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Repellent activity of green detergents and raw vegetable extracts against *Drosophila Melanogaster*

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Abstract
This study observed the repellency effects of green detergents (raw neem extract, vinegar, baking soda) and raw vegetable extracts (ginger, garlic, onion) on *Drosophila melanogaster*. With rising concerns about the hazards of chemical insecticides, natural and eco-friendly repellents are gaining importance in today's world. The results of this study revealed moderate to maximum repellency across different treatments. Among the green detergents, raw neem extract showed strong repellent activity, while baking soda showed moderate but consistent results, whereas vinegar acted as an attractant instead of repellent. Among the raw vegetable extracts, raw garlic extract showed the highest effectiveness followed by raw ginger extract and raw onion extract. The repellency is likely linked to bioactive compounds such as Azadirachtin compound present in neem, sulphur containing compounds present in garlic and onion, volatile compounds present in ginger, acidic and alkaline properties of vinegar and baking soda respectively. The results of the study suggest that green detergents and raw natural extracts can serve as sustainable alternatives to chemical repellents against *Drosophila melanogaster*.

Keywords: *Drosophila melanogaster*, repellency, neem, vinegar, baking soda, ginger, garlic, onion, eco-friendly insect repellent

Introduction

Drosophila melanogaster, the fruit fly is a species of the order Diptera in the family Drosophilidae. In the wild, *Drosophila melanogaster* are attracted to ripe fruits, rotting fruits and fermenting beverages and are often found in orchards, garbage bins and kitchen area. They are
often found near human settlements and are considered as commensal, through access to food source.The mean lifespan of *Drosophila melanogaster* is about 45-60 days, from egg to death, at 25 degree centigrade under optimal conditions (Ashburner *et al*., 2005 [3]); the developmental period of *Drosophila melanogaster* varies with temperature. Usually it takes 7-8 days for a *Drosophila melanogaster* to develop from egg to adult, at 28 degree centigrade (Ashburner and Thompson, 1978 [4]). During the larval stage, the larva feed on the microorganisms that decompose the fruits as well as on the sugar of the fruit itself.
The rapid reproduction of *Drosophila melanogaster* can sometime cause nuisance. They can spoil food with bacteria and other disease causing organisms, making them a potential health concern. In agricultural area, they can attack fruits and vegetables, causing damage and economic losses. Green detergents such as raw neem (*Azadirachtaindica*) extract, vinegar and baking soda can be used as repellent compounds against *Drosophila melanogaster*. They are called as green detergents because of their harmless and biodegradable properties, and also because of their cleansing property. Raw neem extract cause toxicity and developmental issues in *Drosophila melanogaster*. It particularly effect larvae, causing it to melanize and fail to pupate. The melanization and antifeedent activity revealed that neem extract hormonal level of insect (Anjum *et al*., 2010 [2]). However, *Azadirachtaindica* has been found to be toxic to non-target organisms where it induces marked alterations in experimental animals (Siriwattanarungss, S.; Sukontason, K.L.; Kuntalue, B.; and Sukontason, K., 2008 [14]). The inhibitory effect of neem is been in the reducing body size of different developmental stages of *Drosophila melanogaster*, which may be due to the presence of azadirachtin (Akhare *et al*., 2020 [1]). Baking soda can also be used as a repellent to repel fruit flies, that is, *Drosophilamelanogaster* from fruits. Baking soda can inhibit the fermentation process in fruits where fruit flies rely on for food and reproduction. Baking soda can cause dehydration and other issues, leading to a reduction in their pupation, by interacting with the flies' digestive system. Vinegar can also be used as a control remedy for *Drosophila melanogaster*. The scent of vinegar, lures flies into traps and make them unable to escape. Low to moderate concentration of vinegar are known to attract *Drosophila melanogaster*, but high concentration can act as a repellent. This is because odour of vinegar activates a specific olfactory receptor neuron, DM5, which is associated with avoidance.
Vegetables such as ginger (*Zingiberofficinale*), garlic (*Allium sativum*) and onion (*Allium cepa*) are prevalently recognized for their traditional uses and therapeutic potential. These vegetables are rich source of bioactive compounds such as gingerols in ginger, organosulphur compounds in garlic and flavonoids in onion, all of these compounds possesses anti-oxidant, anti-inflammatory and anti-microbial properties (Rahman and Lowe, 2018 [12] ; Oyawoye *et al*., 2022 [11]).
In this study, the repellent ability of green detergents like, raw neem extract, vinegar and baking soda and also repellent ability of raw vegetable extract of ginger, garlic and onion on *Drosophila melanogaster* were observed and reported.

