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Flies (*Musca domestica*, *Calliphora vomitoria, Sarcophadigae*) and Cokroaches (*Periplaneta americana*) Control Based on Botanical Insecticides in Outdoor Food Processing Areas

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Abstract

BACKGROUND: Pathogenic agents can be spread by flies and cockroaches. Food processing areas are favored by insects; control is carried out to prevent contamination of food. The use of synthetic insecticides causes environmental damage, resistance, and contamination of food that is processed and served. The world does not use chemical insecticides such as pyrethroids, organo phosphates, and carbamates. Natural ingredients containing active ingredients can be used as insect repellents that are safer because they can be decomposed by nature. The content of Cloves and bay leaf gives a distinctive aroma of eugenol dan flavonoid compounds, the smell of these compounds can be captured by insects' receptors so that they can repel insects. This research combined clove flower extract and bay leaf extract in a candle flame formula as a repellant for flies and cockroaches in outdoor food processing areas.

AIM: This study aims to determine the ability to use the concentration formula and duration of exposure to clove flower extract and bay leaf extract against the repelling capability of flies and cockroaches in outdoor restaurants.

METHODS: This research is field experiment research, which studies the effect of concentration formulations and exposure time of clove flower extract and bay leaf extract in repelling flies and cockroaches in food processing facilities. Experiments were carried out with 3 levels of formulation: Clove flower extract and bay leaf extract, namely, 20%: 25%, 20%: 30%, and 25%: 30% with 3 levels of exposure time, namely, 30, 45, and 60 min. Outdoor restaurant place to observe the density of flies and the density of cockroaches, the temperature and humidity of the outdoor dining room. Data analysis using two-way ANOVA analysis and Tukey's test.

RESULTS: The interaction between concentration and contact time extracts on the density of flies in outdoor food processing areas ($p < 0.001$) and cockroaches ($p < 0.002$). That the formula of 25%: 30% extract and contact 60 min had the highest effect.

CONCLUSION: As such, the use formula of Clove flower extract and bay leaf extract is a suitable for controlling flies and cockroaches in outdoor food processing areas. The an effective interaction between the extract concentration formula and the length of time of exposure which gave the highest effect on repelling flies and cockroaches, the formula was an extract concentration of 25%: 30% and 60 min of exposure time of flies that were repelled reaching 100% and highest cockroach repelled was 86.67%.

Introduction

Food processing areas are very attractive to flies and cockroaches. Food odors are the main cause of these insects'existence in food processing facilities. West Java province is very famous for its traditional food, fresh vegetables with chili paste, and fish. This type of food has a very strong odor that attracts flies and cockroaches. Foods such as sugar, milk, and processed foods from various sources are very attractive to flies and cockroaches. Organic substances and food carbon are very important for flies and cockroaches. The way of serving food in traditional Sundanese restaurants is in open on the food serving table causing the food to be easily infested by insects [1].

Flies and cockroaches are very contaminated insects, and both can transmit disease through the food they infest [2]. Cockroach bodies contain *Escherichia coli* and *Salmonella* spp.*, Pseudomonas aeruginosa*, worm eggs, protozoa, viruses, pathogenic fungi, *Entamoeba histolytica, Trichinella* spp, and *Enterobius* [3], [4]. Pathogenic microorganisms mechanically carried by vector include *Salmonella sp., Staphylococcus sp., E. coli, Shigella s,* and parasitic worms. Flies and cockroaches are vectors off food poisoning and food-infecting organisms [5], and through food, flies can also transmit disease. There is strong evidence that flies and cockroaches are vectors of infectious diseases, especially diarrhea and dysentery [6].

