Evaluation of Insecticidal and Antifungal Potential of some Plant Extracts against Maize Weevil (*Sitophillus zeamais*) and Fungal Pathogens of Maize (*Zea mays* L.) in Storage

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Abstract

Maize (Zea mays L.) is the world's leading crop widely cultivated as cereal grain and domesticated in Central America. It is the only food cereal crop that can be grown in diverse seasons. There are many varieties of maize, in spite of the regular white and yellow coloured type with nutritional benefits. The study was intended to determine the effect of plant extracts and field inventories on the maize weevil (Sitophilus zeamais) and the fungal pathogens associated with the crop. The varieties (Sammaz 51, Oba 98 and Local maize) were treated with three plant extracts (Carica papaya L., Moringa oleifera Lam. and Ficus exasperata Vahl.) and the synthetic insecticide (Caterpillar force) were used. The standard cultural laboratory technique was used to isolate the mycoflora. The results showed highest weevil emergence in sammaz 51 control (4.16±9.40) and no weevil emergence for sammaz 51 treated with M. oleifera, F. exasperate, synthetic insecticide and local maize variety treated with synthetic insecticide. Weevil death was highest in the local maize variety treated with M. oleifera (4.12±11.63) and highest grain damage was recorded for Oba 98 treated with C. papaya (5.39±7.96) and no grain damage was recorded for sammaz 51 control and local maize variety treated with synthetic insecticide. The results also revealed ten probable fungal pathogens to be associated with the maize varieties in store. These fungi include; Candida species, Mucor mucedo, Fusarium moniliforme, Penicillum italicum, Rhizopus stolonifer, Aspergillus fumigatus, Aspergillus niger, Asgergillus terreus, Fusarium solani and Fusarium oxysporum. The in vitro test with the plant extracts across the maize varieties infected with weevil in store revealed that the zone of inhibition at 50mg/ml by C. papaya was more on Rhizopus and Penicillum (30mm). Aqueous extract of these plant products can effectively be used as a major component for the management of S. zeamais and fungal pathogens during storage.

Keywords: *Maize, Weevil, Sitophillus zeamais Carica papaya, Moringa oleifera, Ficus exasperata, Caterpillar Force*

Background of Study

Maize (*Zea mays* L.) is the world's highest-yielding cereal crop, accounting for significant food production globally (Whitt *et al*., 2002). Maze plays a vital role in meeting the food demands of its rapidly growing population, which has already exceeded available food supplies (Khan *et al*., 2014). However, maize storage faces significant challenges, including inadequate storage facilities, poor ventilation, and damage from insect pests, rodents, and birds (Islam *et al*., 2017).

Maize is particularly vulnerable to insect pest like maize weevil (*Sitophillus zeamais*) which is hazardous to cultivation and storage of maize (Barre and Jender, 2022) and fungal pathogens that leads to deterioration of maize (Chilaka *et al*., 2012). Weevil infestation on maize can lead to significant yield losses (up to 40%) (Oerke, 2006). Weevil damage can reduce maize quality, affecting its market value (Dhliwayo and Siame, 2015). Maize weevil have also been reported to be the most destructive pest affecting stored maize, causing losses of up to 50% in tropical regions, particularly during summer seasons with high humidity and temperature (Irshad *et al*., 1988; Ahmad and Ahmad, 2002). On the other hand, some fungal species present in maize have been linked to mystic infection of cattle, particularly *Aspergillus fumigatus* (Griffin, 2010). Contamination of maize grains with fungi is regarded as one of the most serious safety problems in the tropical countries and throughout the world (Chilaka *et al*., 2012). Insect infestation as well as fungal infection of maize reduces the nutritional value and palatability of foods, thereby increasing its allergic potential and may result in mycotoxin contamination (Chulze, 2010; Dhliwayo and Siame, 2015).