Materials and Methods

The culturing of *Drosophila melanogaster* and repellency effect of green detergents (raw neem extract, vinegar, baking soda) and raw vegetable extract (ginger, garlic, onion) on the *Drosophila melanogaster* was carried out in the laboratory of Department of Zoology, Bhattadev University, Bajali. The study was conducted for a period of six months from January 2025 to June 2025.

Culturing of *Drosophila melanogaster*

To capture the *Drosophila melanogaster*, a beaker was taken, which was cleaned and dried well. The base of the beaker was filled with mashed banana. Then it was placed in a damp area where *Drosophila melanogaster* often visit. When about 20-25 number of fruit flies entered into the beaker, the opening of the beaker was covered with a muslin cloth in such a way that the flies were trapped inside the beaker.

For the preparation of the culture media, approximately 100 ml of water was warmed, 15 g of sugar and 3 g of agar powder were added to it and the solution was boiled. A paste of maize was prepared by adding 17 g of maize powder to 150 ml of water, then this paste was added to the agar, sugar and water solution. Then, a paste of yeast powder was made by adding 6 g of yeast powder to 110 ml of water, and the paste was mixed with the solution. The entire mixer was boiled until a cooking smell came out of it. The burner was turned off to allow the mixer to cool. 1 ml of propanoic acid and 1 gmnipagin dissolved in 1-2 ml of 90% ethanol were added to the mixer. The mixer was then poured in a separate beaker. The beaker was sterilized before pouring the mixer into it, to avoid fungus contamination. The mixture was then allowed to solidify by covering the opening of the beaker with a muslin cloth. The mixture after cooling down, stick at the base of the beaker.

The beaker containing the culture media was put inverted in contact with the opening of the other beaker filled with *Drosophila melanogaster* and mashed banana. The cloth used to cover the mouth of the beaker filled with *Drosophila melanogaster*, was removed carefully in such a way that there was a passage between both the beakers. The flies flew to the top beaker, where the prepared culture media was present. The beaker is then placed down carefully with a muslin cloth covering its opening. The flies were then allowed to reproduce there.

The eggs laid by the adult females were seen on the surface of the cultured beaker. The first instar larva hatched out of the eggs after 24 hours. The first instar larva moulted to second instar larva after 24 hours, the second instar larva were more active than the first instar larva which were seen crawling on the culture medium and surface of the beaker. Then the second instar larva moulted to third instar larva again after 24 hours. After 2-3 days the third instar larva transformed to pupa. The adults emerged out of the pupa after 3-4 days.

Preparation of the green detergents

Neem leaves were collected from the campus trees of Bhattadev University. The leaves were washed properly under tap water and chopped into small pieces. The chopped leaves were grinded in mixer grinder and the paste was placed in a muslin cloth, which was made into a pouch. Then force was applied to the pouch, so that the juicy material drop in the bowl kept below it.

Baking soda was purchased from a local shop of Pathsala. 4 tablespoon of the baking soda was mixed in 100 ml of water to make a solution.

The vinegar was directly purchased from a local shop of Pathsala.

Preparation of the raw vegetable extract

Ginger, garlic and onion were purchased from the local market of Pathsala. The ginger, garlic and onion were peeled off and washed properly under tap water, and then chopped into small pieces. At first the chopped pieces of ginger were grinded in the mixer grinder, then the paste was placed in a muslin cloth, which was made into a pouch. Force was applied to the pouch so that the juicy material drops to the bowl kept below it. The raw garlic extract and raw onion extract were also obtained by the similar procedure as like that of raw ginger extract.

Applying of green detergents and raw vegetable extracts on individual fruit (banana)

The repellency effect was observed in two ways:

1. By spraying the green detergents and raw vegetable extracts on individual fruit (banana)
2. By placing the green detergents and raw vegetable extracts on a bowl near individual fruit (banana)

Results

1. Repellency effect of the green detergents (raw neem extract, vinegar, baking soda) against *Drosophila melanogaster* when sprayed on Banana

It is observed that the banana on which raw neem extract is sprayed on, act as a repellent for *Drosophila melanogaster*, deterring the adult fruit flies from feeding and laying eggs on the treated surface; whereas vinegar act as attractant rather than repellent. Baking soda solution also did not show effective repellency against *Drosophila melanogaster*.

