Efficacy of *Ocimum gratissimum* and *Vernonia amygdalina* leaves of control of pathogenic fungi in *Citrus Sinensis, Solanum lycopersicum* and *Carica papaya* in Relief Market in Owerri Municipal

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Abstract
This study was to evaluate the efficacy of Ocimum gratissimum and Vernonia amygdalina in control of pathogenic fungi in Citrus sinensis, Solanum lycopersicum and Carica papaya obtained in Owerri municipal, Imo state. Some microbes deteriorate fruits thereby reducing their nutritional and economic values. In order to prevent fruit loses, some synthetic and antimicrobial chemicals have been formulated and applied to prevent or treat these microbes. Sometimes, these chemicals may be harmful to both man and the environment. This study was aimed at investigating the efficacy of ethanol scent leaf and bitter leaf extracts in controlling fungal pathogens associated with the post harvest rot of sweet orange, tomato and pawpaw. The study was carried out at the Department of Plant Science and Biotechnology Laboratory, Imo State University, Owerri. 10 samples of each fruit with signs and symptoms of rot were collected from Relief market in Owerri Municipal and transported in aseptic bags to the laboratory. Fungi isolation was done using Potato Dextrose Agar (PDA). The fungi isolated were Aspergillus niger, Botryodiplodia theobromae, Botrytis cinerea, Fusarium oxysporium, Geotrichum candidum, Mucor racemosus and Penicillum citrinum. The percentage occurrence of the fungi showed G candidum (40%) as the highest occurred organism in orange, B. cinerea (14.29%) as the least occurred in pawpaw and A. niger and G. candidum as highest in tomato. Plant extraction was done using maceration method. Antimicrobial effects of the plant extract were determined using well diffusing method for bacteria and food poisoning method for fungi. The antifungal effect of the plant extracts showed all the fungi isolates were strongly inhibited by them. Scent leaf extract has total inhibition on the growth of B. theobromae (100%), G. candidum (100%) and F. oxysporium (100%). Bitter leaf extract had least effect on A. niger (38.89%) isolated from tomato. Synergistic effect revealed that the combination of the plant extracts has inhibitory effect on the fungi especially G. candidum (100%), B. cinerea (100%), F. oxysporium (100%) and M. racemosus (100%). This study showed the efficacy of these botanicals in inhibiting and control of fungi associated with rot of orange, pawpaw and tomato.

Keywords: Agar, Antifungal, Extract, Dextrose, Fungi

Introduction

Fruits are the comestible part of mature ovary of flowering plants which are normally eaten raw (FAO, 2007). Fruits and vegetables are very important and have high dietary and nutritional qualities. (Akinmusire *et al*., 2019). Fruits and vegetables play very important roles

in nutrition, health, economic development and food security**.** Their consumption has dramatically increased by more than 30% during the past few decades (Barth *et al.,* 2009). It is also estimated that t about 20%of all fruits and vegetables produced is lost each year due to spoilage (Chukwuka *et al.,* 2013). Estimates of production losses of fruits in some African countries have been estimated to reach 50% (Mohammad *et al.*, 2023). This has been associated with spoilage fungi and bacteria, which can be toxigenic or pathogenic.

Post-harvest rots caused by fungi and bacteria cause significant economic loses worldwide and have been a major challenge to agriculture, health, commerce as well as industries (FOA, 2007). Due to the low pH in fruits, most of the spoilage organisms associated with fruit rots are usually fungi (Jay, 2005). Akinmushiri (2011) isolated *Aspergillus niger, Aspergillus citri, Botrydiplodia theobromae, Colletotrichum gloesporiodes, Fusarium species, Galactomycetes citri-anrantii, Penicillium digitatum, P.itallicum and Trichoderma viride* were found to cause rots in *Citrus sinensis*. *Aspergillus flavus, Aspergillus niger, Rhizopus nigricans, Rhizopus oryzae, Curvularia lunata, Fusarium equseti* and *Fusarium moniliforme* have been implicated in the post-harvest rot of *Carica papaya* in Southern Nigeria (Gupta & Parthak, 1986; Akinmusire, 2011). *Fusarium oxysporium, Fusarium moniliforme, Aspergillus niger,* and *Rhizopus stolonifer* have been found to be responsible for *Solanum lycopersicum* fruits soft rot (Onuegbu, 2002). Similaily, Akinmusire, (2011) isolated *Aspergillus niger, Alternaria solani, Aspergillus flavus* and *Mucor racemosus* from rotten *Solanum lycopersicum.*

Control of plant disease is the use of various methods to reduce the impact of diseases on plant health and productivity. The use of chemical pesticides and fungicides has raised concerns about environmental pollution, human and animal health risk and the development of pathogens that are resistant to these chemicals. As a result, there is a need to explore alternative, sustainable and environmental friendly methods for controlling these pathogens responsible for post-harvest rot of these fruits and vegetables.