Various management techniques are available to control stored product pests. However, the widespread use of synthetic materials has raised concerns due to associated health and environmental issues, including pest resistance, food residues, pest resurgence, and harm to non-target organisms (Kumar *et al*., 2007). Alternatively, local medicinal plants have been recognized for their insecticidal properties and biofungicidal properties (Gaselase and Getu, 2009; Chukwuka *et al*., 2020). The use of plant-based products for managing stored product insects and fungal pathogens dates back to ancient times (Qi and Burkholder, 1981). Botanical powders exhibit diverse and broad-spectrum actions against plant pests (Araya and Emana, 2009). Research has shown that plant extracts can inhibit insect growth, leading to reduced larval, pupal, and adult weight, extended developmental stages, and decreased adult emergence rates (Koul *et al*., 2008). It has also been shown that plant extracts can inhibit fungal growth (Qi and Burholder, 1981; Kumar *et al*., 2013; Chukwuka *et al*., 2020; Nmom and Ajuru, 2020). Plant-derived materials offer a more environmentally friendly solution, being readily biodegradable and easily produced by farmers at a low cost. Integrating insecticidal and biofungicidal natural products from locally available plants appears to be a safe and promising approach (Jillani *et al*., 1988; Hanif *et al*., 2015). Given the limitations of chemical insecticides and fungicides, this study aimed to evaluate the efficacy of various plant extracts against maize weevil and fungal pathogens of maize in storage.

Materials and Methods

Study Area

This study was carried out in the laboratory of Plant Science and Biotechnology, Faculty of Science, Rivers State University, Port Harcourt, which lies in the coordinates of 40 201 50 S1 N (Lat) and 60 201 and 70 351 E (Long); bounded on the South by the Atlantic Ocean; to the North by Imo and Abia States; to the East by Akwa Ibom and to the West by Bayelsa State.

Source and Collection of Samples

Seeds of three maize varieties (SAMMAZ 51, OBA 98 and Local maize) were obtained from Agricultural Development Programme (ADP) Port Harcourt, and were identified by Mr. O. Chima. The leaves of three plants (*Carica papaya*, *Moringa oleifera* and *Ficus exasperata*) used were obtained from Emohua and identified by Dr. M. G. Ajuru, a Taxonomist in the Department of Plant Science and Biotechnology, Faculty of Science, Rivers state University, Port Harcourt. Synthetic insecticide (Caterpillar force) was sourced from a local market (Mile 3), Port Harcourt, Rivers State.

Shelf-life Evaluation of Maize

Shelf-life of the three maize varieties stored for a period of three months was evaluated using the method of Singh and Anderson (2004). 5g of the powdered leaves of different plant extracts were applied unto the maize samples as biocides and monitored for the specified duration.

Fungal Isolation

Sabouraud Dextrose Agar (SDA) were prepared according to the manufacturer's instructions in which 32.5g of powdered SDA medium was dissolved in 500ml of sterile distilled water and autoclaved at 121°C for 15 minutes at 15psi (Agrios, 2005). The solution was then cooled and dispensed into 15 sterile Petri dishes. To selectively isolate fungi, tetracycline was added to the SDA medium to inhibit bacterial growth. Subsequently, 0.1ml aliquots of 10^{-1} dilution of each sample was plated on to the SDA and incubated at 27.5°C for 5 days in an inverted position.

After incubation, discrete colonies on SDA plates were counted, and the mean values from replicate plates were recorded. Fungal cultures were observed directly on plates and afterward wet mounted with cotton blue in lactophenol stains on slides under a compound microscope. The observed characteristics of the fungal cultures were recorded and compared with established techniques described by Cheesbrough (2006) and James and Natalite (2001); to enable the accurate identification and enumeration of fungal isolates present in the samples.

Identification of Fungal Isolates

Isolates were identified based on their morphological features such as colour, shapes, texture, spore types followed by microscopic examination of their wet mounts prepared with cotton blue lactophenol and reference made to fungal identification (Shamsi *et al*., 2012).

