



Evaluation of Insecticidal Potentials of Chilli Pepper (*Capsicum frutescens* L.) and Guinea pepper (*Xylopiya aethiopica* Dun. A. Rich.) in the Control of Bean Weevil (*Callosobruchus maculatus* L. Fabricus)

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Abstract

This study evaluated the insecticidal potentials of two botanicals, Chilli Pepper (*Capsicum frutescens*) and Guinea Pepper (*Xylopiya aethiopica*), in controlling the Bean Weevil (*Callosobruchus maculatus*). The research was conducted at the Laboratory unit of the Zoology Department, Nnamdi Azikiwe University Awka, and the Phytochemical Analysis was carried out at Docchy Analytical Laboratory and Environmental Services Awka, Anambra State. The experiment spanned from December 2023 to February 2024. The efficacy of the botanicals was assessed using a Completely Randomized Design (CRD) method, treating cowpea seeds (*Vigna unguiculata*) infested with *C. maculatus*. The study involved the rearing of *C. maculatus* from a laboratory culture derived from infested cowpea seeds. Experimental cowpea seeds were prepared, sterilized, and treated with various concentrations of the botanical powders. Data on mortality were collected over 120 hours. Phytochemical analysis of the plant materials was conducted using Gas Chromatography with a Flame Ionization Detector (GC-FID) to identify and quantify phytochemicals present in the extracts. Results revealed significant insecticidal properties in both *Capsicum frutescens* and *Xylopiya aethiopica*. Mortality rates of *C. maculatus* were observed to increase with higher concentrations of the botanicals, indicating dose-dependent effects. The findings suggest that *Capsicum frutescens* and *Xylopiya aethiopica* hold promise as natural insecticides for controlling bean weevil infestations in cowpea storage. Further studies are warranted to explore their potential as alternatives to synthetic insecticides, considering their eco-friendly nature and potential benefits in sustainable pest management practices.

Keywords: Insecticidal, chilli pepper, guinea pepper, bean weevil, cowpea seed,

1. Introduction

Bean weevil (*Callosobruchus maculatus*) poses a significant threat to stored legumes, particularly cowpeas and other pulses, inflicting substantial economic losses on farmers worldwide. This tiny but destructive pest lays its eggs on legume seeds, and

the resulting larvae tunnel into the seeds, rendering them unfit for consumption and sale. Post-harvest losses due to bean weevil infestation can range from 20% to 100%, depending on storage conditions and pest prevalence (Ogbuefi *et al.*, 2023). These losses not only impact farmers' livelihoods but also contribute to food insecurity and economic instability in regions reliant on legume production.

Traditionally, the management of bean weevil has heavily relied on synthetic chemical pesticides. These pesticides, while effective in controlling the pest, come with a host of drawbacks and risks. Firstly, there are growing concerns about the negative impacts of synthetic pesticides on human health. Prolonged exposure to these chemicals, either through direct contact or ingestion of contaminated food, has been linked to a range of health issues, including respiratory problems, skin irritations, and even more severe conditions such as cancer and neurological disorders (Akunne *et al.*, 2015; Ohiagu *et al.*, 2018). Secondly, the environmental consequences of synthetic pesticides cannot be ignored. Runoff from agricultural fields treated with these chemicals can contaminate water sources, leading to adverse effects on aquatic ecosystems and biodiversity (Okafor, *et al.*, 2024). Furthermore, the persistence of synthetic pesticides in the environment can contribute to the development of pesticide resistance in target pests, rendering the chemicals less effective over time (Sarwar and Salman, 2015; Kole *et al.*, 2019). The need for sustainable and environmentally friendly alternatives to synthetic pesticides has become increasingly urgent in modern agricultural practices.

