



Comparative Efficacy of *Ocimum basilicum* and *Ocimum gratissimum* Essential Oils Against *Cyclas puncticollis* Infesting Sweet Potatoes in Burkina Faso

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Authors' contributions

This work was carried out in collaboration among all authors. Author RS designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors DO, BN and EM managed the analyses of the study. Authors GK and SN managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The aim of the present study was to compare the insecticidal effect of the essential oils *Ocimum basilicum* and *Ocimum gratissimum* on the sweet potato weevil *Cyrtolabus puncticollis*.

Study Design: The aim of this approach was to contribute to the management of the sweet potato weevil in Burkina Faso.

Place and Duration of Study: The experiments were carried out at the INERA Entomology laboratory in Bobo-Dioulasso during the cropping season 2022-2023.

Methodology: Five essential oil concentrations (25; 50; 75; 100 and 125 µL/L) were used. Toxicity tests were carried out by fumigation in jars by depositing a charge of essential oil on a 6 cm disc of filter paper. Batches of ten *C. puncticollis* adults were introduced into the jars containing a fresh, healthy tuberous root of the sweet potato and immediately closed. Each test was repeated five times. The number of dead insects in each batch (treated and untreated jars) was counted every 30 min up to 5 h of exposure and for 4 days (24 h, 48 h, 72 h and 96h) per observation.

Results: The results showed that the different oils had an insecticidal effect on *C. puncticollis* and that these oils contained chemical substances responsible for the mortality observed. Indeed, mortality rates of 100% were observed after 2 hours of exposure of the weevils with the 125µL/L concentration of *O. gratissimum*, followed by concentrations of 100µL/L, 75µL/L, 50µL/L after 24 hours and 48 hours with 25µL/L. With *O. basilicum* essential oil, 100% mortality was observed after 24 hours of weevil exposure with *O. basilicum* concentrations of 125µL/L and 100µL/L, followed by 98% mortality with concentrations of 75µL/L, 50µL/L and 25µL/L after 96 hours.

Conclusion: These results suggest that the essential oils of *Ocimum gratissimum* and *Ocimum basilicum* can be used in the management of *C. puncticollis*. However, it would be necessary to carry out a concrete application of these oil extracts on large potato stocks in order to confirm or not their efficacy.

Keywords: Oil; essential; weevils; sweet; potato.

1. INTRODUCTION

In Burkina Faso, sweet potato (*Ipomea batata* (L)) is the main tuber crop produced, ahead of yam and potato (DGESS, 2022). Production takes place in almost all areas of the country, but the largest production areas are in the provinces of Sissili and Nahouri, in the south of the country, and in the province of Kéné Dougou in the southwest (DGESS, 2022). Most of the varieties produced are white-fleshed, but orange-fleshed sweet potato varieties are increasingly being offered to growers. They are rich in β carotenoids, a precursor of vitamin A. They are a means of combating vitamin A deficiency, which in Burkina Faso affects children under 5. Sweet potato production in Burkina Faso fell from 167,550 tons in 2013 (DGESS, 2014) to 114,925 tons in 2021 (DGESS, 2022). This drop in production could be explained mainly by soil poverty, insufficient water, diseases, climatic hazards, edaphic conditions, and insect pests (Alghali et al., 1994, Okonya et al., 2014). The sweet potato weevil species *Cyrtolabus puncticollis* Boheman has been identified as the main pest of sweet potato tuberous roots (Koussoubé et al., 2018). This species exerts strong pressure on both the crop and the tuberous roots. Sweet

potato cultivation is by nature seasonal. It is therefore necessary to store the harvest in order to make it available to consumers at the right time. As the crop is not normally processed, it is the whole roots, which may contain 60 to 80% water, that are stored throughout the period prior to marketing or self-consumption. Losses of tuberous roots can reach 100%, depending on the sweet potato variety, during storage (Baimey et al., 2017). By allowing the eggs of the insect pest to remain inside the tuberized roots, the larvae develop by digging holes, resulting in huge losses to production and consequently reduced income for growers. Growers are powerless to cope with the damage caused by this pest to post-harvest roots, as control methods are essentially based on indigenous practices and the use of chemical insecticides. The growing popularity of organic production lines has led to an interest in non-chemical disinfection treatments, as the use of chemicals for insect management has become problematic (FAO, 2015). The search for alternative methods of protecting stored sweet potato tuberous roots through the use of plant extracts such as essential oils with insecticidal effect is promising in the management of sweet potato weevil. In recent years, numerous studies have highlighted

the insecticidal and insect-repellent potential of essential oils from a number of aromatic plants (Bouzouita et al., 2008; Camara, 2009; Mostafa et al., 2014; Kanko et al., 2017; Asmae et al., 2018). Essential oils and their constituents are biologically active by direct contact or sprinkling with a very diverse spectrum of action (Cissokho et al., 2015; Asmae et al., 2018). *Ocimum basilicum* and *O. gratissimum* oils have been selected to assess their insecticidal properties as part of the search for alternatives to chemical control. The objective of this study was to evaluate the insecticidal effect by fumigation of essential oils of *O. basilicum* and *O. gratissimum* on *C. puncticollis* Boheman, the main sweet potato insect pest.