Quantitative Analysis of the Chemical Constituents of Plant Materials Used

Alkaloid Determination

Dry plant parts sample of 5grams was weighed into a 250ml beaker and 200ml of 10% acetic acid in ethanol was added, covered and allowed to stand for 4 hours. This was filtered and the extract was stood over a water bath and allowed to concentrate to one quarter of the original volume. Drops of concentrated ammonium hydroxide were added to the extract until the precipitation was complete. The whole solution was allowed to settle and the precipitate collected and washed with diluted ammonium hydroxide and then filtered. The residue is the alkaloid, which was dried and weighed.

Saponin Determination

The sample was ground and 2grams of sample was put into a conical flask and 100cm^3 of 20% aqueous ethanol were added. The sample was heated over a hot water bath for 4 hours with continuous stirring at about 55^{o}C. The mixture was filtered and the residue re-extracted with another 200ml 20% ethanol. The combined extract was reduced to 40ml over water bath at about 90^{o}C. The concentrate was transferred into a 250ml separatory funnel and 20ml of diethyl ether was added and shaken vigorously. The aqueous layer was recovered while the n-butanol extract was washed twice with 10ml of 55% aqueous sodium chloride. The remaining solution was heated in a water bath; after evaporation the samples were dried in the oven to constant weight; to obtain the percentage saponin content.

Flavonoid Determination

Plant sample of 5g was extracted with 100ml of 80% aqueous methanol at room temperature. The whole solution was filtered. The filtrate was later transferred into a crucible and allowed to evaporate into dryness over a water bath until a constant weight was achieved.

Cyanogenic Glycoside Determination by Alkaline Titrimetric Method

Plant sample of 5g was weighed into a sterile distillation flask, 20ml distilled water was added and the sample was allowed to stand overnight for proper hydrolysis to be attained. The sample was distilled into 20ml sodium hydroxide containing 0.5g crystal. The distillate was titrated with 0.02N silver nitrate in the presence of 0.2ml of 5% potassium iodide and 1ml 6N ammonia hydroxide solution to a permanent turbidity.

Tannin determination

Plant sample of 0.1g was weighed into a 50ml conical flask and shaken for 1 hour in a mechanical shaker. This was filtered into a 50ml volumetric flask and made up to the mark with distilled water; then 5ml of the filtrate was pipetted into a test tube and mixed with 2ml of 0.1M $FeCL_3$ in 0.1M HCL and 0.008m potassium ferrocyanide. The absorbance was measured at 120nm within 10minutes.

Oxalate determination

5g of the sample was weighed and added into 100ml distilled water. The constituent was heated for 1hour and allowed to cool. 25ml of sample was measured into a flask and 20ml of 2M H_2SO_4 was added. The samples were placed in a heating mantle which was brought down after it reached a temperature of 70^oC. The compound was brought down and titrated with $KMNO_4$ until it turned pink, an indication for oxalate.

Ethanol Extraction of the Plant Parts

The powdered plant form under study was extracted using the method of Robinson *et al.,* (2020), in which 50g of the powdered plant parts were transferred into well labelled 500ml conical flasks each, after which 200ml of ethanol was added, swirled carefully for proper homogenization and allowed to stand for forty-eight hours (48hours). After 48 hours of extraction, the supernatant was filtered with sterile filter paper (Whatman No1 filter paper) into sterile 250ml beakers and were labelled according to the type of extract. The filtrate was evaporated to dryness in the hot air oven at 45°C. The resulting oily residue was weighed and stored in sterile containers which were preserved in the refrigerator at 3°C for further analysis.

Preparation of Extracts for Antifungal Assay

Stock solution of the ethanol extract was prepared by dissolving 1g of the oily residue in 2ml of Dimethyl sulfoxide (DMSO) which gave rise to 500mg/ml stock of the ethanol extract. Further two-fold serial dilution was carried out by diluting 1ml of the stock solution into three different test tubes containing 1ml of sterile distilled water to achieve the concentrations of 250mg/ml and 125mg/ml while fluconazole was used as the positive control.

