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(RESEARCH ARTICLE)

EFFECT OF AQUEOUS EXTRACTS OF *AZADIRACHTA INDICA*, *MENTHA SPICATA* AND *MENTHA PIPERITA* ON FRUIT FLIES IN CUCUMBER (*CUCUMIS SATIVUS*) CROPS IN SOUTH OF CÔTE D'IVOIRE

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ABSTRACT

The use of synthetic chemical insecticide against pests in vegetable crops is effective but has harmful consequences for humans and the environment. It is therefore necessary to find effective alternatives to chemical insecticides that are safe for human health and the environment. The aim of this study is to evaluate the effect of aqueous extracts from three local plants, *Azadirachta indica*, *Mentha spicata* and *M. piperita* on the fruit flies *Bactrocera cucurbitae* and *B. dorsalis* in cucumber crops in the locality of Dabou. The experimental plot was laid out in a randomised block design, each block comprising eleven sub-plots, including one untreated control plot and ten treated plots. The aqueous extract of *A. indica* seeds at concentrations of 30 g/l and 40 g/l proved to be more effective, with average fruit infestation rates of 10.02 ± 0.25 % and 10.19 ± 0.15%, and average infestation reduction rates of 80.05 ± 0.57 % and 81.23 ± 0.92 %. The aqueous extract of *A. indica* seeds at concentrations of 30 g/l and 40 g/l also resulted in higher average net yields of 67.95 ± 0.21 t/ha and 68.12 ± 0.48 t/ha. The aqueous extract of *A. indica* seeds could be used as an alternative to chemical insecticides for the control of fruit flies in cucumber cultivation.

Keywords: Cucumber, Aqueous extracts, *Azadirachta indica, Bactrocera cucurbitae*, *B. dorsalis*.

1 INTRODUCTION

Vegetable crops is an important role in human nutrition and contribute significantly to household incomes in West Africa, but their production is hampered by several pests that limit their productivity [1]. In Côte d'Ivoire, the cucumber (*Cucumis sativus*) is an important vegetable crop that contributes to food security [2,3]. However, this crop is affected by the damaging action of several insect pests, including *Bactrocera cucurbitae* and *B. dorsalis*, two species of fruit flies

that cause considerable damage [4]. To control these flies, chemical control based on the use of to control these flies, chemical control based on the use of synthetic insecticides is commonly employed. Unfortunately, the overuse of synthetic insecticides has adverse effects on public health, the environment and non-target fauna and also leads to insect resistance [5]. Given the harmful effects associated with the overuse of chemical insecticides, there is a pressing need to explore alternative control methods. Current trends are moving towards the use of biopesticides, which are thought to offer significant benefits for human health and the environment. We are therefore undertaking this study to control *Bactrocera cucurbitae* and *B. dorsalis* in cucumber crops using aqueous extracts of local plants from Côte d'Ivoire.

2 MATERIALS

2.1 Study area

The study was carried out in Dabou, a locality in south of Côte d'Ivoire. The climate of this area is sub-equatorial, characterised by two annual rainy seasons (April to mid-July and September to November) and two dry seasons (mid-July to August and December to March).

2.2 Plant material

The plant material consisted of Tokyo variety cucumber, leaves of *Mentha spicata* and *M. piperita*, and seeds of *Azadirachta indica.*

3 METHODS

3.1 Preparation of aqueous extracts

Three plants were used to prepare aqueous extracts, the seeds of *A. indica*, the leaves of *M. piperita* and *M. spicata.*

The aqueous extract of neem seeds was prepared according to the protocol by [6]. Ripe neem seeds were harvested and dried in the shade for four weeks. They were then shelled and ground using a blender. A quantity of the ground material was weighed, mixed with distilled water in a bucket and left well covered for 24 hours. This mixture was filtered through a sieve and then through muslin to obtain the aqueous extract of *A. indica* seeds. Three concentrations were prepared (20 g/l; 30 g/l and 40 g/l).

The aqueous extracts of *M. spicata* and *M. piperita* leaves were prepared according to the protocol by [7]. Freshly leaves of *M. spicata* and *M. piperita* were harvested and dried in the shade during four weeks. These dried leaves were ground to using a blender until a fine powder was obtained. A quantity of 100 g of powder obtained from each plant species was diluted in 200 ml of distilled water. The mixture (powder + distilled water) was then homogenised in the blender for ten minutes. Two further filtrations were carried out, one using Whatman filter paper and the other using a funnel lined with cotton wool. The product obtained from these filtrations was placed on melamine plates and then concentrated by evaporation in an oven set at 50 °C for 48 hours, until a dry residue was obtained. The dry residue obtained from each plant species was also used to prepare three concentrations of aqueous extracts : 30 g/l, 40 g/l and 50 g/l. A chemical insecticide used as a reference was diluted to the recommended dose for treating the plants.