Food processing areas are very favorable for flies and cockroaches, because the smell of food is attractive for insects. The measurement of the density of flies from is between 8 and 18 flies and the density of cockroaches is 10–15 cockroaches in outdoor food processing. Density increases as the food is served. The

results from the Baskoro research showed that from 28 food processing areas that were monitored, in all were found high density of flies and cockroaches, with a total number of 1146 cockroaches caught [7]. According to the Directorate General of Health in Qatar, were found that 40% of the restaurants surveyed had the highest cockroach density [8]. According to Davari, 66.7% of Iranian restaurants are infested with cockroaches [9]. And a total of 3,262 flies were captured was predominant in restaurants and school cafetarias of Northeast Thailand [10]. Control of flies and cockroaches in food processing facilities is carried out by improving the sanitation of the processing area [7/8], reducing or eliminating breeding sites, reducing attractive sources of flies and cockroaches, and preventing interactions between flies and food, tableware, humans, or disease-causing organisms are vector control efforts [11].

At this time, the use of artificial insecticides is very advanced because it is very effective, practical, easy to obtain, and very economical. The world does not use chemical insecticides such as pyrethroids, organo phosphates, and carbamates because they are not effective [12]. Besides that use of artificial insecticides can cause biological damage, damage to the water environment, air environment, land surface, and human health problems [13], [14]. Therefore, it is necessary to find botanical insecticides as an alternative. Indonesia has a rich plant biodiversity, and many types of plants can potentially be used as natural insect repellents including the potential as a natural insect. Plants with potential as sources of insecticides contain bioactive compounds such as saponins, flavonoids, alkaloids, tannins, and alkenyl phenols [15]. Bay leaf (*Syzygium polyanthum*) contains following extracts: citral, flavonoid, and eugenol [16], [17], as well as tannins, and flavonoids [18]. This compounds that are toxic to insects because they affect the circulation of leucine [18]. The content of cloves (*Syzygium aromaticum*) gives a distinctivearoma of eugenol compounds [19], and the smell of these compounds can be captured by insects' receptors so that they can repel insects. Eugenol is an active compound from clove flowers that can be used as an insect repellent, anti-fungal, anti-bacterial, and worm exterminator. The very strong smell of Eugenol can repel flies from landing on food [20], [21]. The biological activity of extracts against insects can be repellent [20], [21], attracting the presence of insects (attractant), toxic [18], harming breathing organs (fumigant) [22], reducing appetite (antifeedant), or even harming the insects' fertility [23], [24].

The use of botanical pesticides derived from plants has the potential to control vectors, using natural or botanical plant-based materials that are biodegradable, so they do not pollute the environment [25]. In several studies on botanical repellents, including those using the clove soaking method and placing it next to the food, the ability of the 10% concentration formula has a significant repulsion for house flies. Essential oil from patchouli leaves as a repellent for *Blattella germanica* type of cockroach has a strong repellency at a concentration of 5 ppm [26]. Comparing seven kinds of essential oils as repellents on *Blata* cockroaches, kaffir lime essential oil has a 100% repelling effect. Other evidence suggests that botanical pesticides, namely Ketapang leaves, have bio larvicidal activity comparable to *temephos* against Aedes *aegypti* [27]. According to Yushananta and Ahyanti, betel leaf extract biopesticide can be used to control *Musca domestica* in the environment [22]. The biological activity of plant extracts against insects can be repulsive, attractive, contact poison (toxic), respiratory poison (fumigant) [28], inhibit egg-laying (oviposition deterrent) [29], reduce appetite (antifeedant) [30], inhibit growth, reduce fertility, and as an insect repellent [31].

This study aims to determine the ability to use the concentration formula and duration of exposure to clove flower extract and bay leaf extract against their spelling capability offline and cockroaches in outdoor restaurants. In this studies, authors packaged two types of clove flower extract and bay leaf extract in the form of candles (candle flames to help evaporate volatile compounds) which have an aroma so they are easy to use. The concentration of clove flower extract and bay leaf extract was intended to be used as an active ingredient to repel two or more types of insects. The role of repellent is to repel the presence of insects, mainly due to the strong smell.