2. MATERIALS AND METHODS

2.1 Study Site

The experiments were carried out at the INERA Entomology Laboratory in Bobo-Dioulasso. In the laboratory, the mean temperature was $29.43 \pm 2.71^\circ\text{C}$ and relative humidity $67.64 \pm 5.36\%$.

2.2 Plant Materials

The aerial parts of *O. gratissimum* and *O. basilicum* were harvested. The white-fleshed tuberous roots of the Djankani variety of sweet potato used for efficacy testing came from a crop planted at Bama, a town located 30 km North-West of Bobo-Dioulasso.

2.3 Animal Material

The adult sweet potato weevil *C. puncticollis* Boheman was used for the biological tests. The populations used were derived from mass rearing in the laboratory.

2.4 Laboratory Equipment

The following equipment was used in the laboratory:

- a 50 ml test tube was used to measure the quantities of the various solutions
- muslin cloth (5mm) to cover the plastic tubs containing the attacked potatoes.
- glass bottles for testing essential oils.
- scissors for cutting blotting paper.
- Whatman paper (110 mm diameter) to absorb the various quantities of neem extract solutions to be tested.

- a 1000 μl micropipette for pipetting the various solutions.

2.5 Methods

2.5.1 Weevil rearing

The weevils were reared in the entomology laboratory at 37°C . White-fleshed tuberous roots of the Djankani variety of sweet potato infected with *C. puncticollis* Boheman were taken from a farm in Bama. In the laboratory, infected samples devoid of adults were stored in plastic bins (80 cm x 30 cm x 50 cm). Each bin was closed with muslin cloth to ensure good aeration and prevent the insects from escaping. Old potatoes no longer containing larvae were removed from the bins and replaced.

2.5.1.1 Essential oil extraction

Ocimum gratissimum L and *O. basilicum* L leaves were harvested at IRSAT-Bobo and brought to the laboratory prior to essential oil extraction. The essential oils were obtained by steam distillation using a 250-litre stainless steel still. The steam entrainment principle used in this study is similar to that described by Tia et al. (2019). The essential oil yield was determined by processing 5 kg of fresh plant material, then the oil sample was stored at 4°C protected from light until their use.

The extraction yield of the essential oil was determined according to the following formula:

$$\text{Yield (\%)} = \frac{\text{mass(g)essential oil}}{\text{mass(g)vegetable matter}} \times 100$$

(Equation 1)

2.5.1.2 Essential oil extraction process

The essential oil was extracted from dried fresh leaves by hydrodistillation. The fresh leaves were harvested at IRSAT-Bobo. Extraction took place in the laboratory, using a device comprising gas, a decanting bulb and two tanks, one for distillation and the other for cooling.

After collecting the leaves and cleaning the apparatus, the fresh leaves were placed and packed in the distillation tank. Five liters of water were added and the fire was lit after opening the gas. Sometime after cooking, the water vapor mixed with the essential oil rises through the pipes to reach the cooling tank. Here, the steam containing the oil gradually cools as it passes through the coil immersed in water. This is how

the first refluxes into the decantation bulb takes place. This collects the floral water mixed with the essential oil, helping it to settle. As the ampoule filled, we opened it periodically to drain off the floral water and retain the essential oil. After a minimum of three hours, extraction was complete. With three fifty kg bags of fresh leaves, we obtained around eighty (80) ml of essential oil.

