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PHYTOCHEMICAL, PROXIMATE, AND PHYTONUTRIENT PROFILES OF SELECTED BOTANICALS FOR INSECT PEST CONTROL AND THEIR IMPACT ON CUCUMBER (CUCUMIS SATIVUS) FRUITS

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ABSTRACT

Plant secondary metabolites exhibit diverse biological activities, acting as repellents, feeding deterrents, and fumigants. Cucumber (*Cucumis sativus*), a widely consumed vegetable, faces insect pest infestations, affecting yield and quality. In this study, five plant extracts were applied as foliar sprays on cucumber plants for pest control: rhizomes of *Zingiber officinale*, seeds of *Piper guineense* and *Azadirachta indica*, and leaves of *Lantana camara* and *Tithonia diversifolia*. The quantitative and qualitative contents of phytochemicals present in the plant materials used were analyzed. On the other hand, the proximate and mineral compositions in the harvested fruits were analyzed using standard laboratory methods. Phytochemical analysis revealed alkaloids, saponins, tannins, terpenoids, phenolics, flavonoids, and steroids. Qualitative data revealed the presence of Alkaloids, Saponins, Tannins, Terpenoids, Phenolics, Flavonoids, and Steroids while quantitative data showed the quantity of each constituent in the plant materials used as +++: strongly present; ++: moderately present; +: fairly present; -: Absent. Proximate analysis showed that carbohydrate, moisture, protein, ash, and crude fiber contents varied between treatments with improved nutritional quality of botanically treated crops. Mineral composition, including Fe, Ca, K, and Na, was significantly higher in botanically treated fruits. These results confirm that the bioactive compounds identified in this study reinforce the pesticidal potential of these plants and their value as sources of natural insecticides botanical treatments enhance nutritional content and safety, aligning with previous studies that suggest such treatments positively impact pest management and crop quality. This suggests that botanicals not only serve as effective pest control agents.

Keywords: Botanical, Proximate, Cucumber, Minerals, Pest Control

INTRODUCTION

Cucumber (*Cucumis sativus*) belongs to the Cucurbitaceae family and is one of the most important vegetable crops cultivated in both tropical and subtropical regions (Weng, 2021). In 2020, global cucumber production reached 91.3 million metric tonnes (MMT), with China accounting for approximately 77% of the total production (70.3 MMT) -Weng, 2021. In West Africa, key cucumber-producing countries include Nigeria, Egypt, Ghana, and Niger. Egypt is the largest producer in Africa, producing around 488,723 tonnes, followed closely by Nigeria with 27,000 tonnes (Falade, 2002).

Cucumber fruits are highly beneficial to human health due to their abundant nutritional compounds, including vitamins A and C, minerals, flavonoids, and polyphenols (Septembre-Malaterre *et al*., 2018; Kostecka-Gugała *et al*., 2020). In addition to their nutritional benefits, cucumber has been shown to possess anti-carcinogenic, antioxidant, antibacterial properties, and low-calorie phytonutrients (Adesuyi *et al*., 2012; Kumaraswamy, 2016; Uthpala *et al.,* 2020). However, the high-water content and nutrient composition of cucumber make it highly susceptible to insect pest infestations, which can lead to rotting and make the fruits unfit for human consumption. Insects pose significant threats to cucumbers, especially during the fruiting stage. Pests such as *Phylotreta cruciferae* and *Epilachna vigintopunctata* attack the fruits, leading to reduced yield and quality (Odewole *et al*., 2018).

Various methods have been employed to manage insect infestations, but most conventional approaches are not environmentally friendly. The use of synthetic insecticides, for example, introduces problems such as food residues, soil and water pollution, and health risks (Srivastava and Joshi, 2021; Boudh and Singh, 2019). In contrast, plant-based insecticides offer an environmentally safe alternative. These botanicals are biodegradable, easy to produce, and do not leave harmful residues on crops (Odewole *et al* 2014;

Odewole *et al*., 2020). Several plant materials, including *Zingiber officinale* (ginger), *Azadirachta indica* (neem), *Piper guineense* (black pepper), *Lantana camara*, and *Tithonia diversifolia* have demonstrated effectiveness in controlling insect pests on cucumber (Odewole *et al*., 2020; Ranz, 2022; Ngegba *et al.*, 2022).

While botanicals have shown promise in pest control, the phytochemical and proximate compositions of treated cucumber fruits have not been empirically documented. This research aims to determine the quality and quantity of phytochemicals present in botanicals used for insect pest management, as well as to analyze the proximate and phytonutrient composition of cucumber fruits treated with these botanicals.

MATERIALS AND METHODS

Study Area

Field experiments were conducted during the cropping seasons of 2015 and 2016 at the Ladoke Akintola University of Technology (LAUTECH) Teaching and Research Farm, located in Ogbomoso, Nigeria (Latitude 08º 05'N, Longitude 04º 50'E, elevation 34.1 m). The region is characterized by a hot, humid tropical climate and falls within the Southern Guinea Savannah zone of Nigeria.

Collection of s**eeds of cucumber (Cucumis sativus) and** Plant Materials

Cucumber seed var. Point-set, used for this study were obtained from Agro Allied shop in Ogbomoso, Nigeria. The plant materials selected for insecticidal screening were mature leaves of *Lantana camara* and *Tithonia diversifolia*, as well as ripe seeds of *Azadirachta indica*. These were collected from the LAUTECH Teaching and Research Farm. Additionally, rhizomes of *Zingiber officinale* (ginger) and seeds of *Piper guineense* (black pepper) were obtained from local markets in Ilorin and Ogbomoso, respectively. The fresh leaves of *T. diversifolia*, *L. camara*, and *A. indica*, as well as dried seeds of *P. guineense* and *Z. officinale* rhizomes, were sourced from LAUTECH and the Waso market in Ogbomoso.