Antifungal Activity of Extracts

The antifungal activity of the extracts was carried out using the well in agar diffusion methods as described by Robinson *et al.,* (2020), where 48 hours old fungal isolates which were standardized to 1.5x10^8 CFU/ml was inoculated on well dried and labelled (according to the isolates) SDA plates in duplicates. The plates were allowed to dry for 3 minutes before wells (holes) were bored using sterile 6mm cork-borer. The different concentrations (500, 250,125mg/ml and Fluconazole 200mg/ml) of the ethanol extracts and fluconazole were transferred into the wells using sterile pipettes. The plates were incubated at 22°C for forty-eight hours. Zone diameters were measured using graduated rule and the results recorded.

RESULTS AND DISCUSSION

Table 1: Effect of Treatments on Weevil Emergence, Death and Grain Damage of Maize Varieties in Storage

Parameter	Weevil Emergence	Weevil Death	Grain Damage
V1T1	0.12±0.86^{d}	0.12±0.86^{c}	0.66±2.66^{d}
V1T2	0.00±0.00^{e}	1.00±2.82^{bc}	2.00±4.44^{cd}
V1T3	0.00±0.00^{e}	0.90±2.66^{bc}	1.52±3.52^{d}
V1T4	0.00±0.00^{e}	0.00±0.00^{c}	0.09±0.60^{d}
V1T0	4.16±9.40^{a}	3.90±9.15^{a}	0.00±0.00^{d}
V2T1	1.17±2.97^{c}	1.17±2.97^{bc}	5.39±7.96^{a}
V2T2	0.75±2.38^{d}	0.75±2.38^{c}	1.05±2.32^{d}
V2T3	0.54±1.79^{d}	0.54±1.79^{c}	0.68±1.55^{d}
V2T4	0.02±0.14^{d}	0.02±0.14^{c}	0.95±2.72^{d}
V2T0	0.21±0.84^{d}	0.21±0.84^{bc}	0.30±0.97^{d}
V3T1	0.90±3.61^{d}	0.90±3.61^{c}	1.80±4.21^{cd}
V3T2	4.12±11.63^{a}	4.12±11.63^{ab}	3.50±7.20^{bc}
V3T3	3.02±10.48^{b}	3.02±10.48^{ab}	4.27±8.02^{ab}
V3T4	0.00±0.00^{e}	0.00±0.00^{c}	0.00±0.00^{d}
V3T0	0.42±2.87^{d}	0.42±2.88^{c}	0.20±0.00^{d}
P value	0.000	0.000	0.000

Means with difference superscripts within the same row are significantly different (P≥0.05).

Where V1T1 = Sammaz 51 treated with *C. papaya*; VIT2 = Sammaz 51 treated with *M. oleifera*; V1T3 = sammaz 51 treated with *F. exasperate*; V1T4 = Sammaz 51 treated with Caterpillar Force; V1T0 = Sammaz 51 Control; V2T1 = Oba 98 treated with *C. papaya*; V2T2 = Oba 98 treated with *M. oleifera*; V2T3 = Oba 98 treated with *F. exasperata*; V2T4 = Oba 98 treated with Caterpillar Force; V1T0 = Oba 98 Control; V3T1 = Local maize treated with *C. papaya*; V3T2 = Local Maize treated with *M. oleifera*; V3T3 = Local Maize treated with *F. exasperata*; V3T4 = Local Maize treated with Caterpillar Force; V1T0 = Local Maize Control

