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Evaluation of the Insecticidal Potential of *Azadirachta indica* and *Moringa oleifera* Seed Oils Against *Bactrocera dorsalis* (Diptera: Tephritidae) Under Topical Application

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Abstract
Fruit flies, particularly the invasive *Bactrocera dorsalis*, cause significant damage and yield losses in fruit crops worldwide. Although synthetic insecticides are commonly used, they raise environmental concerns. This study therefore investigates the biological effects of *A. indica* and *M. oleifera* seed oil extracts on *B. dorsalis*. Contact toxicity of *A. indica* and *M. oleifera* seed oil extracts at 2.0%, 4.0%, 6.0%, 8.0%, 10.0% concentrations were tested by topical application of the extracts (1.0 µL) on the dorsum of adult *Bactrocera dorsalis* (from fruit fly culture) using standard techniques. Treatments were replicated 5 times in a completely randomized design. The topical application of neem and moringa oils caused clear and significant differences ($p < 0.05$) in mortality between male and female fruit flies. For female flies, the highest mortality was **80% at 72 hours** using **6.0% neem seed oil**, while the lowest was **10% at 24 hours** with **2.0% oil.** For male flies, the highest mortality was **70% at 72 hours** using **10.0% neem seed oil**, and the lowest was **10% at 24 hours** with **2.0% oil.** *Azadirachta indica* seed oil extract of 8.0% and 10.0% concentration caused higher mortality in adult *Bactrocera dorsalis*.

Keywords: *Azadirachta indica, Bactrocera dorsalis,* Bioassay*, Moringa oleifera*

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INTRODUCTION

Fruits constitute an essential component of human nutrition, serving as important sources of vitamins, minerals, and dietary fiber (Wargovich, 2000; Slavin, 2012). Common examples include mango, citrus, cashew, cherries, and grapes. However, fruit production is heavily constrained by fruit flies, which attack and inflict severe damage on numerous fruit crops. Fruit flies remain problematic throughout the year because they are highly attracted to ripened fruits and vegetables.

Their development requires only a moist layer of fermenting material, making many fruit-growing environments suitable for infestation. Typical indicators of fruit fly

presence include larvae found in cut fruits, visible adult flies, and pupae.

Bactrocera dorsalis (Diptera: Tephritidae), commonly referred to as the oriental fruit fly, is an invasive and highly destructive pest in regions where it has become established (Umeh and Onukwu, 2016). Originally introduced to East Africa from Sri Lanka, this species has since spread across much of sub-Saharan Africa (Drew *et al*., 2005). Currently, fruit fly management relies predominantly on chemical insecticides. However, conventional chemical-based control strategies face multiple challenges, including the development of pest resistance, accumulation of pesticide residues in food, environmental pollution, secondary pest outbreaks, reduced populations of beneficial organisms, and limited penetration of insecticides into infested fruits to reach larvae (Sultana *et al.*, 2013).

Botanical pesticides offer an alternative and more sustainable approach to pest management. They are effective against various crop pests, relatively inexpensive, biodegradable, possess diverse modes of action, and exhibit low toxicity to non-target species. Botanicals such as neem (*Azadirachta indica*) and moringa (*Moringa oleifera*) have gained increasing attention due to their bioactive constituents that deter insect pests while minimizing environmental risks. Neem contains azadirachtin, a key compound that disrupts insect feeding and growth, thereby reducing pest populations without harming beneficial insects (Dawkar *et al*., 2019). Additionally, neem exhibits antifungal and antibacterial properties that help protect crops from pathogens (Mahmoud et al., 2011). Moringa, rich in various phytochemicals, has demonstrated the ability to enhance plant resistance to pests and improve soil conditions when applied as a biofertilizer (Mashamaite et al., 2022; Abd El-Hack et al., 2018). Due to their rapid biodegradation, botanical pesticides leave minimal residues, reduce environmental contamination, and align well with integrated pest management (IPM) principles.

Therefore, this study sought to evaluate the biological activity of different concentrations of moringa (*Moringa oleifera*) and neem (*Azadirachta indica*) seed oil extracts on adult male and female *Bactrocera dorsalis* mortality.