3.2 Experimental field

The experimental plot was laid out in a randomised block design comprising sub-plots. It covered an area of 708.10 $m^2$with a length of 36.5 metres and a width of 19.4 metres. It consisted of three blocks separated from one another by 2.5 metres. Each block comprised 11 sub-plots, including one untreated control plot and 10 treated plots. To prevent cross-contamination between the sub-plots during treatment, they were spaced 2 metres apart. Each sub-plots consisted of two rows of 10 plants spaced 0.60 metres apart, making a total of 20 treated plants per sub-plots.

3.3 Treatments of cucumber plants

Four backpack sprayers were used to treat the crops. One was used to apply the chemical insecticide. The other three were used to apply aqueous extracts of *A. indica* seeds, *M. piperita* leaves and *M. spicata* leaves. Different concentrations of each plant extract were applied to the cucumber plants in the experimental plot. The plants were treated weekly from the14th day after sowing until the end of the fruit harvest.

3.4 Assessment of efficacy the aqueous extracts

During the fruiting stage, every week five days after treatment, all fruits were harvested on 10 plants selected at random from each experimental plot. The numbers of healthy and infested fruits were counted and weighed. The fruit infestation rates and reduction of infestation, as well as the gross and net yields, were calculated using the following formulae:

$$\text{Infestation rate} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits harvested}} \times 100$$

$$\text{Rate of reduction infestation} = \frac{\text{Number of infested fruits in the control plot} - \text{Number of infested fruits in the treated plot}}{\text{Number of infested fruits in the control plot}} \times 100$$

$$\text{Gross yield} = \frac{\text{Weight of healthy and infested fruits}}{\text{Corresponding area}}$$

$$\text{Net yield} = \frac{\text{Weight of healthy fruits}}{\text{Corresponding area}}$$

4 RESULTS

4.1 Average fruit infestation rates

The average fruit infestation rates recorded on the control plot and the plot treated with a chemical insecticide were 52.79 ± 0.17 % and 4.34 ± 0.41 % respectively.The aqueous extract of *A. indica* seeds at concentrations of 30 g/l and 40 g/l recorded the lowest average fruit infestation rates, which were 10.02 ± 0.25% and 10.19 ± 0.15% respectively compared with the aqueous extracts of *M. spicata* and *M. piperita* leaves, which recorded average infestation rates ranging from 21.71 ± 0.83% to 33.65 ± 1.32% for all concentrations (30 g/l, 40 g/l and 50 g/l) (**Figure 1**).

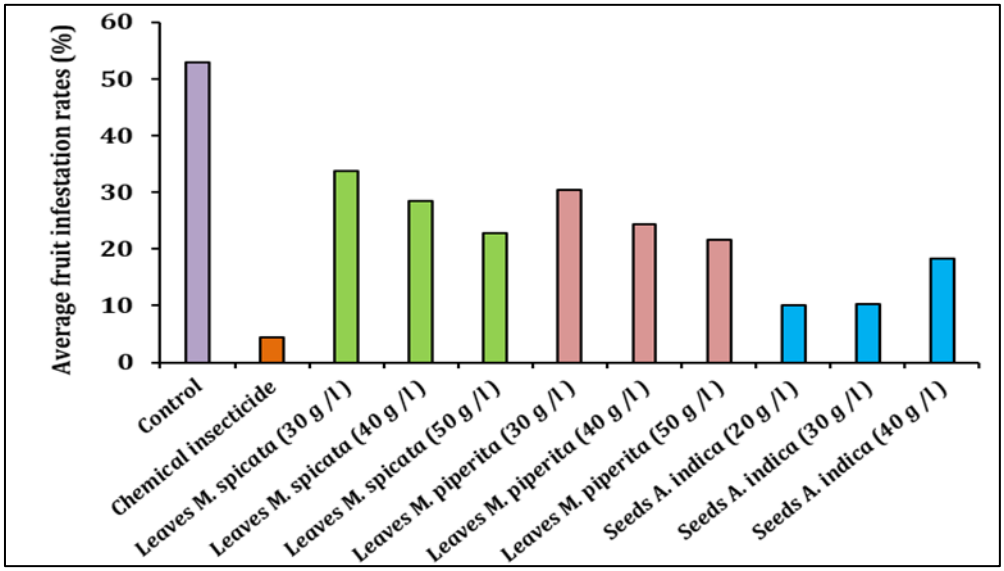


Figure 1: Average infestation rates of cucumber fruit according to the chemical insecticide and the concentrations of the aqueous extracts applied.