2.5.1.3 Fumigation toxicity of essential oils

Five doses of essential oils corresponding to the following respective concentrations (25; 50; 75; 100 and 125 µL/L air), calculated in relation to the volume of air in the jars (µL/L), are used in a single application. Toxicity tests are carried out by fumigation in 1 L canning jars (glass), by depositing a charge of essential oil on a 6 cm diameter filter paper disk (disk adapted to the base of the jar) to promote its evaporation into the jars. Subsequently, batches of ten unsexed adult insects of *C. puncticollis* are introduced into the jars containing a fresh, healthy tuberous root of the sweet potato. The jars are immediately sealed. Each trial is repeated four times (4 replicates). The number of dead insects in each batch (treated and untreated jars) is counted every 24 h of exposure and for 4 days (24 h, 48 h, 72 h and 96 h) by observation with a hand-held magnifying glass, and the corrected percentage mortality is expressed according to Abbott's (1925) formula.

$$MC (\%) = \frac{(Mt - Mo)}{(100 - Mo)} \quad (\text{Equation 2})$$

With:

Mc: corrected mortality in percent

Mt: mortality in treated batch

Mo: mortality in untreated control batch

2.5.2 Statistical analysis

The Microsoft Office 2019 Excel spreadsheet was used to enter and process the data collected and to produce the various graphs. R software version 3.6.2 was used for statistical analysis. The distribution of the data did not follow the normal distribution law. A non-parametric Kruskal-Wallis analysis was performed to detect differences between treatments. When there was a significant difference between treatments, pairwise comparison of means was performed using the pairwise t-test at the 5% threshold.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Average mortality rate of *Cylas puncticollis* adults to different concentrations of *Ocimum gratissimum* as a function of exposure time

Fig. 1 shows the results of the mean mortality rates of *C. puncticollis* adults to different concentrations of *O. gratissimum* oil as a function of exposure time of *C. puncticollis* adults. Whatever the concentration of *O. gratissimum* oil, mean mortality rates increased with the duration of exposure of *C. puncticollis* adults. The analysis of variance (ANOVA) revealed a highly significant difference between mortalities, with 100% mortality of *C. puncticollis* observed from the 48th to the 96th hour of exposure with 25µL/L concentration of *O. gratissimum*. Mortality rates of *C. puncticollis* increased progressively from the 30th minute to the 24th hour. The ANOVA showed a highly significant difference between mortalities and 100% mortality of *C. puncticollis* from the 24th hour to the 96th hour of exposure with 50µL/L, 75µL/L and 100µL/L concentrations of *O. gratissimum*. Mortality rates of *C. puncticollis* increased progressively from the 30th minute to the 5th hour. Finally, the 125µL/L concentration of *O. gratissimum* induced significant differences between mortalities, and 100% mortality of *C. puncticollis* was observed from the 2nd hour to the 96th hour of exposure.

3.1.2 Average mortality rate of *Cylas puncticollis* adults to different concentrations of *Ocimum basilicum* as a function of exposure time

Fig. 2 shows the results of mean mortality rates of *C. puncticollis* adults to different concentrations of *O. basilicum* oil as a function of exposure time. Mean mortality rates increased with the duration of exposure of *C. puncticollis* adults whatever the concentration of *O. basilicum*. With 25µL/L concentration of *O. gratissimum* the ANOVA revealed a highly significant difference between observed mortalities, with 94% mortality of *C. puncticollis* observed from the 96th hour of exposure. With the 50µL/L and 75µL/L concentrations, the ANOVA showed that there was a highly significant difference between observed *C. puncticollis* adult mortalities and 98% *C. puncticollis* mortality was observed from the 96th

hour of exposure. With concentrations of 100µL/L and 125µL/L, the ANOVA revealed that there was a highly significant difference between observed *C. puncticollis* adult mortalities, with 100% *C. puncticollis* mortality observed from the 24th to the 96th hour of exposure. The mortality rate of *C. puncticollis* increased progressively whatever the concentration of *O. basilicum*.

Table 1. Average mortality rate of *Cylas puncticollis* adults exposed to different concentrations of *Ocimum gratissimum* as a function of exposure time

Time	Concentrations of <i>Ocimum gratissimum</i>				
	25µL/L	50µL/L	75µL/L	100µL/L	125µL/L
30min	18.00±6.43a	4.00±0.84a	8.00±2.02a	8.00±2.40a	70.00±10.35a
1h00mn	32.00±4.50a	6.00±1.04ab	22.00±6.93ab	22.00±6.67ab	82.00±8.36ab
1h30mn	40.00±8.02a	32.00±8.34bc	32.00±7.30ac	32.00±7.30bc	94.00±8.94b
2h00mn	44.00±8.34ab	44.00±10.34cd	52.00±10.39acd	52.00±9.44cd	100.00±0.00b
2h30mn	52.00±9.44bc	48.00±11.24cd	56.00±11.54ace	56.00±11.54de	100.00±0.00b
3h00mn	52.00±9.44bc	56.00±11.54cd	62.00±12.54bce	62.00±12.54df	100.00±0.00b
3h30	52.00±9.44c	60.00±10.70cd	66.00±13.06bce	62.00±12.54df	100.00±0.00b
4h00mn	54.00±9.54cd	68.00±11.54d	72.00±12.16ce	72.00±12.16ef	100.00±0.00b
4h30mn	66.00±10.44cd	72.00±13.54de	72.00±12.16ce	72.00±12.16ef	100.00±0.00b
5h00mn	68.00±1.194cd	72.00±13.54de	72.00±13.16ce	72.00±12.16ef	100.00±0.00b
24h00mn	78.00±12.40de	100.00±0.00e	100.00±0.00e	100.00±0.00f	100.00±0.00b
48h00mn	100.00±0.00de	100.00±0.00e	100.00±0.00de	100.00±0.00f	100.00±0.00b
72h00mn	100.00±0.00de	100.00±0.00e	100.00±0.00de	100.00±0.00f	100.00±0.00b
96h00mn	100.00±0.00de	100.00±0.00e	100.00±0.00e	100.00±0.00f	100.00±0.00b
Probability	4.56.10⁻¹²	2.10⁻¹⁶	6.39.10⁻¹⁰	6.39.10⁻¹⁰	1.16.10⁻³
Significance	VHS	VHS	VHS	VHS	S