2. Repellency effect of the green detergents (raw neem extract, vinegar, baking soda) against *Drosophila melanogaster* when kept in a bowl and placed near Banana

It is observed that when a bowl of raw neem extract is placed near banana, its repellency effect is not that much effective; it deter a few fruit flies due to its scent, which they find indicative of an unsuitable breeding. But, when a bowl of vinegar is place near banana, it is observed that the *Drosophila melanogaster* are attracted towards the vinegar bowl and gets trapped into it and do not feed or oviposit in the banana. The baking soda solution whereas did not show much effectiveness in deterring fruit flies when kept in a bowl near banana.

3. Repellency effect of the raw vegetable extracts (ginger, garlic, onion) against *Drosophila melanogaster* when sprayed on Banana

Raw garlic extract sprayed on banana showed noticeable repellency effect against *Drosophila melanogaster*. Raw onion extract also showed great repellency against *Drosophila melanogaster* when sprayed on the banana; also the raw ginger extract sprayed on the banana showed somewhat repellency against *Drosophila melanogaster.*

4. Repellency effect of the raw vegetable extracts (ginger, garlic, onion) against *Drosophila melanogaster* when kept in a bowl near Banana

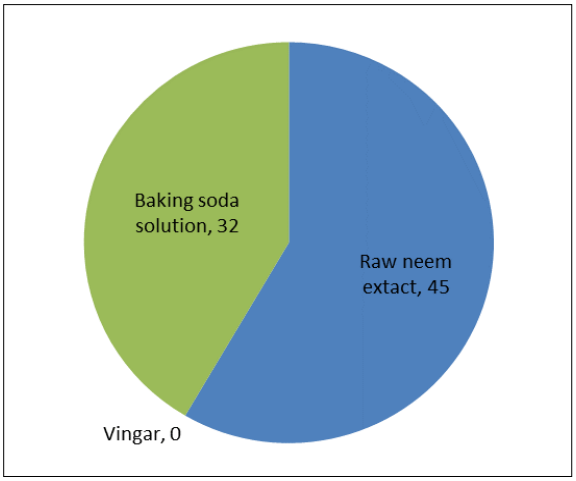
Raw garlic extract showed the most effective repellency against *Drosophila melanogaster*when kept in a bowl near the banana. The raw ginger extract kept in the bowl showed moderate repellency against *Drosophila melanogaster* in deterring them. The raw onion extract showed a slightly stronger repellent effect than raw ginger extract but less potent than raw garlic extract.

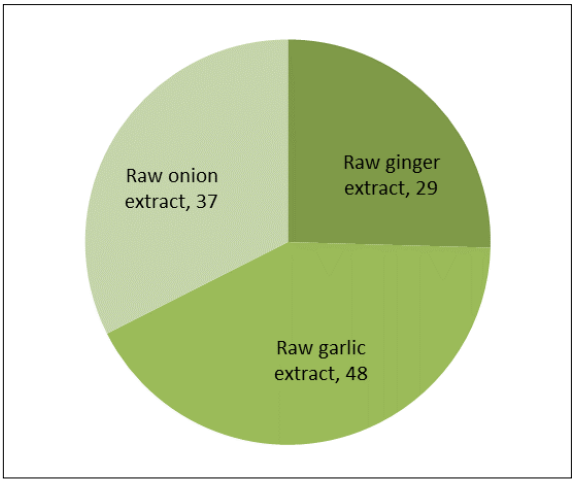
Table 1: Tabulated form of the effective repellency by the green detergents

Green detergents	Effectiveness when sprayed on the fruit (Banana)	Effectiveness when kept in a bowl near the fruit (Banana)
Raw neem extract	Maximum	Moderate
Vinegar	No effect	Maximum
Baking soda solution	Moderate	Minimum

Table 2: Tabulated form of the effective repellency by the raw vegetable extracts