Plant Extract Preparation for Qualitative and Quantitative Analysis

The plant materials were first air-dried under a shaded environment and then ground into a fine powder using a steel-blade blender.

The powdered samples were extracted using Soxhlet apparatus with acetone, petroleum ether, ethanol, and distilled water. Each solvent extract was concentrated by distilling off the solvent, followed by evaporation to dryness. The solvent-free extracts were then subjected to both qualitative and quantitative phytochemical analyses.

Source of cucumber fruits, plant application and application

The cucumber fruits used for the proximate analysis were harvested from experimental plots treated with botanical sprays after eight weeks (Odewole *et al.*, 2020). These plots were part of a study designed to evaluate the efficacy of botanical treatments in pest management under field conditions. The preparation and application of the plant extracts followed the method described by Odewole *et al.*, (2020).

Proximate Analysis

Proximate analysis was carried out following the AOAC (2005) method to determine the moisture, ash, crude fiber, lipid, and nitrogen content. Crude protein content was calculated by multiplying the nitrogen content by a factor of 6.25. All determinations were performed in triplicate, and the results were expressed as means of percentage values on a dry weight basis.

Phytochemical Screening

- **Qualitative Phytochemical Screening**: The presence of alkaloids, steroids, saponins, terpenoids, flavonoids, tannins, and glycosides in the plant extracts was tested using methods described by Sofowora (1993), AOAC (2005), Trease and Evans (2005), and Koruthu et al. (2011).
- **Quantitative Phytochemical Screening**: Quantitative estimations of specific phytochemicals were conducted using various methods. Terpenoid content was quantified using the oxidation method outlined by Harborne (1998). Tannin levels were determined spectrophotometrically according to the method of Gupta and Verma (2010). Flavonoid content was estimated using the ferric chloride colorimetric method (Mattila and Kumpulainen, 2002). Alkaloid determination was performed using the method described by Harborne (1998), while saponin content was quantified using the spectrometric technique

outlined by Uematsu *et al*. (2000). The total phenol content of *Cucumis sativus* fruits was determined spectrophotometrically following the method of Wolfe *et al.* (2003). Cyanogenic glycoside content was assessed using the alkaline picrate method (Harborne, 1998). Steroid levels were measured according to the method described by Edeoga *et al.* (2005).

Statistical Analysis

Data from the phytochemical analysis were subjected to statistical evaluation using a completely randomized design (CRD). The results of qualitative and quantitative phytochemical screening were expressed as mean values ± standard error of the mean (SEM) for each treatment. Differences between treatments were analyzed using analysis of variance (ANOVA) at a significance level of $p \leq 0.05$. When significant differences were found, Duncan multiple range test was applied to compare the means.

RESULTS

The plant materials used in this study were sourced from the families Zingiberaceae, Asteraceae, Verbenaceae, Piperaceae, and Meliaceae (Table 1). The phytochemical screening of these botanicals revealed a variation in secondary metabolites across the different plant parts, including leaves, seeds, and rhizomes. Alkaloids were found to be strongly present in *Tithonia diversifolia*, *Lantana camara*, and *Azadirachta indica*, while they were moderately present in *Piper guineense* and only fairly present in *Zingiber officinale*. Saponins were moderately present in *T. diversifolia*, *P. guineense*, and *L. camara*, but were only fairly present in *Z. officinale* and *A. indica*. Tannins were strongly present in *T. diversifolia* and *L. camara*, moderately present in *P. guineense*, and fairly present in *A. indica* and *Z. officinale*. Cardiac glycosides were observed to be fairly present in *T. diversifolia* and *L. camara*, but absent in *Z. officinale*, *P. guineense*, and *A. indica*. Terpenoids were strongly present in *Z. officinale* and *T. diversifolia*, moderately present in *L. camara*, and fairly present in *P. guineense* and *A. indica*. Phenolics were strongly present in *Z. officinale*, *L. camara*, and *A. indica*, while they were fairly present in *T. diversifolia* and *P. guineense* (Table 2). Flavonoids were moderately present in *T. diversifolia* and *P. guineense*, but only fairly present in *Z. officinale* and *A. indica*. Steroids were moderately present in *T. diversifolia*, *P. guineense*, and *A. indica*, with a lower concentration in *Z. officinale* and *L. camara*.

Effect of Botanical and Synthetic Insecticide Treatments on the Proximate Composition of Cucumber Fruits"

Treated cucumber fruits show that **plant extracts** and **synthetic insecticide** both influenced moisture retention, with slight variation in values (91.60%, 92.5% and 92.0) between the two treatments (Figure 1). The carbohydrate content in cucumber fruits treated with botanicals ranged from 4.87% to 6.20%. All botanically treated samples exhibited higher carbohydrate values, ranging from 5.27% to 6.20%, compared to the synthetic insecticide-treated fruits (Karate), which had a carbohydrate content of 4.90%, and the control (unsprayed) at 4.87% (Figure 2). These results indicate that treatment with botanicals enhances carbohydrate accumulation in cucumber fruits. The ash content of treated cucumber fruits varied between 0.67% and 0.87%. The control group showed the lowest ash content (0.67%), whereas the botanically treated fruits exhibited higher values, ranging from 0.77% to 0.87% (Figure 3). This suggests that botanical treatments positively influence the ash content in cucumber fruits, which may be linked to increased mineral content. Crude fiber content in the cucumber fruits treated with botanicals ranged from 0.83% to 1.07%. This indicates that botanical treatments may also contribute to higher fiber content in the fruits.