MATERIALS AND METHODS

Bactrocera dorsalis culture

Ripe mangoes were purchased from Eleyele market, Ibadan, Oyo state. They were sorted to remove damaged ones; tiny punctures were made on the surface of the mangoes with a needle to allow easy penetration of the female ovipositor to lay eggs. There after the fruits were introduced into a fruit fly culturing cage for infestation. After 24 hours of infestation, the mangoes were removed from the cage and prepared for incubation. The preparation was carried out as follows: Each fruit was put in a plastic bowl containing a mixture of powdered soya beans, powdered wheat, granulated sugar and water in the ratio 1:2:2:1. This mixture constituted the artificial diet used in feeding the emergent larvae.

The plastic bowl (350ml) with the culture was placed in a bigger transparent plastic bowl (1.2L) containing sand and wire gauze; wire gauze helps to prevent the smaller bowls from crushing the emerged larvae. The lid of the bigger bowl was then covered with muslin cloth and fastened with rubber band to prevent the larva from escaping. The incubation period was about 10-14 days. After 10 days, the pupa was sieved out from the sand, collected in a petri-dish and placed in a cage (of 0.4 X 0.6 X 0.6m dimensions). After 10 days, adult fruit flies emerged at a room

temperature of 25±5ºC and relative humidity of 72±6%.

Moringa seed oil extraction

Moringa seeds were purchased from a moringa seed dealer, the seeds were shelled, ground and sent to the National Institute of Science and Laboratory Technology (NISLT), Ibadan for essential oil extraction using soxhlet extractor and n-hexane as a solvent following the method of Tesfaye and Tefera, (2017).

Neem seed oil extraction

Dry neem seeds obtained from the immediate surrounding of trees in Bagauda Kano State were also shelled, ground and sent to the National Institute of Science and Laboratory Technology (NISLT), Ibadan for oil extraction using soxhlet extractor and n-hexane as a solvent following the method of Tesfaye and Tefera, (2017).

Topical application of moringa and neem oil extracts on adult fruit flies

Newly emerged adult fruit flies obtained from the culturing cages were made immobile by exposing them to 4ºC in a refrigerator for 20 seconds. For each plant extract (i.e. neem and moringa), ten adult females were separately placed in a plastic container (350ml) with their lids covered using a net (to allow air into the container). Artificial diet (powdered soya beans, powdered wheat and granulated sugar) and water were also placed in the plastic container. A micro-syringe was used to topically apply 1.0 µL of predetermined concentrations to their thorax (Robertson *et al.,* 2007). Concentrations used include 2%, 4%, 6%, 8% and 10%. Only distilled water was applied to the insects in the control experiment. Each concentration was replicated five times. The arrangement was a Completely Randomized Design (CRD). The experiment was repeated using male fruit flies. Mortality was assessed at 24, 48, and 72 hours.

Statistical analysis

Mortality was expressed as percentages by observing the number of fruit flies that died out of the number introduced in the plastic container. Fruit flies where confirmed dead when there were no movement and no response to touch. Data were analysed using Analysis of variance to establish significant differences. Mortality rate of *Bactrocera dorsalis* treated with neem and moringa seed oil were compared. All statistical analyses were judged significant at 5% probability level (P=0.05).

RESULTS

Sex-Specific Mortality of *Bactrocera dorsalis* After Neem Seed Oil Topical Treatment

Among the females, percentage mortality increased with increase in concentration and time, although the highest percentage mortality of 80% was recorded at 72 hours for 6% neem oil extract. Although at this concentration, there were no significant differences recorded in the different time intervals. At 24 hours there were significant ($p<0.05$) differences in the percentage mortality that occurred at 2, 4 and 8% neem oil extract concentrations. Also, at 48 hours there were significant differences observed in the percentage mortality on 2, 4 and 6% neem oil extract concentrations. Significant differences were also seen at 72 hours in the

percentage mortality on 4, 6 and 8% neem oil extract concentrations. Likewise, on the neem oil extract concentration of 2, 4 and 8%, there were significant differences in the percentage mortality between 24 hours and 72 hours (Fig. 1).

Just like the female, percentage mortality of adult male increased with increase in concentration and time. There were significant ($p<0.05$) differences in the mortality of adult male fruit flies after 24, 48 and 72 hours at the different neem oil extract concentrations. The highest mortality of 70% was observed after 72 hours at 10% concentrations unlike the female which was at 6% concentration. At 24 hours there were significant ($p<0.05$) differences in percentage mortality of adult male that occurred at 4, 6 and 10% neem oil extract concentrations. Also, at 48 hours there were significant differences observed in the percentage mortality of adult male on 4 and 6% neem oil extract concentrations. Same observation was obtained at 72 hours. Moreso, on the neem oil extract concentration of 2, 4 and 6%, there were significant difference in the percentage mortality of adult male between 24 hours and 72 hours. (Fig. 2). There was no mortality recorded in the control experiments for both male and female fruit flies (figures 1 and 2).