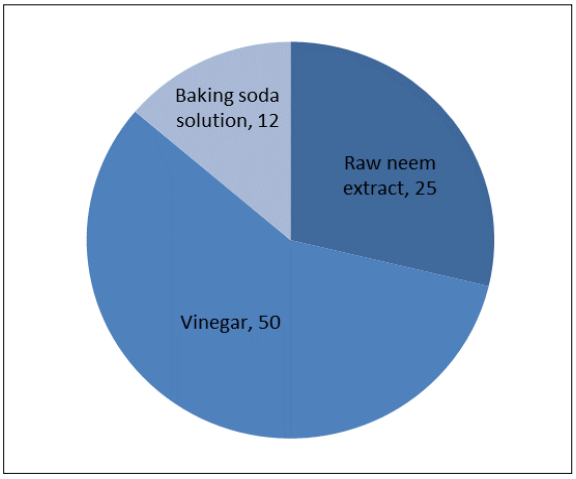
Raw vegetable extracts	Effectiveness when sprayed on the fruit (Banana)	Effectiveness when kept in a bowl near the fruit (Banana)
Ginger	Moderate	Moderate
Garlic	Maximum	Maximum
Onion	Moderate	Minimum

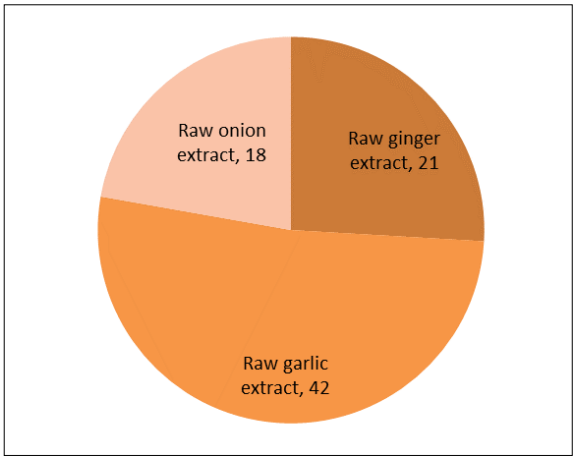




Sprayed	Total no. of flies released	No. of flies deterred
Raw neem extract	50	45
Vinegar	50	0
Baking soda solution	50	32

Sprayed	Total no. of flies released	No. of flies deterred
Raw ginger extract	50	29
Raw garlic extract	50	48
Raw onion extract	50	37





Kept in a Bowl	Total no. of flies released	No. of flies deterred
Raw neem extract	50	25
Vinegar	50	50
Baking soda solution	50	12

Kept in a Bowl	Total no. of flies released	No. of flies deterred
Raw ginger extract	50	21
Raw garlic extract	50	42
Raw onion extract	50	18

Discussion

The result showed that raw neem extract showed the maximum repellency against *Drosophila melanogaster* when sprayed on banana, this is because of the presence of azadirachtin in neem. It discourages feeding because of its bitter taste. It also affect the oviposition in female fruit fly; it coincides with the results found by Chen *et al.*, 1996 [7] and Devaud, 2003 [8]. But, raw neem extract kept in a bowl near banana is not that much effective in deterring *Drosophila melanogaster* rather when sprayed on the fruit, as they do not have strong scent rather they have a bitter taste. Vinegar on the other hand do not act as repellent against *Drosophila melanogaster*, instead it acts as an attractant, because of its fermenting smell. The vinegar when sprayed on banana attracted the fruit flies towards itself, which also fed on the fruit. But, when vinegar kept in a bowl was placed near the fruit, it lured the fruit flies towards itself, causing less nuisance to the fruit. They got trapped in the vinegar bait, which coincides with the study of Alix *et al*., 2022 [6], who studied on *Drosophila melanogaster* and apple cider vinegar. Their study revealed that apple cider vinegar acts as a good bait trap for *Drosophila melanogaster*. Baking soda showed minimum or no repellency against *Drosophila melanogaster* when sprayed on as well as when kept in a bowl near the banana. It is mainly used as a deodourizer, which help to eliminate breeding sites for *Drosophila melanogaster.*