The control group exhibited the lowest crude fiber content at 0.83%, while the botanicals used resulted in values ranging from 1.00% to 1.07%. Karate (synthetic insecticide) treated cucumber fruits showed a crude fiber content of 1.00% (Figure 4). Protein content in treated cucumber fruits ranged from 0.77% to 1.03%, with the highest protein levels observed in fruits treated with botanicals (1.00% - 1.03%). In contrast, Karate-treated fruits had the lowest protein content (Figure 5). Fat (ether) content in the cucumber fruits ranged from 0.10% to 0.20%, with Karate-treated fruits showing the lowest fat content. Figure 6 further illustrates that fruits treated with botanicals had higher fat content compared to Karate-treated fruits. Overall, the proximate composition of cucumber fruits treated with botanicals was higher than those in the control and Karate-treated groups, suggesting a positive impact of botanical treatments on the nutritional quality of the fruits.

Influence of Botanicals and Synthetic Insecticides on the Mineral Composition of Cucumber Fruits

Significant variations were observed in the mineral composition of cucumber fruits treated with botanicals and synthetic insecticides. Iron (Fe), the least abundant mineral in the samples, ranged from 1.20 to 1.47 mg/100kg. The control (unsprayed) had the lowest Fe content (1.27 mg/100kg), while cucumber fruits treated with botanicals showed higher levels, ranging from 1.20 to 1.47 mg/100kg (Figure 7). Potassium (K) content ranged from 6.33 to 8.00 mg/100kg. The synthetic insecticide-treated fruits contained 7.33 mg/100kg of potassium, while the control group exhibited 6.67 mg/100kg. Botanicals-treated cucumber fruits had the highest potassium content, ranging from 6.67 to 8.00 mg/100kg (Figure 8). Calcium (Ca) was the most abundant mineral, with concentrations ranging from 15.00 to 25.00 mg/100kg. Botanical treatments consistently resulted in higher calcium content (25.00–21.67 mg/100kg) compared to the synthetic and control treatments (Figure 9). Sodium (Na) content in the sprayed cucumber fruits ranged from 4.67 to 6.67 mg/100kg, with the control group showing the lowest Na content (4.67 mg/100kg). In contrast, the plant-treated fruits exhibited higher sodium levels, ranging from 5.67 to 6.67 mg/100kg (Figure 10). Overall, the results indicate that cucumber fruits treated with botanicals exhibited higher mineral content compared to those treated with synthetic insecticides and the control, highlighting the potential nutritional benefits of botanical treatments.

Quantitative Phytochemical Analysis of Tested Plant Materials

The seeds of *A. indica* exhibited the highest content of alkaloids and steroids, but the lowest levels of tannins (48.33) and flavonoids (86.66). *Z. officinale* rhizomes had significantly higher terpenoid content (1558.33) compared to the other plant materials, with the lowest values observed for steroids (81.66), saponins (68.33), and alkaloids (113.33). *T. diversifolia* leaves demonstrated the highest tannin content (1555.00) and cardiac glycosides (66.66) among the tested plants. *L. camara* leaves showed significantly higher glycoside (73.33) and phenol (74.23) contents than other plant materials. *P. guineense* seeds had the highest flavonoid (480.00) and saponin (375.00) content, with the lowest phenol content (31.96). Table 3 summarizes the phytochemical composition across all plant materials.

DISCUSSION

The qualitative phytochemical screening results from this study demonstrated that the detection of secondary metabolites in plant species depends on several factors, including extraction temperature, the solvent used, and the collection season. These findings align with previous studies, where variations in the phytochemical profiles of plant extracts were attributed to the solvent polarity and the extraction conditions used (Mugesh *et al.*, 2020; Adebayo *et al.,* 2021). All the plant species in this study showed variations in the abundance of alkaloids, saponins, tannins, terpenoids, phenolics, flavonoids, and steroids, regardless of the solvents used, highlighting the complex nature of phytochemical distribution in plants.

Quantitative phytochemical analysis revealed the presence of certain metabolites that were undetectable in the qualitative screening. For example, cardiac glycosides were absent in the qualitative analysis of *Z. officinale, P. guineense*, and *A. indica,* but were detected in the quantitative analysis. This observation supports the idea that more abundant metabolites may mask the presence of less abundant ones in qualitative screenings. Such discrepancies emphasize the importance of combining qualitative and quantitative approaches for a more complete phytochemical assessment (Ncube *et al*., 2012; Ademola *et al*., 2020).

Similar findings were reported by Babarinde (2012), who found that flavonoids were absent in the qualitative screening of A. *indica* but present in quantitative analysis.

Similarly, Dash *et al.* (2012) documented that phytochemical fractions of *Asteracantha longifolia* exhibited variations in the presence of aromatic amino acids, depending on the extraction method. These observations support the notion that the extraction method, including the solvent and temperature, significantly influences the detection of phytochemicals. The variability in the detection of secondary metabolites—represented as +++ (strongly present), ++ (moderately present), + (fairly present), and - (absent)—is likely due to differences in solvent polarity and extraction protocols. This has been corroborated by studies such as that of Vasantha *et al.* (2012), who evaluated the phytochemical profiles of Kedrostis foetidisima using different solvents (hexane, petroleum ether, chloroform, acetone, and methanol).

Their results indicated that the solvent polarity affected the detection of specific metabolites, with flavonoids and steroids being present in hexane and petroleum ether extracts, while other metabolites such as flavonoids, tannins, triterpenoids, phenols, steroids, and cardiac glycosides were primarily detected in chloroform, methanol, and acetone extracts. This emphasizes that a combination of solvents should be employed to ensure a comprehensive phytochemical analysis (Wang *et al.*, 2015).