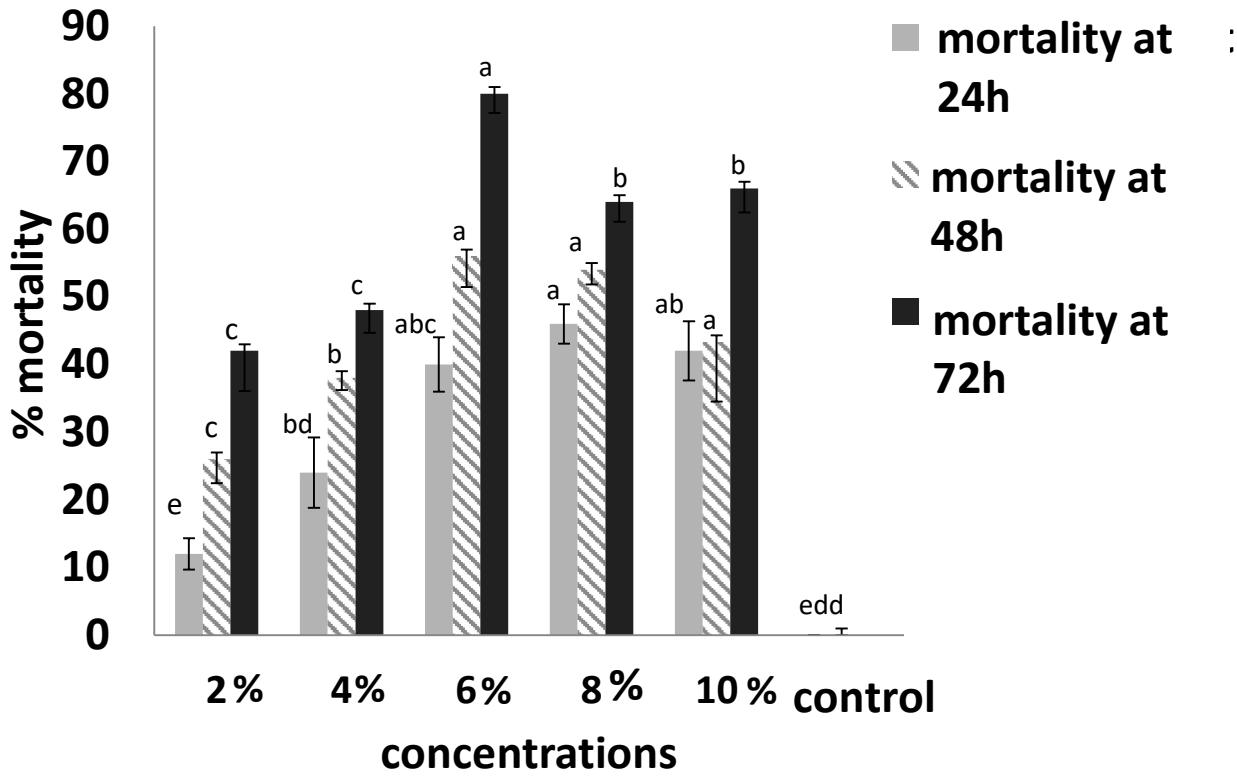

Figure 1: Contact toxicity of different concentrations of neem seed oil extract on adult female *B. dorsalis*.