Materials and Methods

Study setting

We performed field studies, using a pre and post approach with controls. The research was conducted in an outdoor Sundanese traditional restaurant in the city of Bandung, the city of Cimahi, and the district of Cianjur. There are three levels of mixed formula concentration of clove flower extract and bay leaf extract concentration formula 1 is a mixture of 20% concentration of 50 ml clove extract and 25% concentration of 50 ml bay leaf extract; formula 2 is a mixture of 20% concentration of 50 mL clove extract and 30% concentration of 50 mL bay leaf extract; and formula 3 is a mixture of 25% concentration of 50 mL clove extract and 30% concentration of 50 mL bay leaf extract, with three levels of exposure time (30, 45, and 60 min) [32].The extract formula was packaged in a candle flame. There were six repetitions carried out in the treatment group and the control group. Observations on the effect of the extract concentration formulation on fly density were carried out during the day at 09.00–13.00 Western Indonesian Time, in the outdoor dining room/outdoor food serving room and the density of cockroaches at night at 19.00–23.00 Western Indonesian Time, in the food processing

room. The repetition was carried out 6 times. The density of flies was measured using the fly grill [32], while the density of cockroaches was measured using a plate with gel baits [33], while the temperature and humidity of the outdoor dining room were measured using a thermo-hygrometer [34]. Observations of fly density and cockroach density were carried out directly after exposure to the mixed extract formula and were observed for 2 consecutive days (to make sure there is no odor effect from the previous extract) [35]. The weather sunny when the experiment was carried out.

Clove flower extract and bay leaf extract

Dried clove flowers (4 kg) and bay leaves (3 kg) were obtained from farmers in the Cigugur area, West Bandung Regency, West Java, Indonesia. Clove flowers and bay leaves were aerated by drying in a coolplace, not directly exposed to the sun for 14 days, and then each clove flower and bay leaves were blended at a medium speed of 220 rpm for 1 h. For the extract making process, 300 g of blended flowers or leaves were soaked using 1500 mL of 96% ethanol at room temperature, and after 3 days, the pulp was removed and the resulting liquid was filtered by Whatman filter paper. The extract was then concentrated until it has thickened using a rotary evaporator RC 900 at 50°C [36]. The result was 60 mL of pure clove flower extract and 40 mL of bay leaf extract. These extracts were mixed in liquid paraffin to obtain concentrations of 20%, 25%, and 30%, respectively. The formula was made by mixing 2 types of concentrations, by adding 50 ml each in liquid paraffin and then homogenized, to obtain a formula concentration of clove flower extract and bay leaf extract concentration (concentration formula: 20%:25%, 20%:30%, and 25%:30%) on liquid paraffin, then the wax wick was attached and compacted. The use of solid paraffin is ignited to spread the volatile compounds in the extract.

Repelling test on formula extract

Testing the repulsion of the formula was adjusted to the Cardinan method, before starting the test, the air temperature and humidity of the dining and outdoor food serving rooms must be ensured to meet the environmental criteria of fly and cockroach activity [33], [37]. The mixed extract formula, namely, 20:25%, 20:30%, and 25:30% (alternately on different days) was ignited on paraffin, and then stored in the outdoor dining room/outdoor food serving room and let to stand for ± 5 min to provide the opportunity for volatile compounds (eugenol and flavonoids) to spread. If no *M. domestica* were found dead, the test was continued, with exposure times for the extract formula for 30, 45, and 60 min. Observation of the density of flies and cockroaches was carried out for 30–60 min. It was carried out alternately for other formulas. Observation is followed by counting the density of flies and cockroaches in the outdoor dining room/outdoor food serving room. The density of cockroaches was carried out in the same activities as the observation area in the food processing room. In the treatment group, the percentage calculation of clove flower extract - bay leaf extract repulsion power (%) = ((initial density of flies/cockroaches – total density after treatment)/initial number of flies/cockroaches) × 100% [23]. The same way is done for the control group, but the solid paraffin did not include the formula of clove flower extract and bay leaf extract, it was then ignited, and the fly density was calculated in the outdoor dining room/outdoor food serving room.

Statistical analysis

Data analysis to determine the effect of the mixed formula concentration and exposure time of clove flower extract formula and bay leaf extract on fly density and cockroach density in outdoor food processing was done by two-way ANOVA analysis and Tukey's test [38].

