82
	30 grams	10,200*	0,000	8,58	11,82
20 grams	10 grams	-5,200*	0,000	-6,82	-3,58
	30 grams	5,000*	0,000	3,38	6,62
30 grams	10 grams	-10,200*	0,000	-11,82	-8,58
	20 grams	-5,000*	0,000	-6,62	-3,38

There were differences between the different dosage levels, as shown by a significance value of $P < 0.05$, according to the LSD (*Least Significant Difference*) test results in Table 4. The 10 g, 20 g, and 30 g dosages, as well as the positive control, were substantially different from the negative control (0 g). The 20 g and 30 g dosages were considerably different from the 10 g dosage and the positive control. The 10 g and 30 g dosages differed markedly from the 20 g dosage. Except for the comparison between the 10 g dosage and the positive control ($P\text{-value} > 0.05$), the 30 g dosage was significantly different from the 10 g and 20 g dosages. The effective dosage providing the highest fly-repellent efficacy within the test enclosure over 60 minutes was then determined using a probit regression analysis. The test results are shown in the table that follows.

Table 5 Probit Test Results for Kaffir Lime (*Citrus hystrix*) Leaf Aromatic Candles as a Natural Repellent for Houseflies (*Musca domestica*)

PROBIT	Powder dosage (grams)	95% Dosage Limit	
		Lower Limit	Upper Limit

LD_{50}	22,667	20,517	25,143
LD_{90}	40,890	36,145	48,890

The relationship between the dosage of kaffir lime leaf powder and its housefly repellent efficacy (percentage) is displayed in Table 5, above. The LD_{50} value corresponds to a dosage of 22.667 grams, and the ED_{90} value corresponds to a dosage of 40.890 grams in the aromatic candle formulation used as a natural housefly repellent.

Discussion

The houseflies used in this investigation were collected directly from the Lambaroe Market waste collection site in Aceh Besar. Twenty houseflies were used per treatment, and the process was repeated 5 times. For the experiment, kaffir lime leaves from the researcher's garden were dried and ground into a powder. Specifically, 300 grams of mature kaffir lime leaf powder were added to a formulation for an aromatic candle.

The research samples were then put through testing. To ascertain whether environmental factors affected the

effectiveness of the housefly repellent, room temperature and humidity were first measured. The flies' active temperature range was 22-35 °C, and the average room temperature was 29 °C.[11] The average humidity in the room was 80%, which falls within the ideal range of 45–90% for fly activity[11]. These measurements show that the flies were unaffected by temperature and humidity because the conditions remained within ranges appropriate for their activity and survival.

With a calculated repellency rate of 69%, the kaffir lime leaf aromatic candle showed a moderate degree of repellency against houseflies based on the results of the repellency test.[10] This moderate level is different from earlier studies that used papaya leaf powder in paraffin candles. In those studies, a 30-gram dose was effective at keeping flies away, with only one fly landing on the test medium.[12] Problems during the study, particularly an unstable flame that prevented the release of a strong aroma, may have affected the results. An oversized wick or air bubbles inside the candle are two possible reasons. According to the study, an oversized wick makes the fuel burn faster and creates an unstable flame. Because a flare-up can reduce the intensity of the released aroma, this flame instability likely affected the candle's ability to repel houseflies. Nevertheless, this was mitigated by trimming the wick close to the candle's surface, which ensures immediate aroma release upon ignition, and by allowing the flame to stabilize outside the test enclosure for about five minutes before testing the sample.

The percentage of houseflies repelled rose in proportion to the amount of kaffir lime leaf powder in the aromatic candle, according to the study; in other words, a higher powder dosage led to more houseflies being repelled because the flies did not like the smell of the aromatic candle that contained lime (*Citrus aurantifolia*) leaf extract. Depending on the concentration of the lime leaf extract used, different numbers of houseflies were repelled. Because the amount of active compounds in the botanical material increased along with the concentration, more flies were repelled at higher extract concentrations [7].

The essential oil of kaffir lime leaves contains a substance called citronellal, which has a strong insect-repelling effect[13]. One of the compound's distinguishing characteristics is that it releases an aroma that flies find repulsive. Results demonstrating that the citronellal in the essential oil of kaffir lime leaf extract repels *P. americana* insects demonstrate that citronellal has *antifeedant* properties. This repellent effect presumably causes the insects to lose their appetite[8].

Previous research has found similar compounds in *Citrus hystrix* and *Carica papaya* L., including saponins, alkaloids carpine, papain, and flavonoids. These compounds have detergent-like properties and can be used as stomach poisons. Their bitter taste causes stomach irritation when ingested by insects, killing them slowly until feeding ceases..[14]-[15].

The aromatic candle made from kaffir lime (*Citrus hystrix*) leaves repels houseflies (*Musca domestica*) by disrupting their respiratory and nervous systems. Chemicals released from the burning powder of kaffir lime leaves spread into the air and enter the flies'

respiratory tracts. Even in the presence of bait, the flies' appetite is suppressed by the resulting aroma, which makes them avoid the area around the candle.

In addition to its therapeutic applications, this study shows that the kaffir lime leaf (*Citrus hystrix*) can be used as an alternative vector control strategy, particularly as an insecticide or repellent. As a result, using kaffir lime leaf powder in fragrant candles helps reduce reliance on chemicals that are harmful to people and the environment.

Conclusion

According to the study's findings, houseflies (*Musca domestica*) are repelled by the aromatic candle made from kaffir lime (*Citrus hystrix*) leaves; a dosage of 22.667 grams was successful in keeping 50% of the flies away.

Recommendations

The leaves of kaffir lime (*Citrus hystrix*) are intended to be used by the general public as a natural insect repellent, especially against flies. As an alternative to using chemicals to keep flies away, people can use them as fragrant candles for everyday tasks, such as setting them on dinner tables. Further research is recommended to test the kaffir lime (*Citrus hystrix*) leaf aromatic candle against house flies (*Musca domestica*) in public places, such as dining rooms, and to examine its potential impact on adjacent food.

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