4.2 Average fruit infestation reduction rates

The chemical insecticide resulted in an average infestation reduction rate of 91.43 ± 0.67%. The aqueous extracts leaves of *M. spicata and M. piperita* at concentrations of 40 g/l and 50 g/l registered of average infestation reduction rates ranging from 51.97 ± 0.42% to 58.03 ± 0.74%. The aqueous extract of *A. indica* seeds at concentrations of 30 g/l and 40 g/l recorded highest average infestation reduction rates, which ranged from 80.05 ± 0.57 % to 81.23 ± 0.92 %. (**Figure 2**).

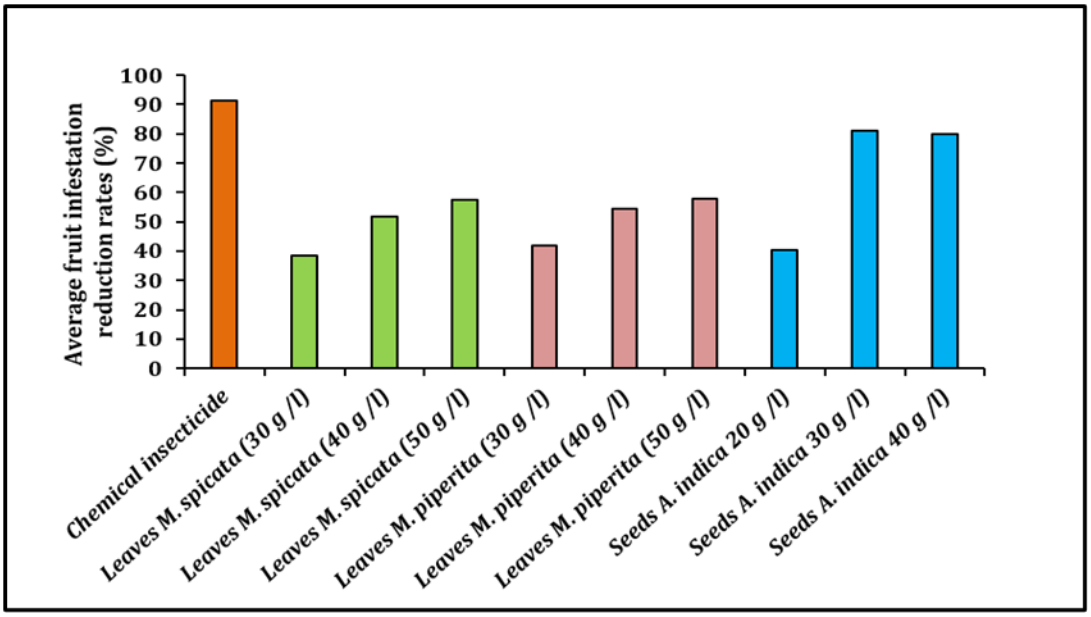


Figure 2: Average rates reduction o f cucumber fruit infestation according to the chemical insecticide and the concentrations of the aqueous extracts applied.

4.3 Number of infested and healthy fruits

The average numbers of healthy and infested fruits in the control plots were 48.32 ± 0.57 and 65.73 ± 0.82, respectively. On plots treated with the chemical insecticide, the average numbers of healthy and infested fruits were 215.61 ± 1.57 and 10.34 ± 0.48 respectively. The aqueous extract of *A. indica* seeds at concentrations of 30 and 40 g/l registered the lowest average numbers of infested fruits, ranging from 18.95 ± 1.26 to 19.43 ± 0.72 and the highest mean numbers of healthy fruits, ranging from 199.17 ± 1.41 to 201.33 ± 0.82, compared with the aqueous extracts of *M. spicata* and *M. piperita,* which recorded average numbers of infested fruits ranging from 32,18 ± 0.33 and 42 ± 0.57 and average numbers of healthy fruits ranging from 88.33 ± 1.72 to 149.25 ± 0.66 at all concentrations (30 g/l; 40 g/l and 50 g/l) (**Table**).

4.4 Average gross and net yields

The aqueous extract of *A. indica* seeds at concentrations of 30 and 40 g/l was the aqueous extract that registered the highest average gross and net yields. Average gross yields were 78.75 ±1.48 t/ha and 79.67 ± 0.93 t /ha. Average net yields were 67.95 ± 0.21 t/ha and 68.12 ± 0.45 t/ha (**Table**).

Table 1: Average numbers of healthy and infested fruits and yields according to the concentrations of aqueous extracts applied and the chemical insecticide.