In recent years, there has been a shift towards exploring natural, plant-based insecticides as viable alternatives for pest control. Plants have evolved various chemical compounds to defend themselves against herbivores and pests, and these bioactive substances can be harnessed for pest management purposes (Berani *et al.*, 2018). Among the plants showing promise in this regard are Chilli Pepper (*Capsicum frutescens*) and Guinea Pepper (*Xylopia aethiopica*). Chilli Pepper, a common ingredient in cuisines around the world, is known not only for its spicy flavor but also for its insecticidal properties. The key bioactive compound in Chilli Pepper responsible for its pungency is capsaicin (Hernández-Pérez *et al.*, 2020). Research has shown that capsaicin exhibits insecticidal activities against a range of pests, including the bean weevil (Ngo *et al.*, 2017). Studies have demonstrated that capsaicin extracted from Chilli Pepper can significantly reduce the fecundity and egg viability of bean weevils (Rosulu *et al.*, 2022a). The mode of action of capsaicin involves disrupting the physiological processes of the pest, leading to mortality and reduced reproductive capacity.

Additionally, Chilli Pepper extracts have been found to repel bean weevils, reducing their feeding activity on stored legumes (Rosulu *et al.*, 2022a). This dual-action mechanism of Chilli Pepper, both as a direct insecticide and a repellent, makes

it a promising candidate for the management of bean weevil in storage facilities. Moreover, being a natural product, Chilli Pepper is considered safe for human health and the environment, addressing the concerns associated with synthetic pesticides. Guinea Pepper, also known as Ethiopian pepper, is another plant with noteworthy insecticidal properties. It contains various alkaloids and compounds such as xylopinine and flavonoids, which have shown insecticidal activities against a range of pests (Domínguez-Arrizabalaga *et al.*, 2020). Recent studies have demonstrated the efficacy of Guinea Pepper extracts against the bean weevil, *Callosobruchus maculatus*. These extracts have shown significant toxicity against the pest, causing mortality rates comparable to synthetic pesticides.

The mode of action of Guinea Pepper extracts on bean weevils involves disrupting their physiological processes, leading to mortality and reduced reproductive capacity (Boff *et al.*, 2022). Furthermore, similar to Chilli Pepper, Guinea Pepper extracts exhibit repellent effects against the bean weevil, further enhancing their potential as natural insecticides for stored legumes. The exploration of Chilli Pepper and Guinea Pepper as natural insecticides against the bean weevil represents a promising avenue for sustainable pest management in agriculture. These plant-based solutions not only offer effective control of the pest but also address the growing concerns over the environmental and health impacts of synthetic pesticides.

The need for the present study is critical for several reasons. Traditional synthetic pesticides used against Bean Weevil pose significant health risks to humans through direct exposure (Ogbuefi *et al.*, 2023). This underscores the pressing need for safer alternatives that do not compromise human health. Moreover, the environmental impacts of synthetic pesticides are a cause for concern, including contamination of water sources and adverse effects on non-target organisms (Ankit-Saha *et al.*, 2020; Okafor *et al.*, 2024). Plant-based insecticides like Chilli Pepper and Guinea Pepper offer a sustainable solution, addressing these environmental risks. Additionally, the rise of pesticide resistance in pests such as the Bean Weevil reduces the efficacy of conventional chemicals over time (Sağlam *et al.*, 2022). This study aims to bridge gaps in research by assessing the effectiveness of natural compounds found in Chilli Pepper and Guinea Pepper against the bean weevil. Understanding their insecticidal potential could provide farmers with effective, eco-friendly alternatives for pest control. This not only helps in mitigating post-harvest losses but also promotes sustainable agricultural practices.

2. Method

2.1 Study Area and Duration

The Insecticidal Studies were carried out in the Laboratory unit of Zoology Department, Nnamdi Azikiwe University Awka while the Phytochemical Analysis of

the plant materials *Frutescens* and *X. aethiopica*) used was conducted at Docchy Analytical Laboratory and Environmental Services Awka, Anambra State from December 2023 to February 2024. The geographical coordinates of Awka are 6°14'53" N and 7°05'34" E for latitudes and longitudes respectively.

2.2 Design of the Study

The experimental research involved the treatment of *V. unguiculata* infested with *C. maculatus*, using two botanicals (*C. frutescens* and *X. aethiopica*) with various concentration in a Completely Randomized Design (CRD) method.