Furthermore, the bioactive secondary metabolites identified in this study—such as alkaloids, flavonoids, steroids, tannins, saponins, terpenoids, and cardiac glycosides—are widely recognized for their therapeutic potential. These compounds have been extensively studied for their pharmacological activities, including antimicrobial, anti-inflammatory, antioxidant, and anticancer properties (Shan *et al.,* 2016; Tan *et al.*, 2018). Their presence in plant extracts suggests that these species may serve as valuable sources for drug discovery, particularly in the development of natural insecticides or other therapeutic agents.

For example, alkaloids and flavonoids, which were abundant in most of the tested species, are well known for their insecticidal and antimicrobial activities (Hossain *et al.*, 2020; Mamedov *et al*., 2019). Steroids, on the other hand, have been implicated in anti-inflammatory and cytotoxic properties (Zhao et al., 2019). These findings support the notion that the medicinal properties of botanicals are often attributed to the synergistic effects of their diverse phytochemical profiles.

In addition to their therapeutic potential, the presence of steroidal compounds is particularly noteworthy, as these compounds are used in the synthesis of pharmaceutical steroids, including hormones such as estrogens and androgens (Santos *et al.,* 2017). Steroidal compounds are of immense interest in modern pharmacology due to their biological significance and their role in the production of numerous drugs used in treating hormone-related conditions (Bhatnagar *et al*., 2020). Therefore, the detection of steroidal compounds in some of the tested plants highlights their potential for further pharmaceutical exploration.

The results of qualitative phytochemical screening indicate that the detection of secondary metabolites in plant species is influenced by various factors, such as the extraction method, solvent type, temperature, and the season in which the plants were collected. All plant species tested demonstrated variations in the abundance of alkaloids, saponins, tannins, terpenoids, phenolics, flavonoids, and steroids, irrespective of the solvent used for extraction. Similar findings have been reported in various studies, emphasizing the complexity and variability in phytochemical extraction methods (Santos *et al.*, 2021; Ayoola *et al.*, 2020).

The quantitative phytochemical analysis revealed that secondary metabolites not detected in the qualitative screening were quantified successfully. For instance, cardiac glycosides, which were not detected in *Zingiber officinale*, *Piper guineense*, and *Azadirachta indica* during qualitative screening, were present in the quantitative analysis. This highlights that certain secondary metabolites may be masked by more abundant compounds during qualitative testing, a phenomenon also observed in earlier studies (Mugesh & Bansal, 2020; Amri *et al.*, 2021). These findings suggest that qualitative phytochemical analysis alone may not provide a complete picture of a plant's phytochemical profile. It is therefore recommended that quantitative analyses be performed to confirm the presence and abundance of specific metabolites, particularly when developing phytochemical-based insecticidal treatments.

This study supports earlier research by Babarinde (2012), who observed the absence of flavonoids in the qualitative screening of *Azadirachta indica* but their presence in quantitative analysis. Similar results were reported by Dash et al. (2012), who found discrepancies between qualitative and quantitative screenings of *Asteracantha longifolia* depending on the fraction of solvent used. These observations underscore the need for careful selection of extraction methods and solvents in phytochemical studies.

Additionally, the variation observed in the secondary metabolites (denoted by +++ strongly present, ++ moderately present, + fairly present, and – absent) could be attributed to the solvent polarity and extraction methods employed. Previous research by Vasantha *et al*. (2012) highlighted that different solvents, such as hexane, petroleum ether, chloroform, acetone, and methanol, yield different phytochemical profiles from the same plant species. This suggests that a single solvent may not be sufficient to extract all valuable bioactive compounds, and a combination of solvents might be necessary for comprehensive phytochemical screening.

Phytochemical studies of botanicals have long demonstrated the presence of bioactive compounds such as alkaloids, flavonoids, steroids, tannins, saponins, terpenoids, and glycosides (Omotayo & Borokini, 2012; Shan & Yao, 2016). These compounds are recognized for their insecticidal, antimicrobial, and therapeutic properties, and they are considered essential precursors in the synthesis of pharmaceutical and pesticide agents (Ahad *et al.*, 2021; Yang *et al*., 2019). In this study, all the plant extracts tested exhibited significant concentrations of these compounds, confirming their potential as natural insecticides and their relevance in drug discovery. It is important to note that some of the plants tested contained steroidal compounds, which are of considerable interest in pharmaceutical research due to their connection with sex hormones and other medicinal uses (Okwu, 2001; Odukoya *et al.*, 2020). Botanical and synthetic insecticide treatments both influenced moisture retention, with values ranging from 91.60% to 92.50%. This reflects the findings by *Oduor et al. (2019)*, who noted that plant-based treatments can help preserve moisture content in treated crops. Higher carbohydrate levels in botanically treated cucumber fruits (5.27–6.20%) compared to synthetic insecticide-treated and control groups align with research by *Ibrahim et al. (2018),* confirming that botanical insecticides can promote carbohydrate accumulation. Also, the increase in ash content (0.77–0.87%) with botanical treatments compared to the control (0.67%) has been similarly observed in *Aiyelaagbe and Adetuyi (2014),* who reported improved mineral retention in fruits treated with botanicals. Higher crude fiber content in botanically treated fruits (1.00–1.07%) corresponds with findings from *Adeyemi and Olayinka (2015),* who demonstrated enhanced fiber content in crops treated with plant extracts. Increased protein levels in botanically treated fruits (1.00–1.03%) this reflects similar results observed by *Akinnifesi et al. (2016),* showing that botanical treatments can enhance protein content in crops. Fat content in botanically treated fruits (0.10–0.20%) was higher when compared to synthetic insecticide-treated fruits was confirmed by *Omoloye and Adebayo (2017),* who reported improved fat accumulation in botanically treated crops.