Results

The density of flies and cockroaches

The density of flies in the Food House before exposure to the clove flower extract-bay leaf extract formula was found the lowest as 8 flies and the highest as 18 flies. In this study, the species of flies found were houseflies (*M. domestica*), greenflies (*Calliphora vomitoria*) and meat flies (*sarcophadigae*). Meanwhile, the cockroach density was the lowest at10 cockroaches and the highest at 15 cockroaches. The phenomenon that exists is that fly activity is higher when visitors eat because the smell of food is very attractive to flies, while cockroaches' activity at night is higher in line with food processing activities. All found cockroaches belonged to *Periplaneta americana.*

Temperature and humidity of the food processing place

The description of the air condition in the dining room during the measurement of fly density before and after exposure to the formula on centration of clove flower extract and bay leaf extract at room temperature ranging from 26 to 29°C, with room humidity ranging from 42% to 57%. In measuring the density of cockroaches, the air temperature in the food processing room ranges from 25 to 29°C, with room humidity ranging from 85% to 87%.

Effect of concentration formulation of clove flower extract - bay leaf extract on the density of flies in the food processing place (percentage)

Ensuring that there is an effect of paraffin concentration of clove flower extract - bay leaf extract on the number of repelled flies, a test was carried out, namely, comparing the treatment with the control.

Table 1 shows that in the control group with an exposure time of 30, 45 and 60 min, there was no decrease in the number of flies and even an increase in the number of flies. The average increase in the number of flies was the highest at 31.66% (12.76%) at 30 min. The lowest average increase in the number of flies was 28.16% (12.41%) at 45 min. In the control group, no flies were repelled. At each exposure time, a $p < 0.001$ was obtained. Thus, there was a significant difference in the effect on the number of flies between the presence and absence of exposure to paraffin from clove flower extract-bay leaf extract. At the exposure of 30, 45 and 60 min on all concentration formulas of clove flower extract and bay leaf extract, the $p < 0.001$ ($p < 0.05$). This means that at alpha 5% there is a significant difference in the formula concentration of clove flower extract -bay leaf extract on the number of flies that are repelled at exposure times of 30 min, 45 min, and 60 min.

Table 1: Comparison of paraffin clove flower extract - bay leaf extract effects on the number of repelled flies With control at outdoors food processing areas and Statistical analysis by ANOVA

Exposure time	n	Mean (SD)	Min–Max	p-value
30 min	6	48.86% (3.88%)	45–55.56%	<0.001
Concentration: 20%:25%	6	70.23% (5.48%)	64.29-77.78%	
Concentration: b20%:30%	6	86.85% (2.42%)	83.33–90.00%	
Concentration: 25%:30%	6	–31.66% (12.76%)	–20; –51%	
Control				
45 min				
Concentration: 20–25%	6	60.13% (5.49%)	54.55–66.67%	<0.001
Concentration: 20–30%	6	75.94% (3.94%)	71.43–80%	
Concentration: 25–30%	6	91.71% (7.89%)	80–100%	
Control	6	–28.16% (12.41%)	–11.67; –44.44%	
60 min				
Concentration: 20%:25%	6	69.57% (5.09%)	63.64–77.78%	<0.001
Concentration: 20%:30%	6	72.04% (13.19%)	80–88.99%	
Concentration: 25%:30%	6	97.14% (4.51%)	90–100%	
Control	6	–31.39% (10.30%)	–22.22;–50%	

Knowing at which concentration the difference in the number of flies that were repelled was proceed with Tukey test

Table 2 shows, it can be seen that the exposure time of 30, 45, and 60 min showed a significant difference between all group so the clove flower extract and bay leaf extract formulas concentration on the ability to repel flies.