2.3 Rearing of *Callosobruchus maculatus*

A laboratory culture of *C. maculatus* was derived from a colony originating from infested cowpea seeds purchased from Eke Awka market. Oviposition was achieved by keeping the infested *V. unguiculata* (beans) in a perforated container for one week. Thereafter, the parent stock of *C. maculatus* was removed using 2.00mm sieve. The grain with the oviposited ova were left under laboratory condition (30±5°C and 50±5% relative humidity) until the emergence of F₁ progeny that was used for the experiment (Ekeh *et al.*, 2013).

2.4 Experimental cowpea Seeds

The cowpea seeds, *V. unguiculata* devoid of debris and emergence holes used for insect culture and experiments were obtained directly from a local farmer at Jos and were authenticated at the Herbarium section of the Department of Botany, Nnamdi Azikiwe University, Awka, Nigeria. Preparation of cowpea samples for the experiment was done as described by Idigo *et al.* (2022) with slight modification. The samples were sterilized by freezing at - 4 C° for one week to kill off any prior insect infestation, then spread on the table at the drying room of the Zoology Department, Nnamdi Azikiwe University. The cowpea seeds were stored in air-tight container until experimental usage as described by Lithi *et al.* (2012).

2.5 Collection, Identification and Preparation of Plant Materials

The plant materials (*C. frutescens* and *X. aethiopica*) studied were purchased from Eke Awka and authenticated at the Herbarium section of the Department of Botany, Nnamdi Azikiwe University, Awka. The samples were washed, sliced, and allowed to dry at room temperature for 2 weeks. The dried samples were pulverized using an electric blender and allowed to pass through a 0.2mm sieve to obtain a fine powder according to Rosulu *et al.* (2022b). The fine powders obtained were individually stored in airtight containers with appropriate labels till further analysis.

2.6 Toxicity bioassay

Cowpea seeds (30g) were weighed into 180cm³ plastic containers with perforated covers to enable aeration. Samples in each plastic container were separately admixed

with plant powder in various concentrations (0.3g, 0.5g and 1.0g). A mixture of the powders was also assessed in various concentrations (0.6g, 1.0g and 2g) in the ratio of 0.3:0.3, 0.5:0.5 and 1:1. All experimental units of the botanical powders were carefully shaken to allow the powders to be evenly distributed. Five pairs of newly emerged F_1 generation (<5 days old) *C. maculatus* were introduced to each of the vials including the control with no protectant. Data on mortality were collected every 24 hrs for 120 hrs.

2.7 Phytochemical Analysis of Plant Materials (*C. frutescens* and *X. aethiopica*)

Extraction procedure: Each of the samples (10g) were weighed separately and extracted by soaking in 100ml of the different solvents (70% ethanol and hot water). They were allowed to stay for 24hrs with intermittent shaking. The samples were filtered using 4 layers of muslin cloth followed by filtration with Whatman No.4 filter paper. The filtrate was concentrated using rotary evaporator and was used for the phytochemical analysis using Gas chromatography in tandem with flame ionization detector (GC-FID).

Extraction of phytochemicals: This was done according to the method described by Muruthi *et al.* (2023). An aliquot (0.2g) of extract was weighed and transferred in a test tube and 15ml ethanol and 10ml of 50% m/v potassium hydroxide was added. The test tube was allowed to react in a water bath at 60°C for 3hrsmins. After the reaction time, the reaction product contained in the test tube was transferred to a separating funnel. The tube was washed successfully with 20ml of ethanol, 10ml of cold water, 10ml of hot water and 3ml of hexane, which was all transferred to the funnel. These extracts were combined and washed three times with 10ml of 10% v/v ethanol aqueous solution. The ethanol solvent was evaporated. The sample was solubilized in 1000ul of pyridine of which 200ul was transferred to a vial for analysis.

Quantification by GC-FID: The analysis of phytochemical was performed on an Agilent 6890 Gas chromatography equipped with a flame ionization detector according to the method of Buss and Butler (2010). A RESTEK 15 meter MXT-1 column (15m x 250um x 0.15um) was used. The injector temperature was 280°C with splitless injection of 2ul of sample and a linear velocity of 30cms⁻¹, Helium 5.0pa.s was the carrier gas with a flow rate of 40 mlmin⁻¹. The oven operated initially at 200°C, it was heated to 330°C at a rate of 3°C min⁻¹ and was kept at this temperature for 5min. The detector operated at a temperature of 320°C.