Means followed by the same letter are not significantly different according to the pairwise-t-test at the 5% threshold; VHS: very highly significant; S: significant

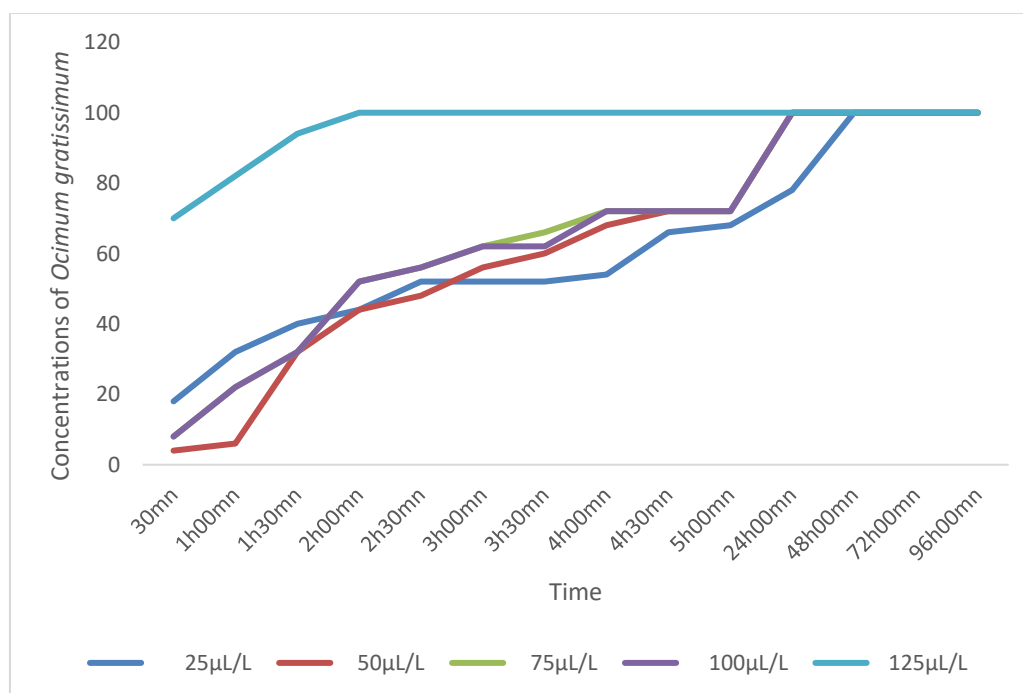


Fig. 1. Average mortality rate of *Cylas puncticollis* adults exposed to different concentrations of *Ocimum gratissimum* as a function of exposure time

Table 2. Average mortality rate of *Cylas puncticollis* adults to different *Ocimum basilicum* concentrations as a function of exposure time