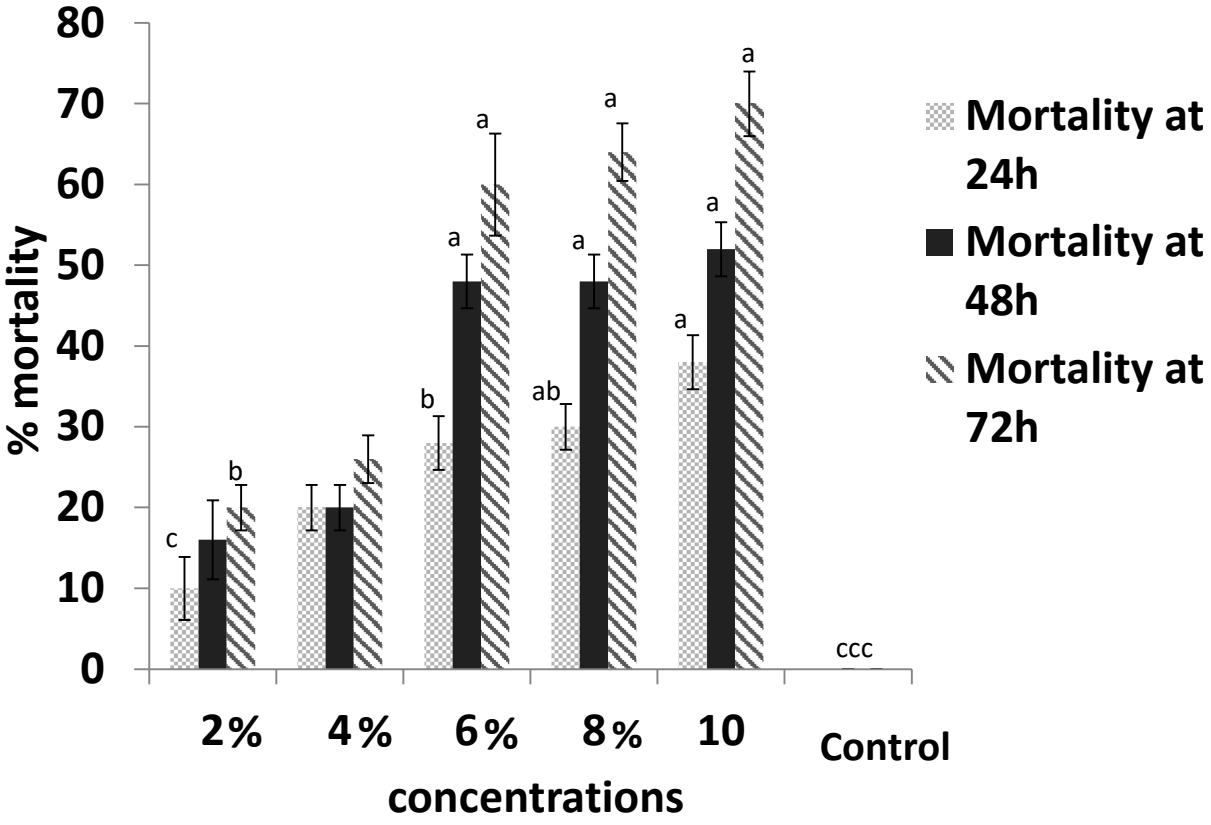

Figure 2: contact toxicity of different concentrations of neem seed oil extract on male *B. dorsalis*

Sex-Specific Mortality of *Bactrocera dorsalis* After Moringa Seed Oil Topical Treatment

Figures 3 and 4 show the effects of moringa topical application on adult female and male fruit flies, respectively. There were no significant differences ($p>0.05$) among mortalities in adult female at 24 and 48 hours across all concentrations. Although at 72 hours, significant differences ($p<0.05$) were observed at different treatment concentrations (4, 6 and 10%). At 10% concentration of moringa seed oil, adult females had the highest percentage mortality of 70% (Fig. 3). In addition, on the moringa oil extract concentration of 2, 4, 6 and 8%, there were significant difference in the percentage mortality of Adult Female at 72 hours compared to 24 and 48 hours (Fig. 3). There was no mortality recorded in the control experiments.

Similar observation was obtained for the adult male. At 24 hours and 48 hours across all treatment concentrations, there were no significant differences ($p>0.05$) in the male fruit fly's mortality (figure 4). However, at 72

hours there were significant differences ($p<0.05$) in the mortality that occurred among adult males at 4, 6 and 10% moringa seed oil concentrations. At 10% concentration of moringa seed oil, adult males also had the highest percentage mortality of 70%.