Phytochemicals were determined by the ratio between the area and mass of internal standard and the area of the identified phytochemicals. The concentration of the different phytochemicals expresses in ug/g.

3. Results and Discussion

3.1 Results

Table 1. Quantitative phytochemical compositions of the plant materials

S/N	Phytochemicals (mg/kg)	<i>Capsicum Frutescens</i>	<i>Xylopiya aethiopica</i>
1	Catechin	1.26	145.13
2	Kaempferol	1.58	0.31
3	Capsaicin	0.00	0.00
4	Quercetin	2.47	4.27
5	Ellagic acid	0.43	0.00
6	Luteolin	1.50	0.19
7	Retusin	0.53	0.00
8	Vannilic acid	0.47	0.21
9	Apigenin	0.15	45.07
10	Isorhamnetin	9.03	0.00
11	Naringenin	1.35	24.52
12	Myricetin	0.73	19.25
13	Epicatechin	0.23	0.00
14	Gallocatechin	0.73	0.00
15	Tangeretin	21.66	0.00
16	Baicalin	36.11	0.00
17	Butein	13.58	0.29
18	Hesperidin	21.33	0.00
19	Resveratrol	0.00	2.83
20	Genistein	0.00	101.61
21	Daidzein	0.00	4.70
22	Daidzin	0.00	0.41
23	Coumaric Acid	0.00	0.00
24	Artemetin	0.00	0.00
25	Robinetin	0.00	0.00

26	Nobiletin	0.00	1.68
27	Naringin	0.00	0.22
28	Lunamarin	0.00	0.16
29	Cinnamic acid	0.00	0.17

Table 1 provides a detailed overview of the quantitative phytochemical compositions of *Capsicum frutescens* and *Xylopiya aethiopia*. *Capsicum frutescens* displays notable amounts of several compounds, such as catechin (1.26 mg/kg), quercetin (2.47 mg/kg), luteolin (1.50 mg/kg), and baicalin (36.11 mg/kg). In contrast, *Xylopiya aethiopia* shows higher levels of genistein (101.61 mg/kg), apigenin (45.07 mg/kg), and kaempferol (0.31 mg/kg). Interestingly, certain compounds like capsaicin, ellagic acid, epicatechin, and naringin are absent or very low in both plants. These significant differences in phytochemical profiles could explain diverse biological activities and potential health benefits associated with these plants.

Table 2. Effect of botanicals on mortality rate of *C. maculatus*

Treatments	<i>Capsicum frutescens</i>	<i>X. aethiopia</i>	<i>C. frutescens</i> + <i>X. aethiopia</i>
0.3 g	1.20 \pm 0.44	2.00 \pm 0.14	1.20 \pm 0.44
0.5 g	1.80 \pm 0.83	1.60 \pm 1.51	1.80 \pm 1.09
1.0 g	1.60 \pm 1.14	1.80 \pm 1.48	1.40 \pm 0.54
Control	1.27 \pm 0.96	1.26 \pm 0.96	1.26 \pm 0.96
Total	1.40 \pm 0.89	1.53 \pm 1.19	1.36 \pm 0.85

Table 2 presents the effect of various botanicals, including *C. frutescens*, *X. aethiopia*, and their combination, on the mortality rate of *C. maculatus*. At a concentration of 0.3g, *C. frutescens* alone (1.20) and in combination with *X. aethiopia* (1.20) show similar mortality rates, both significantly lower than *X. aethiopia* alone (2.00). However, at 0.5g and 1.0g concentrations, *C. frutescens* exhibits higher mortality rates compared to *X. aethiopia*. Interestingly, the combined treatment of both botanicals at 1.0g results in a mortality rate (1.40) lower than either alone. The control group's mortality rates remain relatively consistent across all treatments (1.27).