Time	Concentrations of <i>Ocimum basilicum</i>				
	25µL/L	50µL/L	75µL/L	100µL/L	125µL/L
30min	8.00±2.36a	10.00±2.34a	0.00±0.00a	18.00±5.24a	26.00±5.84a
1h00mn	8.00±2.36a	10.00±2.34a	0.00±0.00a	32.00±6.24ab	40.00±9.47a
1h30mn	8.00±2.36a	10.00±2.34a	0.00±0.00a	40.00±5.24ab	44.00±10.77a
2h00mn	8.00±2.36a	12.00±3.44a	2.00±0.24a	44.00±6.29abc	50.00±9.49a
2h30mn	14.00±4.40a	12.00±3.44a	2.00±0.24a	52.00±8.24abc	52.00±9.86a
3h00mn	8.00±2.40a	12.00±3.44a	4.00±0.84a	52.00±8.24abc	54.00±10.90a
3h30mn	12.00±3.44a	12.00±3.44a	4.00±0.84a	54.00±9.64abc	54.00±10.90a
4h00mn	14.00±4.40a	18.00±5.24a	10.00±2.24ab	66.00±10.44bd	62.00±11.49ab
4h30mn	14.00±4.40a	22.00±4.84a	26.00±5.47bc	68.00±10.94abd	68.00±11.83ab
5h00mn	14.00±4.40a	24.00±5.25a	32.00±4.47c	78.00±9.54cd	68.00±11.83ab
24h00mn	24.00±5.25a	30.00±6.24a	36.00±5.47c	100.00±0.00d	100.00±0.00b
48h00mn	72.00±10.40b	92.00±12.03b	94.00±11.40d	100.00±0.00d	100.00±0.00b
72h00mn	83.00±12.40bc	98.0±4.47b	94.00±11.40d	100.00±0.00d	100.00±0.00b
96h00mn	94.00±5.47c	98.00±4.47b	98.00±4.47d	100.00±0.00d	100.00±0.00b
Probability	2.10 ⁻¹⁶	2.10 ⁻¹⁶	2.10 ⁻¹⁶	4.56.10 ⁻¹²	7.61.10 ⁻⁸
Significance	VHS	VHS	VHS	VHS	VHS

Means followed by the same letter are not significantly different according to the pairwise-t-test at the 5% threshold; VHS: very highly significant

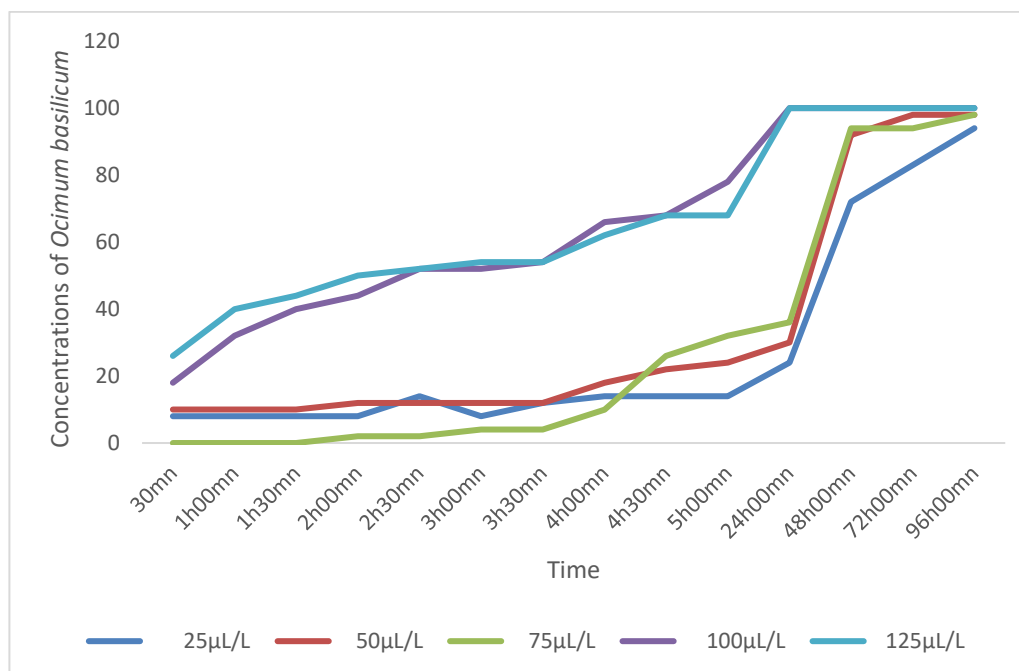


Fig. 2. Average mortality rate of *Cylas puncticollis* adults to different *Ocimum basilicum* concentrations as a function of exposure time

3.2 Discussion

The results of our studies indicate that different concentrations (25, 50, 75, 100 and 125µL/L) of *O. gratissimum* and *O. basilicum* essential oils were toxic to *C. puncticollis* adults after different exposure times.