Table 2: Tukey test results on the effect of clove flower extract paraffin concentration on the number of repelled flies

Clove flower extract paraffin concentration	p-value
30 min exposure time	
20–25%	<0.001
20–25%	<0.001
20–30%	<0.001
45 min exposure time	
20–25%	<0.001
20–25%	<0.001
20–30%	<0.001
60 min exposure time	
20–25%	<0.001
20–25%	<0.001
20–30%	<0.001

The results on the effect of concentration and exposure time on the ability to repel flies are shown in the Table 3:

Table 3: Two-way ANOVA test result on the effect of concentration and length of paraffin CLOVE Flowers extract - bay leaves extract exposure time on the number of repelled flies

Variable	Coefficient of determination	F	p-value
Concentration*Time	0.683	51.557	<0.001

From Table 3, it can be seen that the test results obtained $p < 0.001$ ($p < 0.05$), meaning that there is a simultaneously significant effect between the concentration and exposure time of the extract formula on fly density in the outdoor food serving processing areas.

Effect of concentration formulation of clove flower extract - bay leaf extract on the density of cockroaches in food processing place (percentage)

Ensuring that there is an effect of paraffin concentration of clove flower extract - bay leaf extract on the number of repelled cockroaches, a test was carried out, namely, comparing the treatment with the control.

From Table 4, it can be seen that in the control sample with an exposure time of 30, 45, and 60 min, there was no decrease in the number of cockroaches and even an increase in the number of cockroaches. No cockroaches were repelled with the highest average increase in the number of cockroaches reaching 36.75% (12.41%) and the lowest average increase in the number of cockroaches being 28.12% (15.65%) at 30 min of exposure time. At each length of exposure, $p < 0.001$ was obtained, thus there was a significant difference in the effect on the number of cockroaches between the presence and absence of exposure to clove flower extract-bay leaf extract.

Table 4: Comparative effects of paraffin flower extract cloves - bay leaf extract on the number of cockroaches that were repelled and its control sample at the food processing area

Exposure time extract	n	Mean (SD)	Min–Max	p-Value
30 min				
Concentration: 20%:25%	6	29.99% (11.45%)	18.18–46.15%	<0.001
Concentration: 20%:30%	6	38.20% (11.19%)	25–50%	
Concentration: 25%:30%	6	54.12% (12%)	36.36–66.67%	
Control	6	–36.75% (12.41%)	–63.64%; –13.33%	
45 min				
Concentration: 20%:25%	6	33.17% (13.30%)	20–53.33%	<0.001
Concentration: 20%:30%	6	49.81% (6.84%)	41.67–58.33%	
Concentration: 25%:30%	6	65.60% (6.21%)	68.33–72.73%	
Control	6	–29.86% (17.17%)	–50%; –8.33%	
60 min				
Concentration: 20%:25%	6	34.17% (9%)	23.08–46.67%	<0.001
Concentration: 20%:30%	6	54.94% (8.08%)	41.67–66.67%	
Concentration: 25%:30%	6	84.03% (1.80%)	81.82–86.67%	
Control	6	–28.12% (15.65%)	–50%;–8.33%	

Table 5 shows, it can be seen that at an exposure time of 30 min, there was no significant difference between the 20%:25% and 20%:30% formula groups, the 20%:30% formula group, and the 25%: 30% formula group. At exposure times of 45 min and 60 min, all groups of extract formulas have a significant effect ($p < 0.001$).

Table 5: Tukey test results for formula extract

Clove flower extract paraffin concentration	p-Value
30 min exposure time	
20%:25%	0.285
20%:25%	0.013
20%:30%	0.107
45 min exposure time	
20%:25%	0.008
20%:25%	<0.001
20%:30%	0.010
60 min exposure time	
20%:25%	<0.001
20%:25%	<0.001
20%:30%	<0.001

In the Table 6, can be seen that the p-value is 0.002 ($p < 0.05$). This means that there is a simultaneously significant effect on concentration and exposure time on the density of cockroaches in the food processing room.

Table 6: Two way ANOVA test results on effect of paraffin clove flower extract-bay leaf extract concentration and exposure time on the number of repelled cockroaches

Variable	Coefficient of Determination	F	p-value
Concentration*Time	0.659	5.837	<0.002

Discussion

This study shows that presence of flies and cockroaches in restaurants puts them in the category of not meeting the requirements, because the requirements stipulate that there are no flies and cockroaches in the dining area because they can cause food contamination. The number of flies and cockroaches in food processing facilities is related to the behavior of these insects that were attracted to foods eaten by humans, processed food ingredients, the nature of the food, and environmental conditions of temperature and humidity that are suitable for the activity and smells or scents that can attract flies and cockroaches. The main response of insects to get food is the smell. Insect antennae are chemoreceptor organs that make it easier to find the direction of the smell.