Phytonutrient analysis reveals that botanical treatments significantly improved the mineral composition of cucumber fruits, especially in terms of potassium, calcium, and sodium, compared to synthetic insecticides and control treatments. This is in line with Ojo *et al*., (2020). This suggests that botanicals not only serve as effective pest control agents but also offer potential nutritional benefits by enhancing mineral content in treated fruits.

CONCLUSION

In conclusion, the results of this study highlight the significant variation in the phytochemical composition of the tested plant species, which could be attributed to the choice of extraction methods and solvents. While qualitative phytochemical analysis provides useful preliminary information, it is essential to complement it with quantitative methods to fully understand the phytochemical potential of botanicals.

Furthermore, the bioactive compounds identified in this study—including alkaloids, flavonoids, saponins, terpenoids, and steroids—reinforce the pesticidal potential of these plants and their value as sources of natural insecticides. This research aligns with previous studies (Odewole *et al* 2020; Mugesh & Bansal, 2020) and provides strong evidence that botanicals can offer viable alternatives to synthetic insecticides, especially when extracted using appropriate techniques. In addition, botanical treatments improve the nutritional quality of treated crops by enhancing their carbohydrate, ash, crude fiber, protein, and fat content. This suggests that botanicals not only serve as effective pest control agents.

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Table1: Profile of Botanicals Used for the Control of Cucumber Insect Pests

Botanical Name	Common Name	Family Name	Part Used
Zingiber officinale	Ginger	Zingiberaceae	Rhizome
Tithonia diversifolia	Mexican Sunflower	Asteraceae	Leaf
Piper guineense	West African Black Pepper	Piperaceae	Seed
Lantana camara	Wild Sedge	Verbenaceae	Leaf
Azadirachta indica	Neem	Meliaceae	Leaf

Table 2: Qualitative Phytochemical Analysis of Tested Plant Species

Constituents	*Z. officinale*	*T. diversifolia*	*P. guineense*	*L. camara*	*A. indica*
Alkaloids	+	+++	++	+++	+++
Saponins	+	++	++	++	+
Tannins	+	+++	++	+++	+
Cardiac Glycosides	-	+	-	+	-
Terpenoids	+++	+++	+	++	+
Phenolics	+++	++	+	+++	+++
Flavonoids	+	++	++	++	+
Steroids	+	++	++	+	++

Key: +++ = Strongly Present; ++ = Moderately Present; += Fairly Present; =Absent

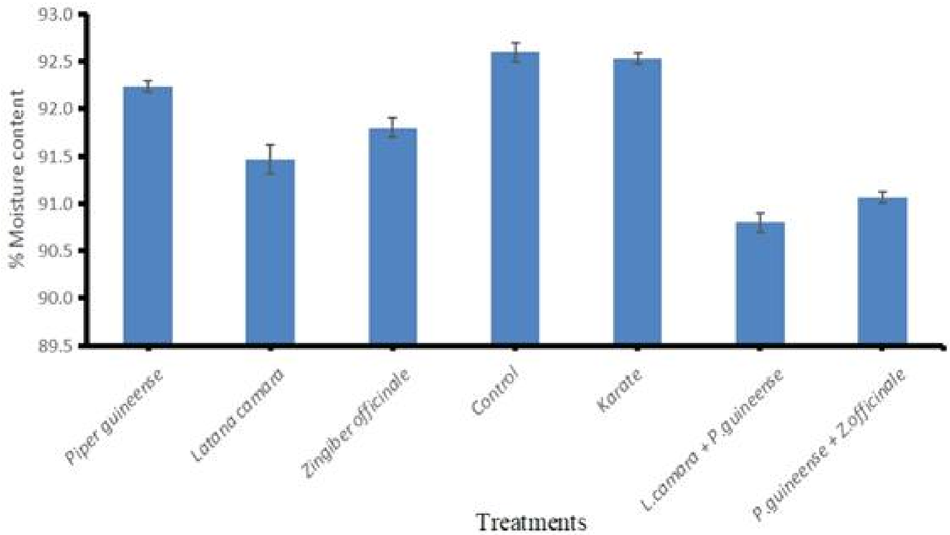

Figure 1: Composition of Moisture content in cucumber treated with plant extracts and synthetic insecticide