Table 2: Fungal Identification and Characterization

Fungal Isolate	Macroscopic Examination	Microscopic Examination	Suspected Organism
Isolate A	**Milk color velvety growth, with milk color reverse**	**Rod-like septate**	***Candida sp.***
Isolate B	**Milk color fluffy growth, with milk color reverse**	**Septate branchy hyphae, no spore, no conidia**	***Mucor mucedo.***
Isolate C	**Pure cottony growth with yellow and green reverse**	**Septate branching hyphae with conidia**	***Fusarium moniliforme***
Isolate D	**Faint green velvety growth with white border and yellow-green reverse**	**Septate hyphae chain-like conidia spores present**	***Penicillium italicum***
Isolate E	**White fluffy growth with brown border and yellow reverse**	**Septate branching hyphae, no conidia**	***Rhizopus stolonifer***
Isolate F	**Faint green velvety growth, reverse**	**Septate branching hyphae with conidia**	***Aspergillus fumigatus***
Isolate G	**Black or brown, velvety on reverse**	**Septate branching hyphae conidia**	***Aspergillus niger***
Isolate H	**light brown velvety, flat on reverse**	**Septate branched conidia**	***Aspergillus terreus***
Isolate I	**White creamy, wholly irregular reverse**	**Septate branched conidia oval**	***Fusarium solani***
Isolate J	**White cottony with tint of pink, irregular rapid growth, reverse conidia**	**Septate branched hyphae conidia**	***Fusarium oxysporum***

Table 3: Phytochemical Analysis (mg\100g) of Botanicals

Phytochemicals	*Moringa oleifera*	*Ficus exesperata*	*Carica papaya*
Flavonoid	**12.26±0.00**	**8.88±0.00**	**8.22±0.00**
Oxalate	**3.43±0.00**	**3.34±0.03**	**2.69±0.11**
Saponin	**3.80±0.00**	**1.30±0.00**	**1.40±0.00**
Tannin	**3.40±0.01**	**3.25±0.04**	**1.68±0.06**
Phenol	**2320.0±0.00**	**2381.80±0.00**	**2320.00±0.00**
Alkaloid	**8.60±0.00**	**9.44±0.00**	**9.00±0.00**
Cynogenic glycoside	**0.20±0.00**	**0.20±0.00**	**0.20±0.00**

Table 4: Antifungal Sensitivity of *Carica papaya*

Zone of inhibition (mm)	***Candida sp.***	***M. mucedo***	***F. moniliforme***	***A. fumigatus***	***A. niger***	***F. oxysporum***	***F. solani***	***R. stolonifer***	***A. terreus***	***P. italicum***
100mg/ml	**11**	**8**	**0**	**12**	**5**	**0**	**23**	**10**	**0**	**20**
50mg/ml	**6**	**11**	**15**	**10**	**5**	**20**	**0**	**30**	**20**	**30**
25mg/ml	**10**	**7**	**25**	**10**	**6**	**0**	**0**	**25**	**30**	**20**
Fluconazol (200mg/ml)	**10**	**20**	**27**	**7**	**5**	**0**	**0**	**35**	**20**	**10**

Table 5: Antifungal Sensitivity of *Moringa oleifera*

Zone of inhibition (mm)	*Candida sp.*	*M. mucedo*	*F. moniliforme*	*A. fumigatus*	*A. niger*	*F. oxysporum*	*F. solani*	*R. stolonifer*	*A. terreus*	*P. italicum*
100mg/ml	**0**	**15**	**20**	**0**	**25**	**0**	**0**	**0**	**18**	**10**
50mg/ml	**0**	**0**	**12**	**0**	**23**	**0**	**0**	**20**	**10**	**18**
25mg/ml	**0**	**0**	**15**	**0**	**10**	**0**	**0**	**0**	**21**	**0**
Fluconazol (200mg/ml)	**0**	**0**	**8**	**0**	**0**	**0**	**0**	**0**	**11**	**28**