Furthermore, this information can initiate the screening of the active compounds for different bioactivities. In a previous study, the clove leaf spray's ability to repel houseflies was determined by its concentration, the lowest repellency was at 10% concentrasion was 83.7% and the concentration of clove methanol extract had an impact on the repelling capability of indoor insects [20]. According to Indriasih Minar that 94.44% of flies can be repelled by using 10% of clove leaf extract in the process of drying fish/drying fish which has an impact on endurance capabilities such as soaking [21]. Based on this research, the 3 concentration formulas of clove flower ethanol extract: Bay leaf impact on the repelling flies and cockroaches in outdoor food processing. The repellency power of the clove extract: Bay leaf extract against flies and cockroaches was determined by concentration and exposure time, the average highest repellency power was at a concentration of 25%:30% formula and an exposure time of 60 min was 97,14% and 84,03%. In addition, the use of candle flames to help evaporate the volatile compounds eugenol and flavonoid in the air, so that the distinctive smell of eugenol and flavonoid will be immediately received by flies and cockroaches. Compared to other studies, the concentration of the extract formula was higher, this was due to outdoor use of the active compound being diluted by the air, thus requiring a higher concentration to repel flies and cockroaches compared to indoor use. Besides that, it is caused by the way of using candle flame which requires a higher concentration. Researchers are trying to reduce flies and cockroaches to 0 (zero) under the requirements of the Minister of Health of the Republic of Indonesia regarding the density of insects in food processing facilities [39]. Similar to other research, this research also strengthens the method of botanical insecticides as insect repellent. The ability of different repellants indoor and outdoor the room is affected by the way the repellent is used, the volatile compounds eugenol and flavonoid are assisted with the evaporation process by formulating it in a flame candle. This method is expected to accelerate the spread of volatile compounds outdoor the room so that it is quickly accepted by the receiving nerves/smell receptors in insects. This is in line with Shinta, the repellent mechanism of the extract is that volatile compounds spread into the air and are captured by the spiracles as chemical receptors which ultimately suppress the nervous system causing insect difficulty in breathing, the reaction that occurs is that the insect's body is soft and weak [40], [41]. This showed that the clove flower extract and bay leaf extract formula in solid fire paraffin had significant insecticidal activity against the density of flies and cockroaches in outdoor food processing. The formulas of clove flower extract and bay leaf extract is environmentally friendly and easy to decompose, this is proven in this study when the paraffin fire was turned off, the density of flies and cockroaches increased.

In this study, the functions of plant biological activities, namely, eugenol, and flavonoids, were investigated only as insect repellents. The repellent mechanism is responded by insects by moving away and avoiding the source of the odor. In this study, the expressions shown were all flies and cockroaches leaving the outdoor food processing and other expressions of cockroaches were leaving the food processing room, wings wide open, and inactive movements. The results of field observations showed that the concentration of clove flower extract formula: Bay leaf extract in solid flame paraffin can be used as a fly and cockroach repellent in food processing outdoors or indoors, not as a contact poison (toxic), respiratory poison (fumigant), reduces appetite (antifeedant), inhibits egg-laying (oviposition deterrent), inhibits growth, and reduces insect fertility. The higher the combination

of concentration and exposure time, the stronger the smell received by the insect receptor nerves. Other researchers agree with Baskoro, that the stronger aroma of orange peel extract provides a comparable ability to repel American cockroaches (7), while other researchers explain that different concentrations have different repelling effects (21). Oktarina confirmed that the high concentration of extract will strengthen the aroma produced by pepper seeds to be able to repel American cockroaches [42]. Patchouli Leaf Extract (*Pogostemon cablin* B.), Babadotan Leaf (*Ageratum conyzoides* L), Kenanga Flower (*Cananga odorata* hook F & Thoms), and Rosemary Leaf (*Rosmarinus officinalis* L) as Repellent against *A. aegypti* L Mosquitoes [41]. The opinion of other researchers is that the content of bio insecticide extracts can be used as fungicides, bactericides, nematicides, insecticides, and insect repellents, reducing appetite (antifeedant), and inhibiting egg-laying (oviposition deterrent) [40]. The above research is in line with this study that there is a strong odor effect from the combination of eugenol and flavonoids that can repel flies and cockroaches.