Aqueous extracts	Concentrations (g/l)	Average number of healthy fruits	Average number of infested fruits	Average gross yields (t/ha)	Average net yields (t/ha)
Leaves of *M. spicata*	30	88.33 ± 1.72^{h}	42.33 ± 0.57^{b}	53.95 ± 0.17^{g}	30.02 ± 0.10^{h}
	40	96.66 ± 0.88^{g}	37.89 ± 0.25^{c}	56.41 ± 0.70^{f}	35.34 ± 0.43^{g}
	50	122.53 ± 0.66^{e}	38.66 ± 0.54^{c}	70.36 ± 0.17^{d}	48.47 ± 0.22^{e}
Leaves of *M. piperita*	30	90.33 ± 0.39^{h}	41.74 ± 1.16^{b}	55.66 ± 0.17^{g}	32.31 ± 0.58^{h}
	40	103.66 ± 0.45^{f}	32.18 ± 0.33^{d}	57.13 ± 0.35^{f}	38.45 ± 0.84^{f}
	50	149.25 ± 0.66^{c}	33.56 ± 0.62^{d}	73.64 ± 0.78^{c}	59.43 ± 0.51^{c}
Seeds of *A. indica*	20	140.33 ± 1.20^{d}	26.51 ± 0.33^{e}	67.31 ± 0.71^{e}	56.97 ± 0.19^{d}
	30	201.33 ± 1.41^{b}	19.43 ± 0.72^{f}	78.75 ± 1.48^{b}	67.95 ± 0.21^{b}

	40	199.17 ± 0.82[b]	18.95 ± 1.26[f]	79.67 ± 0.93[b]	68.12 ± 0.45[b]
Chemical insecticide	0.093	215.61 ± 1.57[a]	10.34 ± 0.48[g]	85.90 ± 0.52[a]	76.53 ± 0.18[a]
Control		48.32 ± 0.57[i]	65.73 ± 0.82[a]	38.43 ±0.35[h]	14.83 ± 0.09[i]

Means followed by the same letters in the same column are not significantly different according to the Newman-Keuls test at the 5% significance level.

5 DISCUSSION

The number of fruits, infestation rates, rates of reduction fruit infestation, gross and net yields varied according to the concentrations of the aqueous extracts applied.The three aqueous extracts recorded, at all concentrations, in lower fruit infestation rates than those observed on the untreated control plot. The aqueous extracts of *M. spicata* and *M. piperita* at concentrations of 40 g/l and 50 g/l reduced fruit infestation more than 50 %. These aqueous extracts are thought to have prevented a large number of flies from laying eggs on the fruit due to their repellent effect, which has been demonstrated by several authors. [8]**,** in his research on the use of *M. spicata* and *M. piperita* in New Caledonia, revealed the repellent effect of these plants on the fruit flies *Bactrocera curvipennis*, *B. psidii* and *B. tryoni*. [9] reported the repellent activity of mints against the fruit fly *Anastrepha ludens.* [10] also reported that mint extracts repelled several groups of insects. The repellent and insecticidal properties of mint extracts are governed by their major and minor constituents, which are thought to act synergistically to enhance their effect [11]. Indeed, according to [12], mint extracts interfere with the fundamental metabolic, biochemical, physiological and behavioural functions of insects. They act locally or at a distance, deterring the insect from flying or descending to sting the fruit. The aqueous extract of *A. indica* seeds at concentrations of 30 g/l and 40 g/l registered at high average rates of infestation reduction compared with the other aqueous extracts. This is thought to be due to the insecticidal activity of *A. indica,* linked to the presence of azadirachtin, which acts in certain insects as a growth and reproductive disruptor, thereby preventing hormone secretion. Our results are similar to those of [13] who reported that aqueous extracts of *A. indica* were effective in controlling watermelon fruit flies in Burkina Faso. Our results are also similar to those of [14,15] who reported that extracts from the seeds of *A. indica* were effective against pests on melon and cucumber crops, respectively.The aqueous extract of *A. indica* almonds is reported to have had a repellent effect on *B. cucurbitae* and *B. dorsalis***,** as reported by [16] for *B. cucurbitae* and by [17] for *B. zonata* in their studies. The aqueous extract of *A. indica* seeds at concentrations of 30 g/l and 40 g/l registered at higher yields. Similar results were reported by [18] who, in their studies, achieved higher yields on tomato plots treated with garlic and basil extracts. Similar results were also reported by [19] who recorded higher cabbage yields on plots treated with hydroethanolic extract of neem leaves during their studies.

6 CONCLUSION

The study revealed that the aqueous extract of *A. indica* seeds was more effective than the other aqueous extracts. It considerably reduced fruit infestation caused by fruit flies at concentrations of 30 g/l and 40 g/l and significantly improved average net yields. The aqueous extract of *A. indica* seeds could be recommended as an alternative to the use of chemical insecticides for the control of fruit flies in cucumber cultivation.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare that there is no conflict of interest.

Authors' Contributions

- ASSI A.N.M. and OBODJI A. contributed to the conduct of this study and writing of the manuscript.
- N'GUESSAN E. N. M. and YAO N. contributed by proposing this journal and writing of the manuscript.

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