Comparing mortality in adult male and female fruit flies, cocentrations of moringa seed oil extract showed no significant difference in their percentage mortality

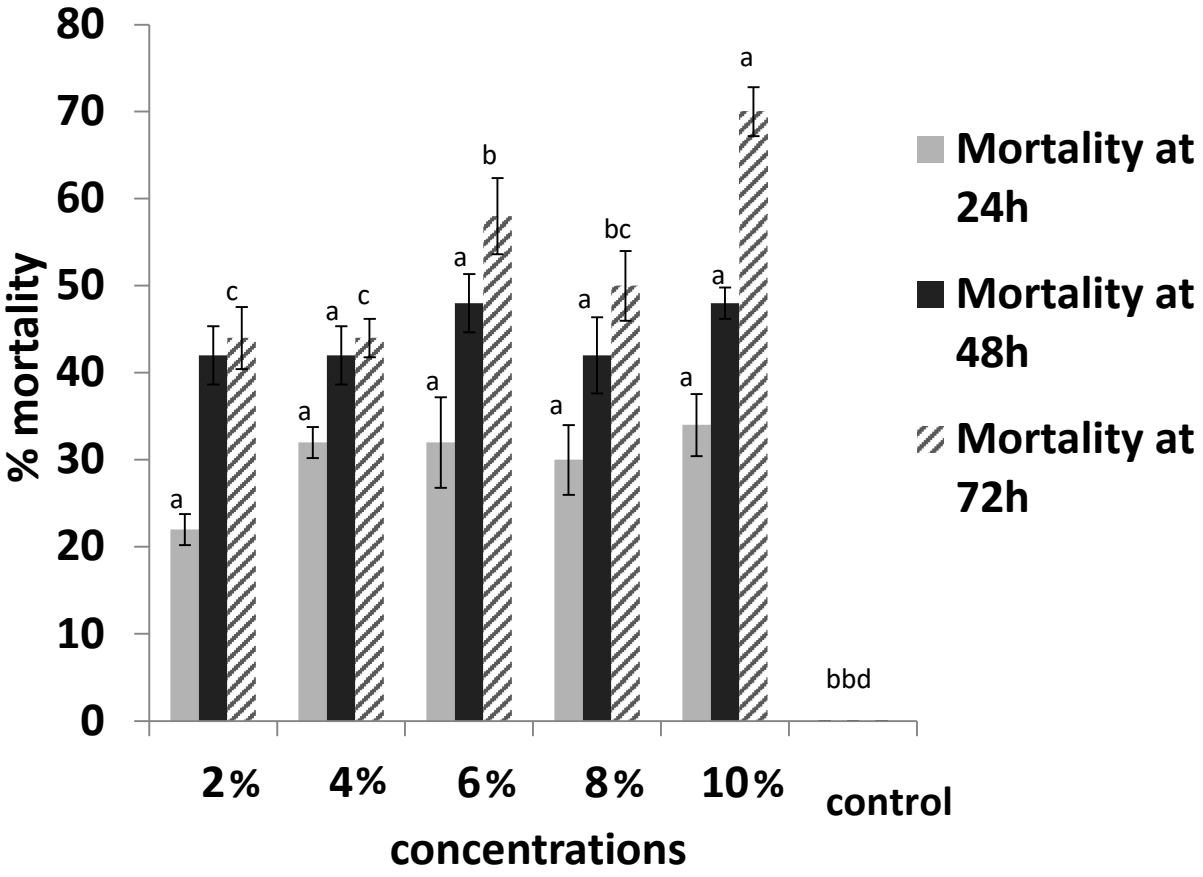

Figure 3: Contact toxicity of different concentrations of moringa seed oil extract on adult female *B. dorsalis*.