This research is aimed to investigate the efficacy of scent leave and bitter leave extracts and to ascertain their synergistic effects for the control of fungal pathogens associated with the post-harvest rot of tomatoes, sweet orange and pawpaw.

Aims and objectives

The aim of the study was to determine the efficacy of *ocimum gratissimum* and *vernonia amygdalina* leaves of control of pathogenic fungi in *citrus sinensis, solanum lycopersicum* and *sarica papaya* in relief market in Owerri Municipal, specifically the study sought to:

1) determine the percentage of fungi occurrence
2) determine the pathogenicity on the three fruits
3) determine the percentage inhibitory effects of bitter leaf and Scent leaf extracts on isolated fungi species

Materials and Methods

Sample Collection

Fresh infected Pawpaw, Oranges and tomatoes fruits were gotten from Relief market in Owerri municipal L.G.A. Samples were collected with sterile polyethene bags and transported immediately to the Department of Plant Science and Biotechnology Laboratory of Imo State University, Owerri, Imo State.

Preparation of Culture Media

The medium used for the isolation of the fungal pathogens was potato dextrose agar (PDA). This was prepared by dissolving 39.6g of PDA powder in 1000ml of sterile distilled water. The mixture was stirred vigorously to homogenize and was covered with foil paper and sterilized by autoclaving at 121^0C for 15mins at 15 pounds per square inch (psi). The sterile medium was allowed to cool to body temperature and two to three drops of chlorophenicol was added to inhibit bacterial growth. Approximately 20ml of the cooled medium was aseptically poured into the Petri dishes by flame sterilizing the mouth of the flask containing the medium. This was allowed to set before culturing the fungi.

Preparation of Plants Extracts

Plant extracts were prepared from young leaves and fresh of *Ocimum gratissimum* L and *Vernonia amygdalina* which were obtained from Mgbaike Garden in Owerri West L.G.A. The leaf samples were washed in tap water and surface disinfected with (2 %) sodium hypochlorite solution and then rinsed severally with distilled water. The plant samples were air-dried at room temperature for 7 days. They were pounded in a mortar with the use of a pestle before ground with manual hand grinder to fine powder. 100 g of powder of each plant sample were macerated in 500 ml of ethanol and mixed thoroughly. The mixture was allowed to stand for 48 hours and was filtered using cheese cloth followed by Whatman filter paper N°.1 to obtain pure extracts. The ethanol extracts were evaporated using a Rota vapor at 67°C and were put into labeled sterile bottles and stored at 4 °C until use. The filtrates obtained were used to assess the antifungal activity tests. The antifungal analyses were performed using the poisoned food technique as proposed by Busuman *et al*., (2018) with slight modifications. The extract was added directly to the PDA medium previously prepared. The concentrations of (10%), (20%), and (30%) (v/v) were constituted for the ethanol extract. The mycelia growth area was measured using meter rule. The inhibition effect of the plant extracts on the growth of the isolated fungus was determined by applying the following formula (Nakpalo *et al*., 2018).

$$\text{Percentage Inhibition} = \frac{\text{Colony growth diameter in the control}}{\text{Colony growth diameter in the treatment}} \times 100$$

Isolation of Pathogen

Symptoms of the disease were studied by visual observation as per standard procedure described by Guerber *et al*., (2003). The diseased samples were washed thoroughly under running tap water cut into small pieces surface sterilized with absolute ethanol and rinsed thrice with distilled. The isolation techniques employed by Chiejina (2008) was adopted for this study. Thin sections of 2mm diameter was cut from the periphery of the deteriorated samples and sterilized with ethanol for few minutes and rinsed in several changes of distilled water. The thin section was put into petri dish containing PDA medium amended with antibiotics chlorophenicol, inverted and incubated at 37^0C room temperature for 3 days on the laboratory bench. Three replicates were prepared for each sample. Sub-culturing was done repeatedly until pure cultures of each fungal organism encountered were obtained. The pure cultures were obtained by several Sub-culturing until pure culture was obtained.