Ocimum gratissimum essential oil was effective against *C. puncticollis*. After application at different concentrations to *C. puncticollis*, high mortality rates were observed. These results could be explained by the presence of molecules such as thymol (29.5%), γ-terpinene (20, 5%) and p-cymene (12, 9%) as major constituents of the essential oil (Coulibaly et al., 2023). In

Burkina Faso, *O. gratissimum* essential oil contains γ -terpinene, which is the most abundant compound (20, 95%), followed by thymol (18, 56%) and p-cymene (11, 73%) (Ouédraogo et al., 2016). Analytical studies of *O. gratissimum* essential oil reveal the presence of hydrocarbon monoterpene (44, 9%) and oxygenate monoterpenes (41.8%) (Coulibaly et al., 2023). Plant essential oils contain monoterpenoid compounds that are toxic to insects, destroying the nervous system (Houghton et al., 2006). These compounds could be responsible for the mortality of the insect pest that is reported in this study. These results confirm the insecticidal properties of these essential oils. Indeed, the work of Konstantopoulou et al. (1992) revealed that monoterpenes in essential oils are toxic to many insects. According to Cloyd and Chiasson (2007), this oxygenated compound acts directly on the cuticle of insects and mites, causing its degradation. Thymol, one of the main compounds, interferes with synapse activity, preventing respiration by suffocation and leading to insect death (Priestley et al., 2003; Gonzalez et al., 2013). Similar results were reported by Tchoumboungang et al. (2009) on *Anopheles gambiae* larvae in Cameroon and Ouédraogo et al. (2016) on the main insect pests of maize in storage in Burkina Faso. Previous studies had shown that *C. citratus* and *O. canum* essential oils have significant insecticidal activity against certain insects, notably *Anopheles gambiae* Giles larvae (Tchoumboungang et al., 2009), *Pectinophora gossypiella* Saunders adult insects (Kobenan et al., 2018), *Aphis gossypii* aphids (Akantetou et al., 2011). *Ocimum basilicum* oil generated a high mortality rate at all concentrations. From the minimum to the maximum concentration, mortality rates exceeded 90%. This could be explained by the fact that chemical compounds such as alkaloids, tannins, terpenes, steroids, flavonoids and phenols contained in the oil could disrupt the nervous system of *C. puncticollis*, preventing the transmission of nerve signals, leading to paralysis and death of the weevils. The work of Tshimenga et al. (2018) identified the presence of the same chemical compounds alkaloids, tannins, terpenes, steroids, flavonoids, phenols in *O. basilicum* extracts. Indeed, according to Pikassalé et al. (2020), *O. basilicum* oil is rich in estragol (85.5%), the active ingredient that is effective against pests. These results are similar to those reported by Tshimenga et al. (2018) that for a dose of 2 g/mL, high mortality of the weevil *Sitophilus oryzae* insect pest of rice and maize stocks in South Kivu, Democratic Republic of

Congo was observed with values of 79.4% after 24 h and 90% after 48 and 72 h. This could also explain the very high mortality rates recorded in this study with *O. basilicum* essential oil, according to Chiasson and Beloin (2007). In addition to that, disturbances in *Culex pipiens* and *Culiseta longiareolata* treated with *O. basilicum* were highlighted after experiments carried out at our laboratory with the aim of testing essential oil effects on mosquito energy reserves (Bouzidi and Ziani, 2015). Mousavi and Valizadegan (2013) tested the biological activity of *Artemisia dracunculus* essential oil, containing 71.53% estragole, by fumigation on *A. gossypii*, and found that the higher the concentration, the higher the mortality rate. This oil also acts directly on the cuticle of insects and mites. We plan to continue this study in order to demonstrate the effect of these essential oils on all stages of development and specify their mode of action on *C. puncticollis* Boheman.