Ginger contains some compounds like zingiberene, gingerols, which contributes to its pungent aroma. When raw ginger extract is sprayed on banana, these volatile compounds created an unfavourable environment for *Drosophila melanogaster*, as a result deterring them from the fruit. Raw ginger extract showed great repellency against *Drosophila melanogaster* when sprayed on the fruit as well as when kept in a bowl near the banana. This result coincides with the study of de Melo *et al*., 2011 [9] and Bayala *et al*.,2014 [5] who studied repellency of ginger extract against insect pests and found out that ginger has insecticidal compounds which acts as deterrents against insect pest. Sahayaraj and Sekar, 1998 [13] studied and found out that ginger has antifeedant properties that disrupt the growth of *Spodoptera litura* larvae. Raw garlic extract showed the most efficient repellency against *Drosophila melanogaster*, both when sprayed on and kept in a bowl near the banana. This is because of potent organosulphur compounds which are natural insect repellents and insecticides. It deters fruit flies because of its strong odour, they affect the olfactory receptor of fruit flies resulting in avoiding the place by fruit flies. J McCallum, 2018 [10] studied the affect of tomato, garlic and peppermint as deterrents on *Drosophila melanogaster*, the result showed that garlic would repel the highest percentage of *Drosophila melanogaster* from an attractant. But there is a drawback on spraying raw garlic extract on banana; concentrated raw garlic extract sprayed on banana may lead to the change of flavour of banana, because of its strong pungent odour and flavour, which may render it unpalatable for most people. So, the raw garlic extract should be diluted with water before spraying it on fruits.

Onions also show some repellent properties against *Drosophila melanogaster*. Onions contain volatile organic compounds like thiosulfinates and sulfoxides, which are responsible for their pungent smell and eye irritating effects. When raw onion extract were sprayed on banana, they mask the attractive odours released by ripe bananas, making it harder for the flies to locate their source of food. Even the irritating properties of onion affect the sensory organs of *Drosophila melanogaster*. However, the flavour of banana may change if high concentration raw onion extract is sprayed on it, because of the strong taste of onion. But, keeping raw onion extract in a bowl near the fruit may not cause this problem and also deter fruit flies from coming near the fruit.

The overall result showed that, in case of the three green detergents (raw neem extract, vinegar, baking soda) used as repellents in this study, raw neem extract showed the most effective repellency against *Drosophila melanogaster*, when sprayed on the banana rather than when kept on a bowl near the fruit. Vinegar acts as a good bait trap when placed near the fruit in a bowl, it lure and trap the fruit flies; whereas baking soda has minimum affect as repellent against *Drosophila melanogaster*. The green detergents used in this study mainly acts as growth regulator, feeding deterrent and repellent. They disrupt the insect's hormone system, making it harder for them to grow, reproduce and feed. But, vinegar act as trapping bait for *Drosophila melanogaster*, deterring them from approaching the fruits and attracting them towards itself.

In case of the three raw vegetable (ginger, garlic, onion) extracts used as repellents, raw garlic extract showed the highest efficiency as repellent against *Drosophila melanogaster* than raw ginger extract and raw onion extract. But, it is more favourable to use as a repellent by placing it in a bowl near the fruit rather than spraying it on the fruit, as the flavour of garlic may interrupt the taste of the fruit. Similarly, raw onion extract also may disrupt the taste of the fruit, so rather than spraying on the fruit, it can be placed in a bowl near the fruit to deter the fruit flies. Raw onion extract repel *Drosophila melanogaster* because of its irritable properties, that affect the sensory organs of *Drosophila melanogaster*. The raw ginger extract showed high repellency effect against *Drosophilamelanogaster* when sprayed on the fruit. Due to its antifeedant properties, *Drosophilamelanogaster* find it difficult to feed on the fruit; it also affect their oviposition. The raw vegetable extracts used in this study are very effective as repellents for *Drosophila melanogaster*, because of their strong and irritating aroma, and the composition of the compounds present in them, which repel the *Drosophila melanogaster* from approaching fruits and vegetables.

Conclusion

The green detergents and raw vegetable extracts used in this study for repelling *Drosophila melanogaster* are effective in deterring *Drosophila melanogaster* from fruits and vegetables, which cause nuisance in orchards, garbage bins and kitchen area. They even do not have any harmful affect as like that of chemical insecticides, instead some of them have medicinal value and are used as natural alternatives for prevention of diseases and treatment. So, their consumption do not cause any hazardous affect on human body, rather they are beneficial to human body. They also have biodegradable properties. Even they are of low cost and easily available and even present in kitchen of every household, which are used in day to day life for cooking and as preservative of food.

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