Identification of Pathogen:

The Identification of the pure isolates was done after incubation in the laboratory for four days. After incubation, representatives' colonies were selected and sub-cultured till pure cultures of the colonies were obtained. Slides of fungal isolates from pure cultures were made. A drip of lactophenol cotton blue stain was dropped on a slide and with the help of an inoculation needle; a small slice of the mycelium from the fungi pure cultures was taken and placed in the slide. The fungus mycelium was carefully separated very well on the slide then gently covered with cover slip. The slide was observed under light microscope at magnification of X40. Fungal species were identified macroscopically and microscopically as described by Barnett and Hunter (1998), Dugan, (2006) and Liamngee *et al*., (2015). Shapes of the conidia and conidiophores were observed and recorded. Photographs were taken using digital camera fixed directly on the microscope.

Determination of Percentage of Fungal Occurrence

This was done to determine the rate of occurrence of different fungal isolates. Isolations were made on different diseased pawpaw, oranges and tomatoes cultured differently. The number of occurrences for each of the isolates were recorded, calculated and expressed as percentage. The Formula of Muhammed *et al.* (2023). was followed with slight modification as:

$$\text{Percentage colonization} = \frac{\text{Number of colonies per pathogen}}{\text{Total number of colonies observed}} \times 100$$

Pathogenicity of Isolated Fungi

Pathogenicity test was carried out to determine if the isolated fungi pathogens were actually responsible for the spoilage observed in pawpaw, oranges and tomatoes fruits. Healthy samples of these fruits were obtained, washed under running water and sterilized with (70%) ethanol and cleaned with distilled water. With the aid of a sterile 2mm cork borer, cylindrical

plug tissues were made on the fruits and 2mm diameter disc of fungi mycelia from pure culture of the isolates with the aid of a sterile inoculating loop were taken out and put in healthy fruit. To prevent contaminations, Vaseline gel was used to seal the inoculated points and the fruits put inside sterile transparent polyethene bag. The inoculated fruits were kept on the laboratory bench for three (3) days at a room temperature. After the incubation period, the infected fruits were examined and cut across using a disinfected knife along the horizontal of inoculation to assess the rot depth. The diameter of the rotten portion of the pawpaw, orange and tomatoes fruits was measured using meter rule.

Data collection and Statistical analysis

The data obtained were from (a) frequency of occurrence of fungal pathogens associated with the spoilt fruits and (b) Pathogenicity test result by measuring the diameter of spoilage. Data generated were subjected to analysis by means of descriptive statistics.

Results and Discussion

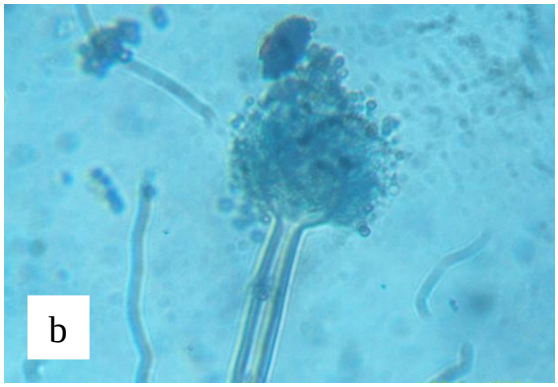
The result of pathogenic fungi isolates obtained from rotten oranges showed (30%) *Botryodiplodia theobromae*, (40%) *Geotrichum candidum* and (10%) *Penicillium citrinum* and *Fusarium oxysporum* respectively (Table 1). For Pawpaw fruits, *Aspergillus niger* and *Geotrichum candidum* (42.86%), *Botrytis cinerea* (14.29%). In tomato, *Aspergillus niger* and *Goetrichum candidum* (33.33%), *Fusarium ozysporium* has (25%) and *Mucor racemosus* (8.33%) occurrence (Table 1).