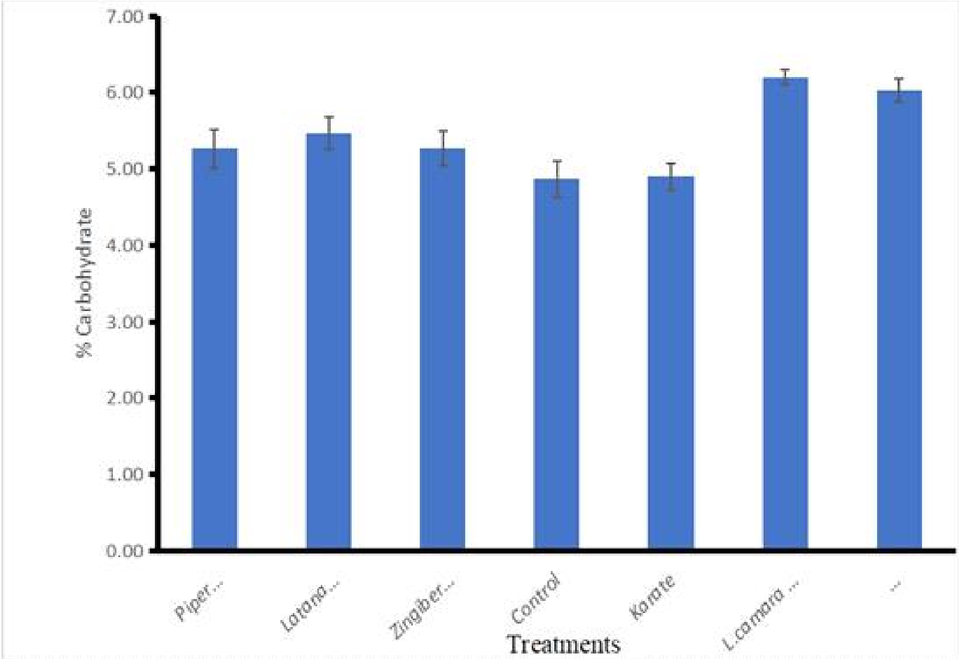

Figure 2: Composition of carbohydrate content in cucumber treated with plant extracts and synthetic insecticide

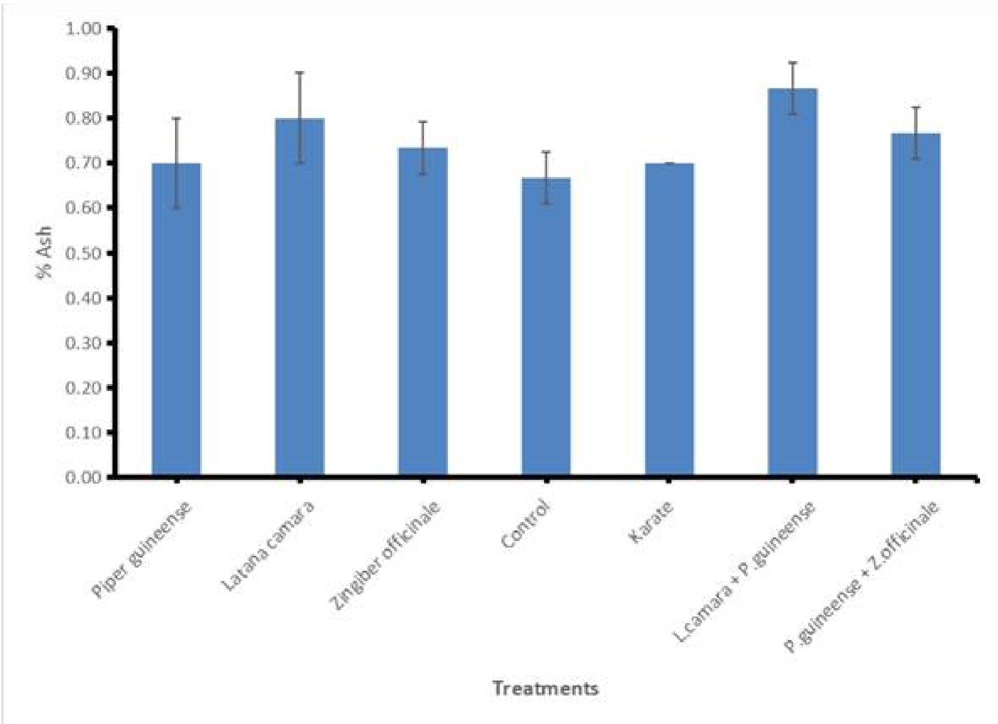

Figure 3: Composition of Ash content in cucumber treated with plant extracts and synthetic insecticide

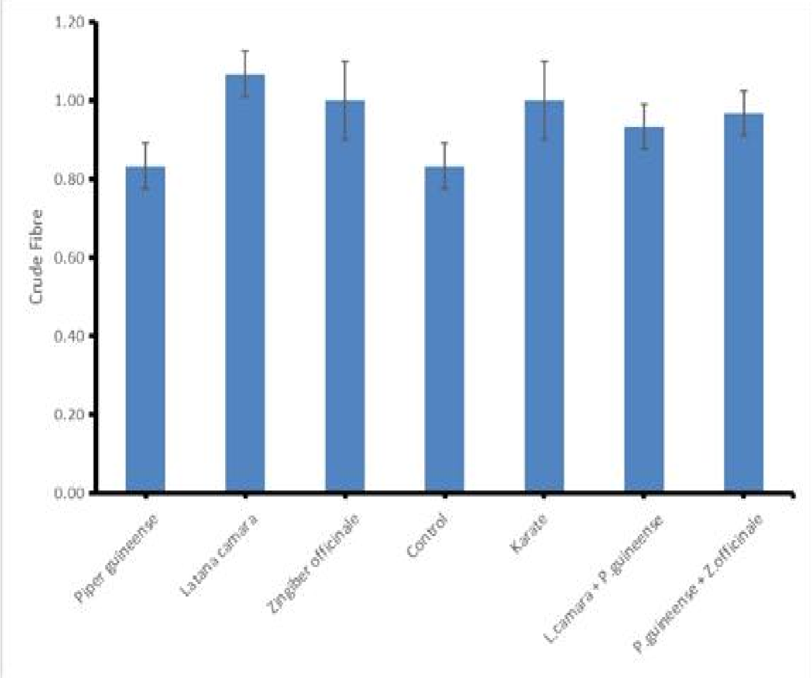

Figure 4: Composition of Crude fiber content in cucumber treated with plant extracts and synthetic insecticide