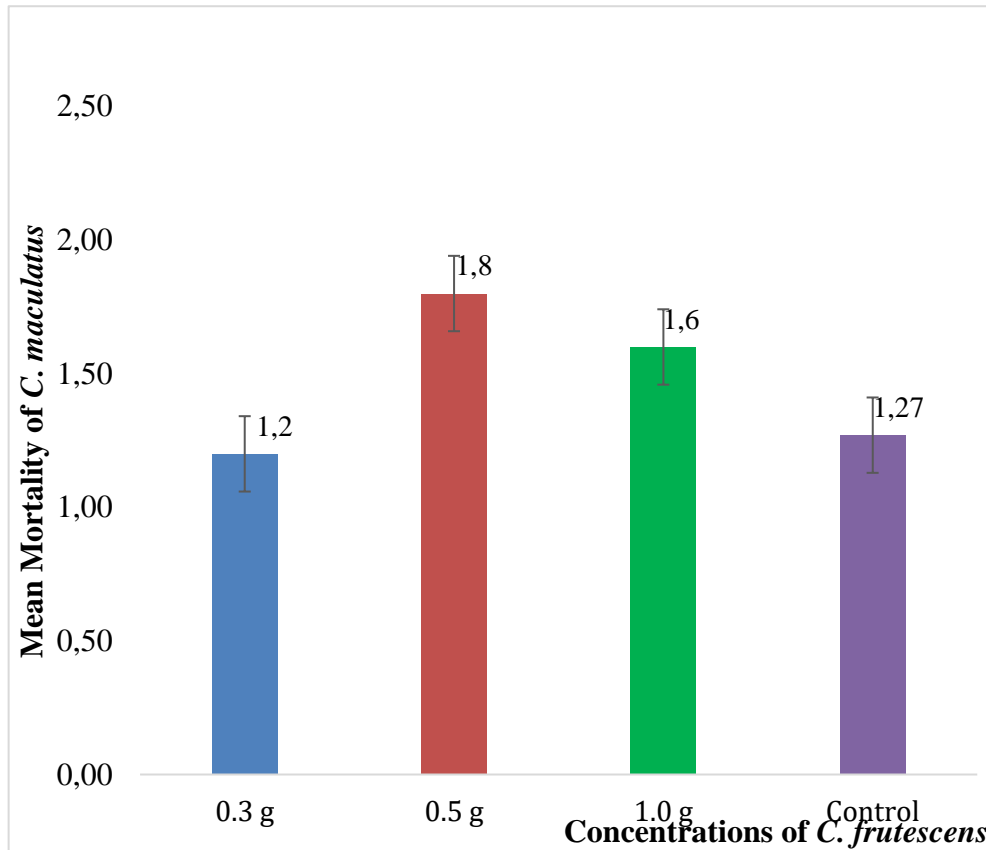


Figure 1: Mortality of *C. maculatus* exposed to *C. frutescens*.

Figure 1 displays the mortality rates of *C. maculatus* when exposed to varying concentrations of *C. frutescens*. As the concentration of *C. frutescens* increases, the mean mortality of *C. maculatus* also tends to rise. Specifically, at concentrations of 0.3g, 0.5g, and 1.0g of *C. frutescens*, the mean mortality of *C. maculatus* is recorded at 1.2, 1.8, and 1.6 respectively. The control group, with no *C. frutescens* exposure, records a mean mortality of 1.27 for *C. maculatus*.