Table 6: Antifungal Sensitivity of *Ficus exasperata*

Zone of inhibition (mm)	*Candida sp.*	*M. mucedo*	*F. moniliforme*	*A. fumigatus*	*A. niger*	*F. oxysporum*	*F. solani*	*R. stolonifer*	*A. terreus*	*P. italicum*
100mg/ml	**15**	**0**	**0**	**25**	**15**	**0**	**0**	**0**	**10**	**12**
50mg/ml	**32**	**20**	**0**	**0**	**2**	**0**	**0**	**25**	**17**	**26**
25mg/ml	**0**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**15**	**15**
Fluconazol (200mg/ml)	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**20**	**15**

The results of this study are presented in Tables 1 – 6. The result on Table 1 recorded 4.16±9.40 and 0.12±0.86 weevil emergence for the control plate and plate treated with C. papaya leaf extract for Sammaz 51. However, there was no weevil presence recorded for plates treated with *Moringa oleifera* leaf, Ficus exasperate leaf and insecticides. Prior to this finding, 73-92% reduction in weevil emergence has been reported in maize treated with M. oleifera (Srinivasan *et al*., 2018; Kumar *et al*., 2020). The result for weevil death recorded high mortality in the control plates for

sammaz 51 (3.90±9.15) with no mortality recorded for the plates treated with insecticides. This aligns with the findings of Sharma *et al*. (2020) that recorded 015% weevil mortality in maize treated with synthetic fungicide in storage. There was no significant difference in the mortality rate recorded for the plates treated with the plant extracts but *Moringa oleifera* and *Carica papaya* leaf extracts recorded highest (1.00±2.82) and lowest (0.12±0.86) mortality respectively. No significant reduction in weevil population for maize in store has been reported in previous studies (Patel *et al*., 2016; Gupta *et al*., 2019; Singh *et al*., 2020). No grain damage was reported in this study for controlled plates of sammaz 51 maize variety and insecticide plates of local maize variety. Grain damage values was similar in sammaz 51 and oba 98 maize varieties treated with botanicals except for oba 98 plates treated with pawpaw leaf extract that recorded higher value (5.39±7.96). The local maize variety recorded highest (4.27±8.02) and comparably high (3.50±7.20) grain damage in the plates treated with *Ficus exasperate* and *Moringa oleifera* leaf extracts respectively. This finding seems to be in line with the report of Vijayan *et al*. (2023) that plant materials which are biodegradable, non-residual, equally effective, and widely available may show to be a superior solution for controlling insect pests, particularly storage pests, without grievous impact on grain or seed quality or harming our ecology or environment. Research has shown that plant extracts can inhibit insect growth, leading to reduced larval, pupal, and adult weight, extended developmental stages, and decreased adult emergence rates (Koul *et al*., 2008). However, the synthetic insecticide was more effective in the prevention against the pest *stylophilus zeamais*. This is in line with the work of Kammo *et al*. (2019). They documented that synthetic insecticides were more effective in the incidence of dead hearts caused by fall army worm and stem borers (Busseolafusca, Sesamiacalmistis). This is probably due to the chemical composition and concentration of the synthetic insecticides.

The result on Table 2 revealed *Candida sp., Fusarium solani, Fusarium oxysporum, fusarium moniliforme Mucor mucedo, Aspergillus terreus, Aspergillus niger, Aspergillus fumigates, Rhizophus stolonifer and Penicillum italicum* to be associated with maize in store. Earlier studies had reported that during storage, several kinds of fungi can remain associated with maize seeds either causing their deterioration or simply remaining viable to infect germinating seedling (Poopola and Okungbowa, 2021). The losses caused by seed fungi may occur during seed development, storage or germination. The findings of this study agrees with the report of Kortei *et al*. (2022) who profiled fungi contaminants of maize in Ghana. Moreover, Feng *et al*. (2010) reported that in Ethiopia, various grain fungi including *Fusarium sp., Penicillium sp. and Aspergillus sp*. have been detected in maize samples. According to Chulze (2010), *Fusarium, Aspergillus* and *Penicillium* are the major fungi genera commonly encountered in maize grain in tropic regions. The presence of *candida sp*. agrees with the findings of Jespersen *et al*. (1994). The genus *Candida* belong to the fungi family Saccharomycetaceae and encompasses about 200 species of which many are harmless commensals of host including humans (Kourkoumpetis *et al*., 2011). The presence of *penicillum sp.* and *Rhizopus sp.* in this study aligns with the documentation of Poopola and Okungbowa (2021). Interestingly, Aspergillus sp. has been isolated and identified in the studies of Camilia *et al*. (2015) and Jonathan *et al*. (2018). Ortiz *et al*. (2010) reported that the development of these fungi can be affected by moisture content of the product, temperature,