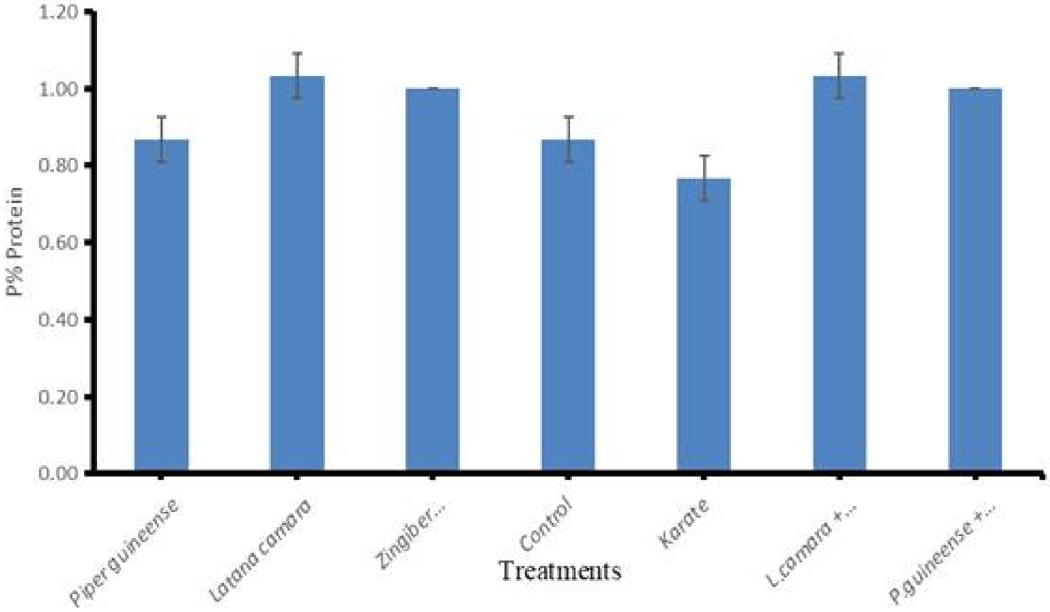

Figure 5: Composition of Protein content in cucumber treated with plant extracts and synthetic insecticide

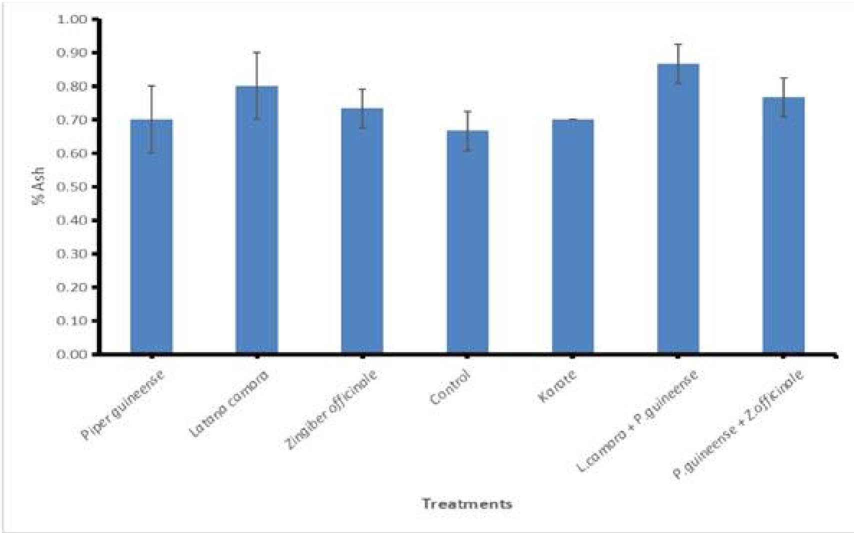

Figure 6: Composition of Ash content in cucumber treated with plant extracts and synthetic insecticide

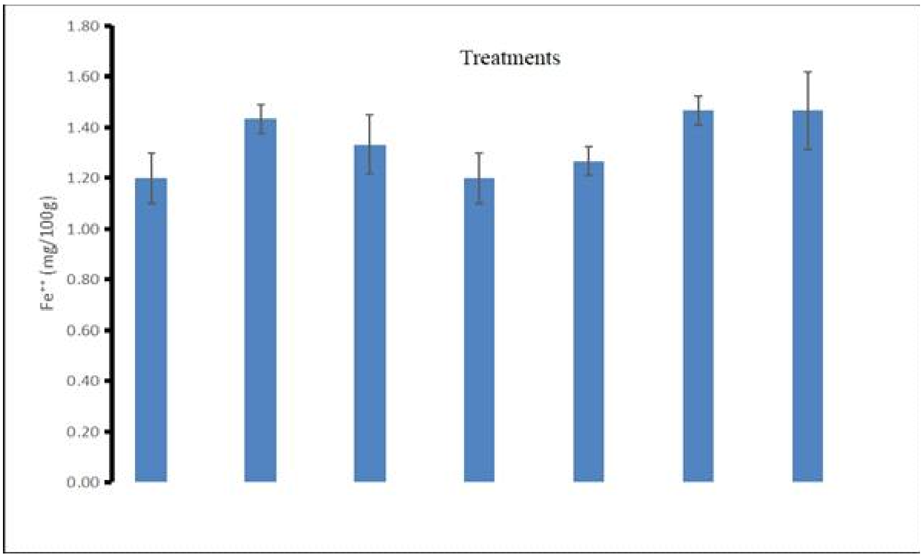

Figure 7: Phytonutrient's composition of Fe^{++} in cucumber treated with plant extracts and synthetic insecticide