4. CONCLUSION

The use of biopesticides for the control of the weevil *Cylas puncticollis* is a promising prospect for Burkina Faso growers. The aim of this study was to compare the insecticidal effect of essential oils on *C. puncticollis* Boheman, a weevil of sweet potato (*Ipomea batata*) in Burkina Faso. Results showed the insecticidal properties of these essential oils on adults of the sweet potato *C. puncticollis*. The vapors of these essential oils are capable of eradicating all adults and disrupting the metabolism of *C. puncticollis* after exposure. In general, the results achieved in this study show that the essential oil of *O. gratissimum* and *O. basilicum* were toxic to *C. puncticollis* and can significantly reduce these populations. However, it would be appropriate to carry out a concrete application of these oil extracts on large potato stocks in order to confirm or not their effectiveness.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- Abbott, W. S. (1925). A method of computing the effectiveness of an insecticide. *Journal of Economic Entomology*, 18, 265-267.
- Akantetou, P. K., Koba, K., Nenonene, A. Y., Poutouli, W. P., Raynaud, C., & Sanda, K. (2011). Evaluation du potentiel insecticide de l'huile essentielle de *Ocimum canum* Sims sur *Aphis gossypii* Glover (Homoptera: Aphididae) au Togo. *International Journal of Biological and Chemical Sciences*, 5(4), 1491-1500. <https://doi.org/10.4314/ijbcs.v5i4.15>
- Alghali, A. M., & Bockarie, A. (1994). Cultural practices and perceptions in sweet potato farming and their implications for pest management in southern Sierra Leone. *International Journal of Pest Management*, 40, 27-30.
- Asmae, B. A., Amal, E. A., Said, Z., & Larbi, T. (2018). Activité acaricide des huiles essentielles du *Mentha pulegium*, *Origanum compactum* et *Thymus capitatus* sur l'acarien phytophage *Tetranychus urticae* Koch (Acari: Tetranychidae). *European Scientific Journal*, 14(3), 119-124. <https://doi.org/10.19044/esj.2018.v14n3p1>
- Baimey, H., Fanou, A., Adandonon, A., Behoundja-Kotoko, O., Aganda, N., Houssou, G., & Dossou, R. (2017). Sweet potato *Ipomoea batatas* (L.) storage practices used in southern Benin and the use of entomopathogenic nematodes to control sweet potato weevil (*Cylas puncticollis* Boheman) under laboratory conditions. *Journal of Entomology and Zoology*, 5(6), 549-556.
- Bouzidi, O., & Ziani, R. (2015). Etude de l'impact des huiles essentielles d'une plante larvicide, l'*Ocimum basilicum* sur une espèce de moustique *Culiseta longiareolata*: Aspect morphométrique et biochimique. *Mémoire du diplôme de Master*, Université des sciences exactes et sciences de la nature et de la vie-Tébessa, 28p.
- Bouzouita, N., Kachouri, F., Ben Halima, M., & Chaabouni, M. M. (2008). Composition chimique et activités antioxydante, antimicrobienne et insecticide de l'huile essentielle de *Juniperus phoenicea*. *Journal de la Société Chimique de Tunisie*, 10, 119-125.
- Camara, A. (2009). Lutte contre *Sitophilus oryzae* L. (Coleoptera: Curculionidae) et *Tribolium castaneum* Herbst (Coleoptera: Tenebrionidae) dans les stocks de riz par la technique d'étuvage traditionnelle pratiquée en Basse-Guinée et l'utilisation des huiles essentielles végétales. (Doctoral thesis). Université du Québec, Canada, 121 pp.
- Chiasson, H., & Beloin, N. (2007). Les huiles essentielles, des biopesticides « nouveaux ». Revue de littérature. *Bulletin de la société d'entomologie du Québec, Antennae*, 14(1), 3-6.
- Cissokho, P. S., Gueye, M. T., Sow, E. H., & Diarra, K. (2015). Substances inertes et plantes à effet insecticide utilisées dans la lutte contre les insectes ravageurs des céréales et légumineuses au Sénégal et en Afrique de l'Ouest. *International Journal of Biological and Chemical Sciences*, 9(3), 1644-1653.
- Cloyd, R., & Chiasson, H. (2007). Activity of an essential oil derived from *Chenopodium ambrosioides* on greenhouse insect pests. *Journal of Economic Entomology*, 100, 459-466.
- Coulibaly, A., Sawadogo, I., Mahomed, T., Hema, D. M., Bationo Rémy, K., Kiendrebeogo, M., & Nébié, R. C. H. (2023). Composition, physico-chemical and antioxidant properties of *Ocimum gratissimum* L. essential oil from Burkina Faso. *Journal of Applied Biological Sciences*, 17(3), 486-499. <https://doi.org/10.5281/zenodo.10035488>
- DGESS. (2014). Résultats définitifs de la campagne agricole et de la situation alimentaire et nutritionnelle en 2013/2014. MASA, 77p.
- DGESS. (2022). *Resultats definitifs_epa21-22-pub_15032022*.
- FAO. (2015). Étude sur le suivi de l'effet des pesticides sur la santé humaine et l'environnement, rapport final. 72p.
- Gonzalez, C. A., Reina, M., Diaz, C. E., Fraga, B. M., & Santana, M. O. (2013). Natural