storage time and degree of fungal contamination prior to storage. Insect and mite activity facilitate fungi dissemination (Griffin, 2010).

The results on Table 3 revealed that some phytochemicals are present in the plants, and they include: phenols, tannins, flavonoids, alkaloid, saponin, as well as oxalate and cynogenic glycoside. The three botanicals recorded high phenol content, moderate flavonoid, alkaloid, tannin, saponin and oxalate content and low cynogenic glycoside. These antioxidants also have antifungal potentials. Plant derived antioxidants as potential antifungal agents have been reported in earlier researches (Singh *et al*., 2019; Kumar *et al*., 2020). Meanwhile, prior to this study, antioxidants of plant origin have been reported to inhibit weevil emergence and mortality (Gupta *et al*., 2018; Singh *et al*., 2019; Kumar *et al*., 2020). Tannin rich plant extracts have been reported to reduce weevil emergence and modulate antioxidant defence of maize (Kumar *et al*., 2018).

The results for Table 4-6 revealed the sensitivity of the plant extracts to fungal pathogens. The results obtained portrayed the botanicals used at different concentrations (100mg/ml; 50mg/ml; 50mg/ml) to possess antifungal potential across the different fungal genera identified in this study. The findings of this study align with the reports of Oniha *et al*. (2021). However, highest zone of inhibition (30mm) was recorded for *Rhizopus stolonifer* and *Penicillum italicum* by *C. papaya at 250mg/ml*. Research has shown that plant extracts can inhibit fungal growth (Qi and Burholder, 1981; Kumar *et al*., 2013; Chukwuka *et al*., 2020; Nmom and Ajuru, 2020) A study by Bakare *et al*. (2015) had reported *Carica papaya* leaf extracts to possess antifungal effect on some fungal pathogens which aligns with this study. On the other hand, *Moringa oleifera* extracts have been deduced to be a potential antifungal agent especially against *Aspergillus sp*. and *Penicillum sp.* (Paray *et al., 2018;* Chiang *et al*., 2005; Ganie *et al*. 2015). Lawal *et al*. (2012) documented that *Ficus exasperata* possess significant antifungal potential which is in line with this study. However, the study of Adebayo *et al*. (2009) disagrees with the finding of this study that reported *F. exasperata* to have no antifungal activity against some fungal pathogens. The control fluconazole was also reported to inhibit the fungal pathogens identified which is similar to the report of Abubakar and Usman (2016) but contrast to the documentation of Bukar *et al*. (2010) that it didn't inhibit the fungal pathogens identified in their study.

Conclusion

The alternative control methods for plant due to bioharzard pollution resistance, resistance to fungicides by fungi pathogens and high cost of producing chemicals, various studies have been done on the introduction of plant extracts as disease control agents as they have minima toxicity and environmental friendliness These plants are medicinal and bestowed with various phytochemicals such as phenols, flavonoids, alkaloids, saponins, tannins, oxalate, glycoside etc. in different parts (bark, leaves, root, seed, fruits) which have important applications as antioxidants and antimicrobial as they are also acknowledged for their biopesticides potentials. The botanicals used in this study proved to possess antifungal and anti-insecticidal properties and can be used as an ecofriendly alternative to synthetic pesticides and fungicides.

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