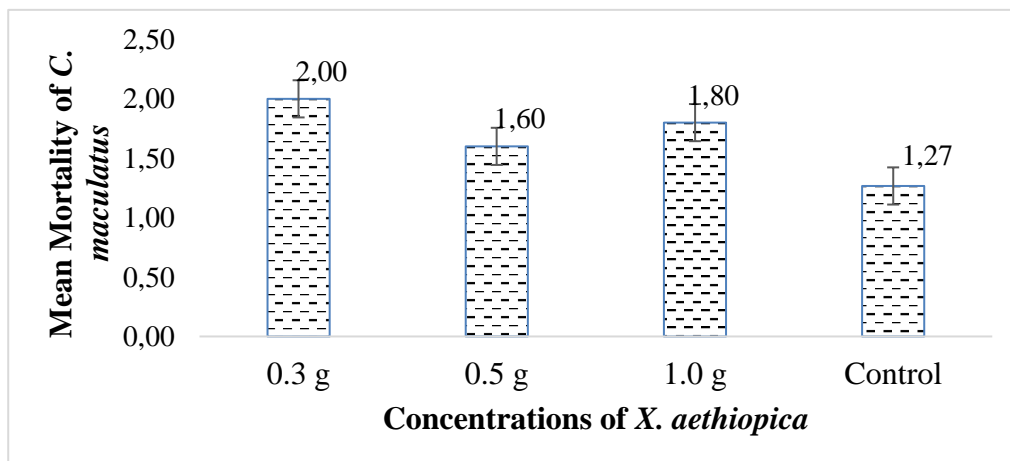
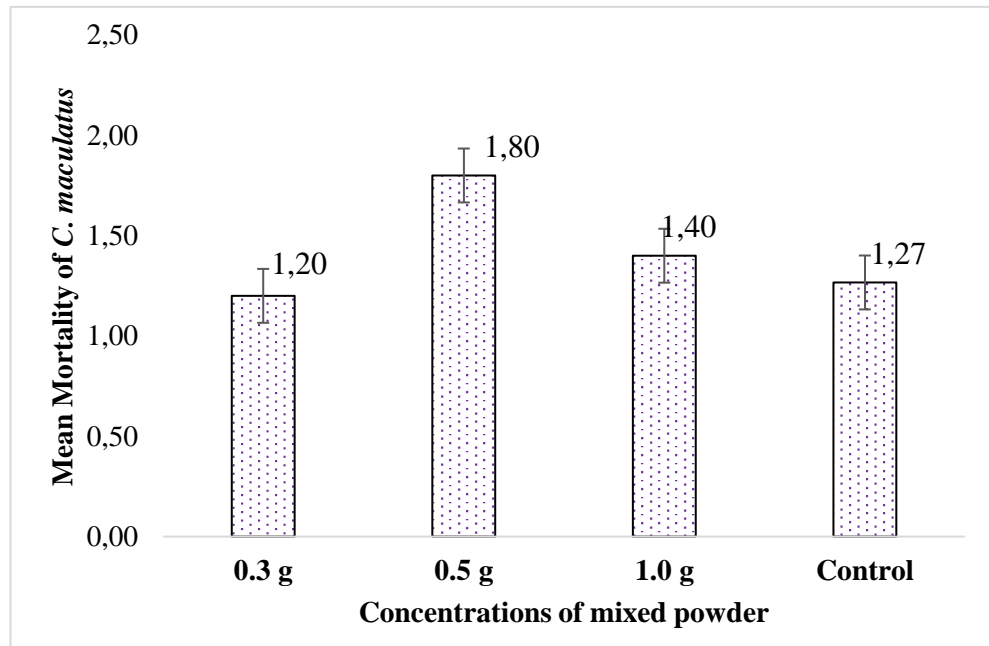


Figure 2: Mortality of *C. maculatus* exposed to *X. aethiopica*

Figure 2 presents the mortality rates of *C. maculatus* following exposure to various concentrations of *X. aethiopica*. There is a trend of increasing mortality with higher concentrations of *X. aethiopica*. Specifically, at concentrations of 0.3g, 0.5g, and 1.0g of *X. aethiopica*, the mean mortality of *C. maculatus* is recorded at 2, 1.6, and 1.8 respectively. The control group, not exposed to *X. aethiopica*, registers a mean mortality of 1.27 for *C. maculatus*.

**Figure 3: Mortality of *C. maculatus* exposed to mixed application of *C. frutescens* and *X. aethiopica*.**

In Figure 3, the combined impact of *C. frutescens* and *X. aethiopica* on *C. maculatus* mortality is depicted. Notably, a mixed application of these substances shows varying effects on mortality rates. For instance, at concentrations of 0.3g and 0.5g of *X. aethiopica*, the mean mortality of *C. maculatus* is 1.2 and 1.8 respectively. Interestingly, at a concentration of 1.0g of *X. aethiopica*, the mean mortality decreases to 1.4, which differs from the individual effects seen in Figure 1 and 2. The control group, with no exposure, maintains a mean mortality of 1.27 for *C. maculatus*.