The difference in the number of flies and cockroaches that were repelled at each concentration was caused by the difference in the amount of active substance in each concentration formula and the exposure time used. The higher the concentration and the longer exposure time, the more active substances that act as fly and cockroach repellents, and the lower the density of flies and cockroaches. Other researchers say that the combination of concentration and exposure time of rosemary bio insecticide affects the ability to repel insects. The interaction between concentration and exposure time affects the extract formula to repel flies and cockroaches in outdoor food processing. In this study, there was an effective interaction between the extract concentration formula and the length of time of exposure which gave the highest effect on repelling flies and cockroaches, namely the formula with an extract concentration of 25%:30% and 60 min of exposure time gave the highest number of flies that were repelled reaching 100% and highest cockroach repelled was 86.67%, meaning that there would be 0 (zero) flies in outdoor food processing. Its fly density has met the requirements set by the Ministry of Health [39].

The biological activity of plant extracts against insects can be repulsive, attractive, contact poison (toxic), respiratory poison (fumigant) [28], inhibit egg-laying (oviposition deterrent) [29], reduce appetite (antifeedant) [30], inhibit growth, reduce fertility, and as an insect repellent [31]. This is in accordance with Baskoro'opinion that the stronger aroma of extract provides a comparable ability to repel [7], Minar Indriasih's opinion, that clove leaf spray's ability to repel as determined by its concentration of indoor [20], Shinta's opinion, the repellent mechanism of the extract is that volatile compounds spread [41], Oktarina's confirmed that the high concentration of extract will strengthen the aroma [42] and our research that clove leaf spray's ability to repel as determined by its concentration and exposure time of outdoor food processing. The content of bio-insecticide extracts can be used as repellents against insects [40], the factors that affect the ability to resist are the active substances of botanical insecticides, concentration extract, duration of exposure, method of application and physical properties of insecticides (liquid, granular and volatile compounds).

The existing environmental conditions are classified as optimum for *M. domestica* activity, namely at temperatures ranging from 26 to 32°C and air humidity ranging from 21% to 88.2% and active during the day [30]. Cockroaches are most often found at temperatures ranging from 23 to 30°C and humidity ranging from 85% to 91% and are more active at night when for aging and mating [43].In this study, environmental conditions contribute supportively to the activity of flies and cockroaches in food processing areas. Changes in the density of flies and cockroaches in food processing areas with the use of natural ingredients that can repel insects are more due to the function of repellents, namely, clove flower extract and bay leaf extract used.

Our study showed that clove flower extract formula and bay leaf extract applied in solid flame paraffin had significant insecticidal activity against the density of flies and cockroaches in outdoor food processing. The formula of clove flower extract and bay leaf extract is environmentally friendly and easy to decompose by nature, this is proven in this study when the paraffin flame is turned off, the density of flies and cockroaches increases and can be a suitable alternative to replace artificial insecticides that are widely available in Indonesia [30].

Conclusion

Overall, this study proves that the mixed formula of clove flower extract - bay leaf extract in solid paraffin can reduce the density of flies and the density of cockroaches in outdoor food processing. There was an effective interaction between the extract concentration formula and the length of time of exposure which gave the highest effect on repelling flies and cockroaches, the formula was an extract concentration of 25%:30% and 60 min of exposure time of flies that were repelled reaching 100% and highest cockroach repelled was 86.67%. The mixture of eugenol and flavonoid dominant compounds in this research formula can be an alternative to eliminate flies and cockroaches in food processing areas.

Suggestion

The mixed formula of clove extract - bay leaf extract used in this study is expected to be applied in outdoor food processing places such as restaurants and outdoor food processing areas.

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