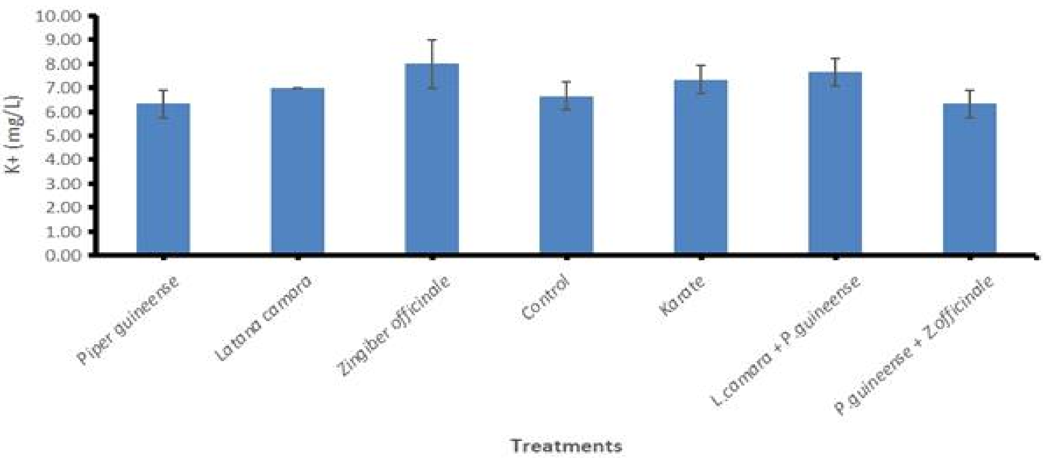

Figure8: Phytonutrients composition of K^{+} in cucumber treated with plant extracts and synthetic insecticide

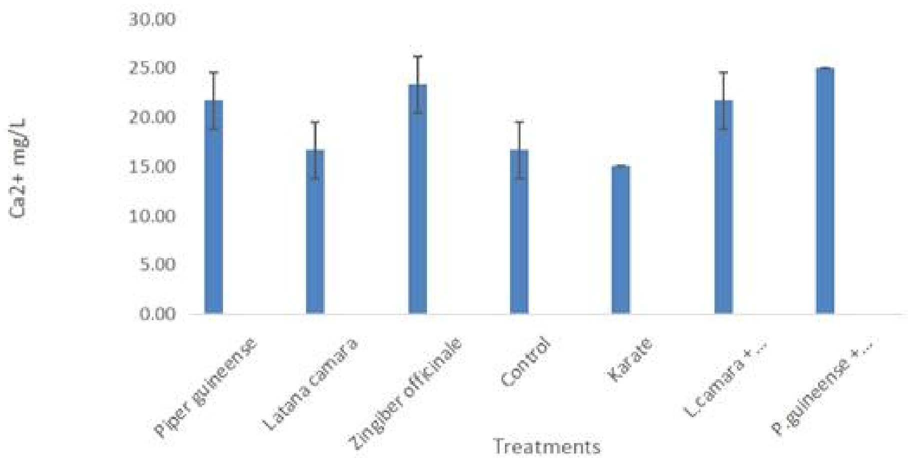

Figure 9: Phytonutrient compositiona of Ca $^{2+}$ in cucumber treated with plant extracts and synthetic insecticide

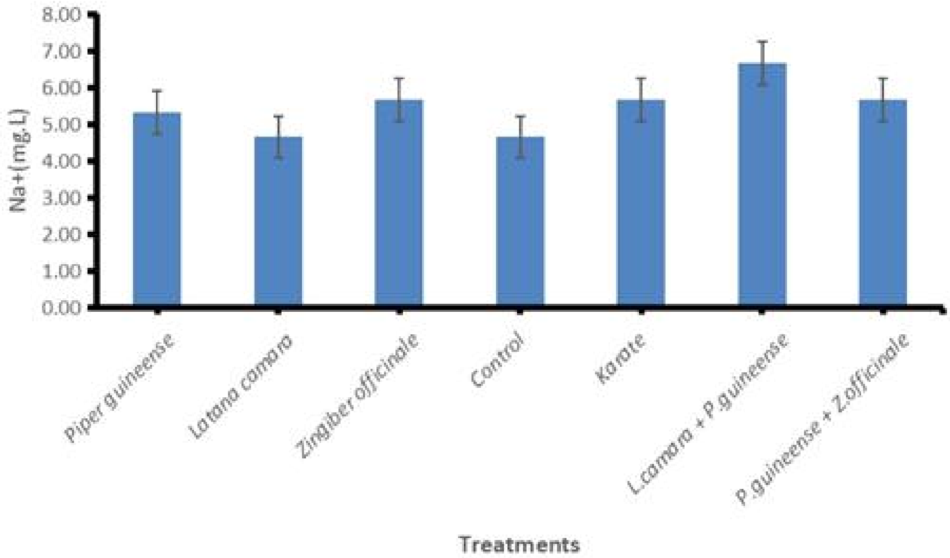

Figure 10: Phytonutrient composition of Na^{+} in cucumber treated with plant extracts and synthetic insecticide

Table 3: Quantitative Phytochemical Screening Analysis of Tested Plant Species

Constituent (%)	*Z. officinale* (Rhizomes)	*A. indica* (Seeds)	*L. camara* (Leaves)	*T. diversifolia* (Leaves)	*P. guineense* (Seeds)
Alkaloids	113.33e	1553.33a	1278.33b	970.00c	325.00d
Saponins	68.33e	120.00d	186.67c	220.00b	375.00a
Tannins	113.33d	48.33e	1470.00b	1555.00a	231.67c
Glycosides	26.66b	26.66b	73.33a	66.66a	13.33c
Terpenoids	1558.33a	161.67d	528.33c	1243.33b	151.67d
Phenols	69.46b	65.53c	74.23a	48.50d	31.96e
Flavonoids	195.00d	86.66e	278.33c	363.33c	480.00a
Steroids	81.66e	281.66a	133.33b	228.33b	185.00c

Means with the same letter (a, b, c, d, e) in each column are not significantly different at the 5% probability level using DMRT (Duncan's Multiple Range Test)