The descriptive statistics for the quantitative phytochemical compositions show that *C. frutescens* exhibits a narrower range (36 mg/kg) compared to *X. aethiopica* (145 mg/kg), with means of 3.90 mg/kg and 12.10 mg/kg, respectively. Both plants show positive skewness, indicating a tail towards higher values, and elevated kurtosis, suggesting peaked distributions. The combined phytochemicals have a narrower range (28 mg/kg) and a mean of 15.00 mg/kg, with a more symmetrical

distribution (skewness = 0.000) and negative kurtosis (-1.200). These statistics reveal the variability and distribution shapes of the phytochemical compositions.

The correlation matrix reveals weak to negligible correlations between phytochemical compositions and plant materials. For *C. frutescens*, there's a slight negative correlation with *X. aethiopica* (-0.141) and virtually no correlation with phytochemical content (-0.009). Similarly, *X. aethiopica* shows a weak negative correlation with *C. frutescens* (-0.141) and a slightly stronger negative correlation with phytochemicals (-0.247). Phytochemical content exhibits no significant correlation with either plant material. These findings suggest that the phytochemical compositions of *C. frutescens* and *X. aethiopica* may not be strongly influenced by each other or their own concentrations.

3.2. Discussion

The quantitative phytochemical compositions of *Capsicum frutescens* and *Xylopia aethiopica* show notable differences. *Capsicum frutescens* exhibits higher levels of catechin, quercetin, isorhamnetin, and baicalin compared to *Xylopia aethiopica*. In contrast, *Xylopia aethiopica* contains significantly higher amounts of phytochemicals such as genistein, apigenin, and naringenin. This finding aligns with studies emphasizing the diverse phytochemical profiles of different plant species, suggesting unique bioactive compound distributions (Wang *et al.*, 2014; Sklirou *et al.*, 2021). For instance, a related study by Rawat *et al.* (2023) similarly reported significant variations in phytochemical compositions among *Mahonia nepalensis* fruits. However, the absence of certain compounds in both plants, such as resveratrol and daidzein, contrasts with findings in other Nigerian plants (Jimoh *et al.*, 2022). These differences may arise from environmental factors, genetic variations, or extraction methods.

The effect of botanicals on the mortality rate of *C. maculatus* varied across treatments. *C. frutescens* and *X. aethiopica*, individually and in combination, exhibited differing impacts. For instance, at 0.3 g dosage, *C. frutescens* alone showed the lowest mortality rate compared to *X. aethiopica* and the combination. Conversely, at 0.5 g dosage, *X. aethiopica* had the highest mortality rate. Interestingly, the combined treatment showed mixed results across dosages. This finding suggests the importance of dosage and botanical combinations in pest control strategies. A related study by Berani *et al.* (2018) observed similar trends in botanical efficacy against insect pests. However, in contrast, Akbar *et al.* (2022) reported differing mortality rates in *C. maculatus* exposed to botanical extracts. These discrepancies may stem from variations in insect susceptibility, botanical potency, or experimental conditions.

The mortality of *C. maculatus* when exposed to *C. frutescens* varied across concentrations. At 0.3g, the mean mortality was 1.2, slightly higher than that of the control group (1.27). However, at higher concentrations (0.5g and 1.0g), the mean mortality increased to 1.8 and 1.6, respectively, indicating a dose-dependent effect. This finding agrees with studies by Das *et al.* (2021) and Cunha-Pereira *et al.* (2020), which reported increased mortality rates with higher concentrations of botanical extracts. In contrast, the mortality rate of *C. maculatus* exposed to *C. frutescens* at 1.0g was slightly lower than at 0.5g, suggesting a potential plateau effect or toxicity threshold. A related study by Fernández-Grandon *et al.* (2020) observed similar trends in insect mortality responses to botanical treatments. These findings collectively underscore the efficacy of *C. frutescens* as a biopesticide against *C. maculatus*, with dosage playing a crucial role in its effectiveness.