- product-based biopesticides for insect control. In J. Reedijk (Ed.), *Elsevier Reference Module in Chemistry, Molecular Sciences and Chemical Engineering* (pp. 237-268). Elsevier. <https://doi.org/10.1016/B978-0-12-409547-2.02770-0>
- Houghton, P. J., Ren, Y., & Howes, M. J. (2006). Acetylcholinesterase inhibitors from plants and fungi. *Nature Product Reports*, 23, 181–199.
- Kanko, C., Oussou, K. R., Akcah, J., Boti, J. B., & Seri Kouassi, B. P. (2017). Structure des composés majoritaires et activité insecticide des huiles essentielles extraites de sept plantes aromatiques de Côte d'Ivoire. *International Journal of Engineering and Applied Sciences*, 4, 2394-3661.
- Kobenan, K. C., Tia, V. E., Ochou, G. E. C., Kouakou, M., Bini, K. K. N., Dagnogo, M., Dick, A. E., & Ochou, O. G. (2018). Comparaison du potentiel insecticide des huiles essentielles de *Ocimum gratissimum* L. et de *Ocimum canum* Sims sur *Pectinophora gossypiella* Saunders (Lepidoptera: Gelechiidae), insecte ravageur du cotonnier en Côte d'Ivoire. *European Scientific Journal*, 14(21), 236-301.
- Konstantopoulou, L., Vassilopoulou, L., Mauragani, T. P., & Scouras, Z. G. (1992). Insecticidal effects of essential oils. A study of the effects of essential oils extracted from eleven Greek aromatic plants on *D. auraria*. *Experientia*, 48(6), 535-619.
- Koussoubé, S., Traoré, F., Somé, I., Binsodabiré, C., & Sanon, A. (2018). Perception paysanne des principales contraintes et pratiques culturelles en production de patate douce au Burkina Faso. *Journal of Applied Biosciences*, 126(6), 12638-12647.
- Mostafa, E. I., Elhourri, M., Amechrouq, A., & Boughdad, A. (2014). Étude de l'activité insecticide de l'huile essentielle de *Dysphania ambrosioides* L. (Chenopodiaceae) sur *Sitophilus oryzae* (Coleoptera: Curculionidae). *Journal of Materials and Environmental Science*, 5(4), 989-994.
- Mousavi, M., & Valizadegan, O. (2013). Insecticidal effects of *Artemisia dracuncululus* L. (Asteraceae) essential oil on adult of *Aphis gossypii* Glover (Hemiptera: Aphididae) under laboratory conditions. *Archives of Phytopathology and Plant Protection*, 47(14), 1737-1745.
- Okonya, J. S., Robert, O. M., Mwanga, R. O. M., Syndikus, K., & Kroschel, J. (2014). Insect pests of sweet potato in Uganda: Farmers' perceptions of their importance and control practices. *SpringerPlus*, 3, 303.
- Ouedraogo, I., Sawadogo, A., Nebie, R. C. H., & Dakouo, D. (2016). Evaluation de la toxicité des huiles essentielles de *Cymbopogon nardus* (L.) et *Ocimum gratissimum* (L.) contre *Sitophilus zeamais* Motsch et *Rhyzopertha dominica* F., les principaux insectes nuisibles au maïs en stockage au Burkina Faso. *International Journal of Biological and Chemical Sciences*, 695-705.
- Pikassalé, K. A., Nafadjara, A. N., Magnim, E. B., Tozoou, P., Kilimou, P., Koba, K., Wiyao, P. R. C., & Sanda, K. (2020). Effet aphicide de l'huile essentielle de *Ocimum basilicum* L. et de son composé majoritaire sur le puceron du cotonnier *Aphis gossypii* Glover (Homoptera: Aphididae) au Togo. 96p.
- Priestley, C. M., Williamson, E. M., Wafford, K. A., & Sattelle, D. B. (2003). Thymol, a constituent of thyme essential oil, is a positive allosteric modulator of human GABA receptors and a homooligomeric GABA receptor from *Drosophila melanogaster*. *British Journal of Pharmacology*, 140, 1363-1372.
- Tchoumboungang, F., Dongmo, J. M. P., Sameza, L. M., M'Bamdjo, N. G. E., & Fotso, T. B. G. (2009). Activité lavicide sur *Anopheles gambiae* Giles et composition chimique des huiles essentielles extraites de quatre plantes cultivées au Cameroun. *Biotechnology, Agronomy, Society and Environment*, 13(1), 77-87.
- Tia, E. V., Cisse, M., Douan, G. B., & Kone, A. (2019). Etude comparée de l'effet insecticide des huiles essentielles de *Cymbopogon citratus* DC et d'*Ocimum canum* Sims sur *Cylas puncticollis* Boheman, un charançon de la patate douce. *International Journal of Biological and Chemical Sciences*, 13(3), 1789-1799.
- Tshimenga, K., Mbabu, D., Kayolo, J., Mukuna, A., & Kanyinda, J.-N. M. (2018). Evaluation

of the insecticidal effect of the extracts of six plants (*Maesa lanceolata*, *Solanum syzybrifolium*, *Annona squamosa*, *Cymbopogon citratus*, *Ocimum basilicum*,

and *Ocimum gratissimum*) against *Sitophilus*. *International Journal of Innovation and Applied Studies*, 24(1), 89-95.

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