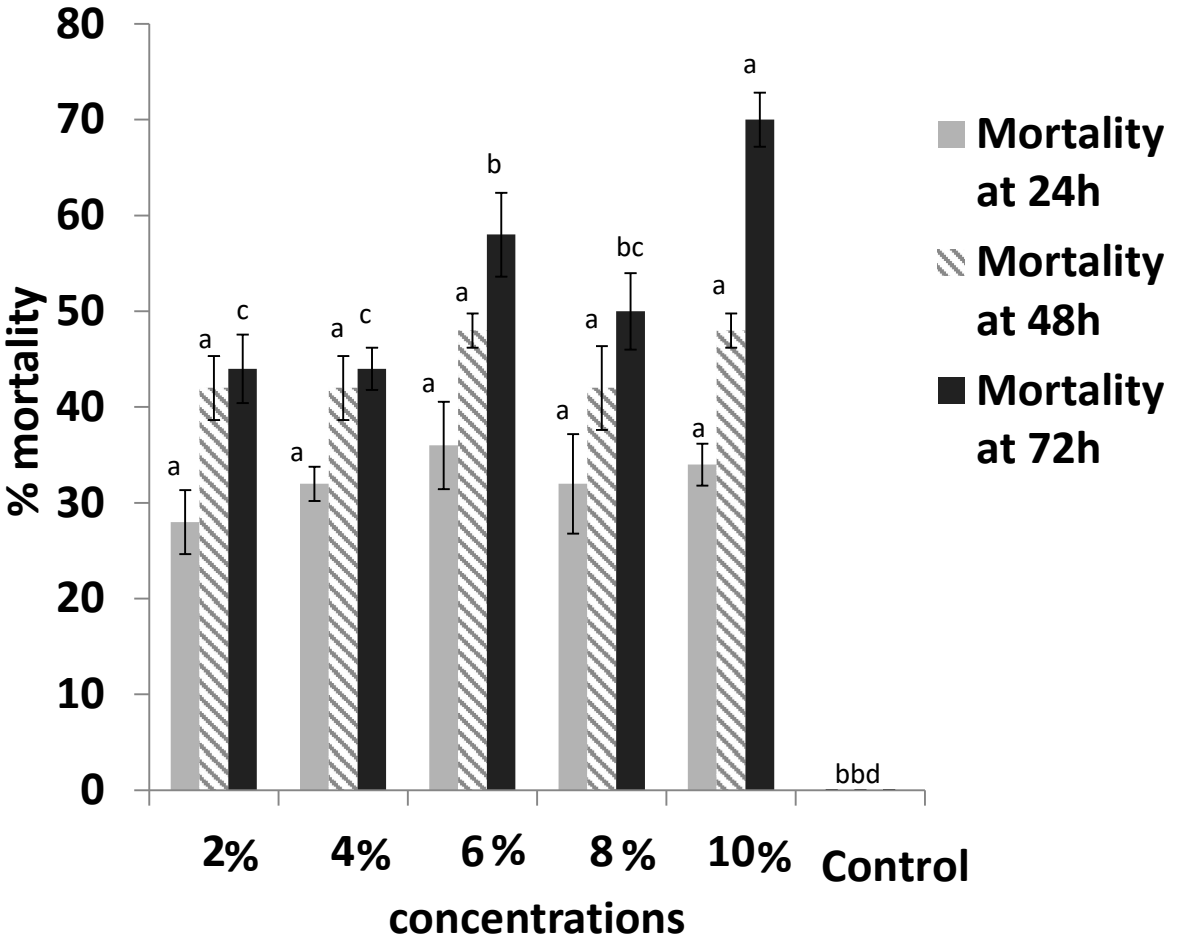

figure 4: Contact toxicity of different concentrations of moringa seed oil extract on adult male *B. dorsalis*.

DISCUSSION

In this study, there was significant difference between the concentrations of seed oil extracts in female and male mortalities when neem was topically applied. Mortality was observed in male and female adult fruit flies probably due to the neem's active compound, azadirachtin, which has been shown to disrupt insect growth and feeding behaviors, effectively reducing pest populations without adversely affecting beneficial organisms (Kilani-Morakchi *et al*., 2021). Hasan and Ansari, (2011), also reported that neem-based insecticides had toxic effects on cabbage moth.

In this study moringa seed oil extract showed no significant difference in the mortality rate of both male and female fruit fly

on the different concentrations used compared to the neem seed oil extract.

This is probably due to the lower efficacy of the pesticidal active ingredients in moringa when compared to neem. Although recent studies have compared the pesticidal efficacy of neem (*Azadirachta indica*) and moringa (*Moringa oleifera*), indicating that neem often exhibits superior pest control properties. For instance, Shah *et al*. (2017) reported that neem seed extract significantly reduced aphid infestation, leading to higher yields, whereas moringa leaf extract was less effective in comparison to wheat aphid management. This agrees with Irikannu *et al.,* (2015) that moringa seed oil has poor mortality effects on *Tribolium castaneum* and *Tribolium confusum*.

There was increase in mortality as concentrations and time increased for both neem and moringa seed oil extracts (males and females). This is probably due to the residual effects of biopesticides on fruit flies. This agrees with the findings of (Zanuncio *et al*., 2016) and Mordue and Blackwell (1993), they referred to neem effects as dose and time dependent on insect pest management.

CONCLUSION

The study indicates that the effects of both neem and moringa seed essential oil extracts on pest management are dosage and time effective. The more the dosage and longer the duration, the higher the effect in the mortality rate of the fruit fly.

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Conflicts of Interest: There was no conflict of interest during and after the course of this work.

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