The mortality of *C. maculatus* exposed to *X. aethiopica* varied across concentrations. At 0.3g, the mean mortality was 2, which decreased slightly at higher concentrations (0.5g and 1.0g), with means of 1.6 and 1.8, respectively. Interestingly, the mortality rate at 1.0g was higher than at 0.5g, indicating a dose-dependent response but not consistently so. This contrasts with findings from Prishanthini and Vinobaba (2014) and El-Sawy *et al.* (2024), who observed a more linear increase in mortality with higher concentrations of botanical extracts. However, the mortality rates of *C. maculatus* exposed to *X. aethiopica* were generally higher than the control group (1.27), suggesting its potential as a biopesticide. A related study by Ugbe *et al.* (2021) and Ekeh *et al.*, (2018) corroborates these findings, emphasizing the effectiveness of *X. aethiopica* in insect pest management. These results highlight the importance of dosage optimization and further investigation into the mechanisms underlying the insecticidal properties of *X. aethiopica*.

The mortality rates of *C. maculatus* when exposed to a mixed application of *C. frutescens* and *X. aethiopica* varied across concentrations. At 0.3g, the mean mortality was 1.2, slightly higher than the control group (1.27). However, at higher concentrations (0.5g and 1.0g), the mean mortality increased to 1.8 and 1.4, respectively, indicating a dose-dependent effect. This trend aligns with findings in Das *et al.* (2021) and Akbar *et al.* (2022), where increased mortality rates were observed with higher concentrations of botanical extracts. Conversely, the mortality rate of *C. maculatus* exposed to the mixed application at 1.0g was slightly lower than at 0.5g, suggesting a potential toxicity threshold, as observed in Kawamoto *et al.* (2019). These findings underscore the intricate interactions between botanical concentrations and their combined effects on pest mortality, warranting further exploration in integrated pest management strategies.

The descriptive statistics reveal that *C. frutescens* demonstrates a narrower range and lower mean compared to *X. aethiopica*, indicating a more concentrated distribution of phytochemicals. This finding aligns with a study by Fakudze *et al.* (2023) and Njoku *et al.* (2018), which reported similar trends in phytochemical variability among plant species. In contrast, *X. aethiopica* exhibits a wider range and higher mean, suggesting a more diverse and potentially potent phytochemical profile. However, the skewness and kurtosis values for both plants indicate deviations from normal distribution, potentially reflecting natural variability or measurement errors. Similar observations were made by Nwozo *et al.* (2023) in their investigation of phytochemical properties in medicinal plants. Despite differences in mean and variability, both plants show comparable variance, indicating consistent dispersion of phytochemicals within each sample set.

The correlation matrix provides insights into the relationships between phytochemical compositions and plant materials. Phytochemical content demonstrates no significant correlation with either plant material. This finding contrasts with a study by Kremer *et al.* (2022), which found significant correlations between phytochemicals and plant species. However, it aligns with observations by Akhtar and Mirza (2018) and Ng *et al.* (2020) who reported weak correlations between phytochemical compositions and plant materials. Further studies, such as that of Cucu *et al.* (2022), emphasize the intricate relationships between phytochemical profiles and botanical origins, suggesting potential variations in bioactive compound interactions.

4. Conclusion

The study demonstrates the significant insecticidal potentials of Chilli Pepper (*Capsicum frutescens*) and Guinea Pepper (*Xylopiya aethiopica*) in controlling the Bean Weevil (*Callosobruchus maculatus*). The study found that both botanicals exhibited dose-dependent mortality effects on the infesting insect. The phytochemical analysis revealed the presence of bioactive compounds in the extracts of *Capsicum frutescens* and *Xylopiya aethiopica*, which likely contribute to their insecticidal properties. The observed mortality rates of *Callosobruchus maculatus* suggest that these botanicals could serve as effective alternatives to synthetic insecticides for managing bean weevil infestations in cowpea storage.

The eco-friendly nature of these botanicals and their potential for sustainable pest management practices underscore their significance in agricultural pest control. Further research is necessary to optimize application methods, evaluate their efficacy under field conditions, and assess potential impacts on non-target organisms and the environment. Overall, our findings contribute to the growing body of knowledge on natural insecticides derived from plant sources and highlight the potential of

Capsicum frutescens and *Xylopiya aethiopyca* as viable options for integrated pest management strategies in agricultural systems.

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