Research Question1: what is the fungi colony percentage occurrence

Table 1 Fungi colony percentage occurrence

Fruit Samples	Fungi Isolates	Percentage Occurrence (%)
Orange	*Botryodiplodia theobromae*	30.00
	Penicillium citrinum	10.00
	Geotrichum candidum	40.00
	Fusarium oxysporium	10.00
Pawpaw	*Aspergillus niger*	42.86
	Geotrichum candidum	42.86
	Botrytis cinerea	14.29
Tomatoes	*Aspergillus niger*	33.33
	Fusarium oxysporium	25.00
	Geotrichum candidum	33.33
	Mucor racemosus	8.33


a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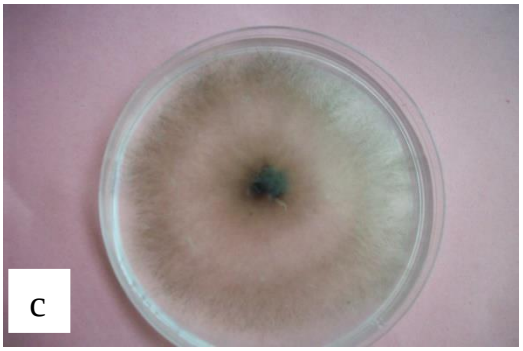
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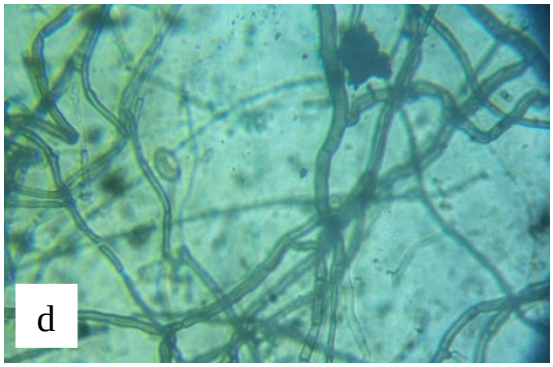
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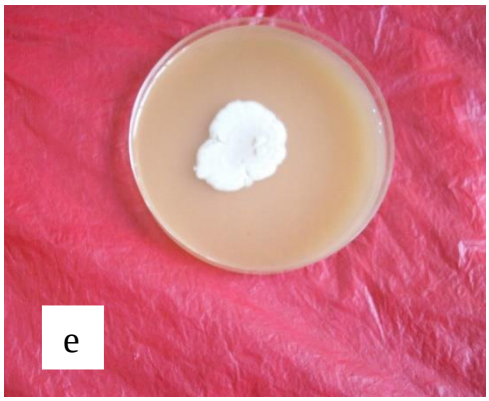
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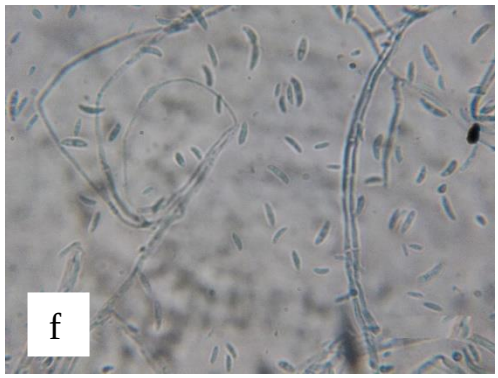
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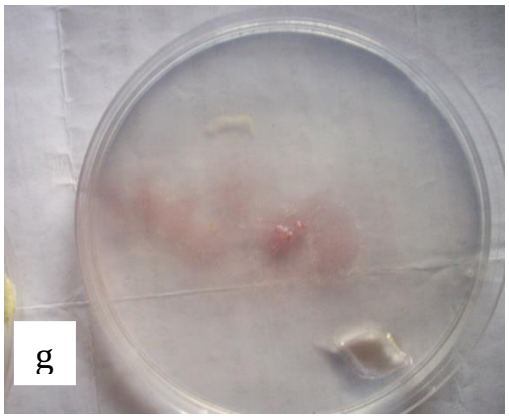
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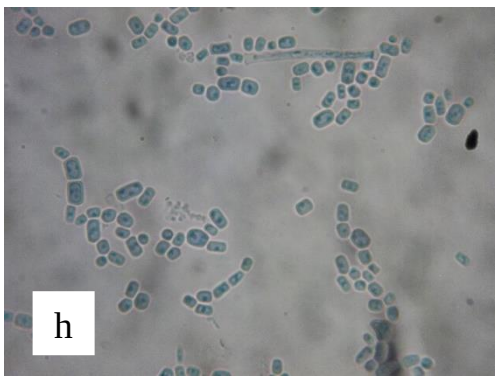
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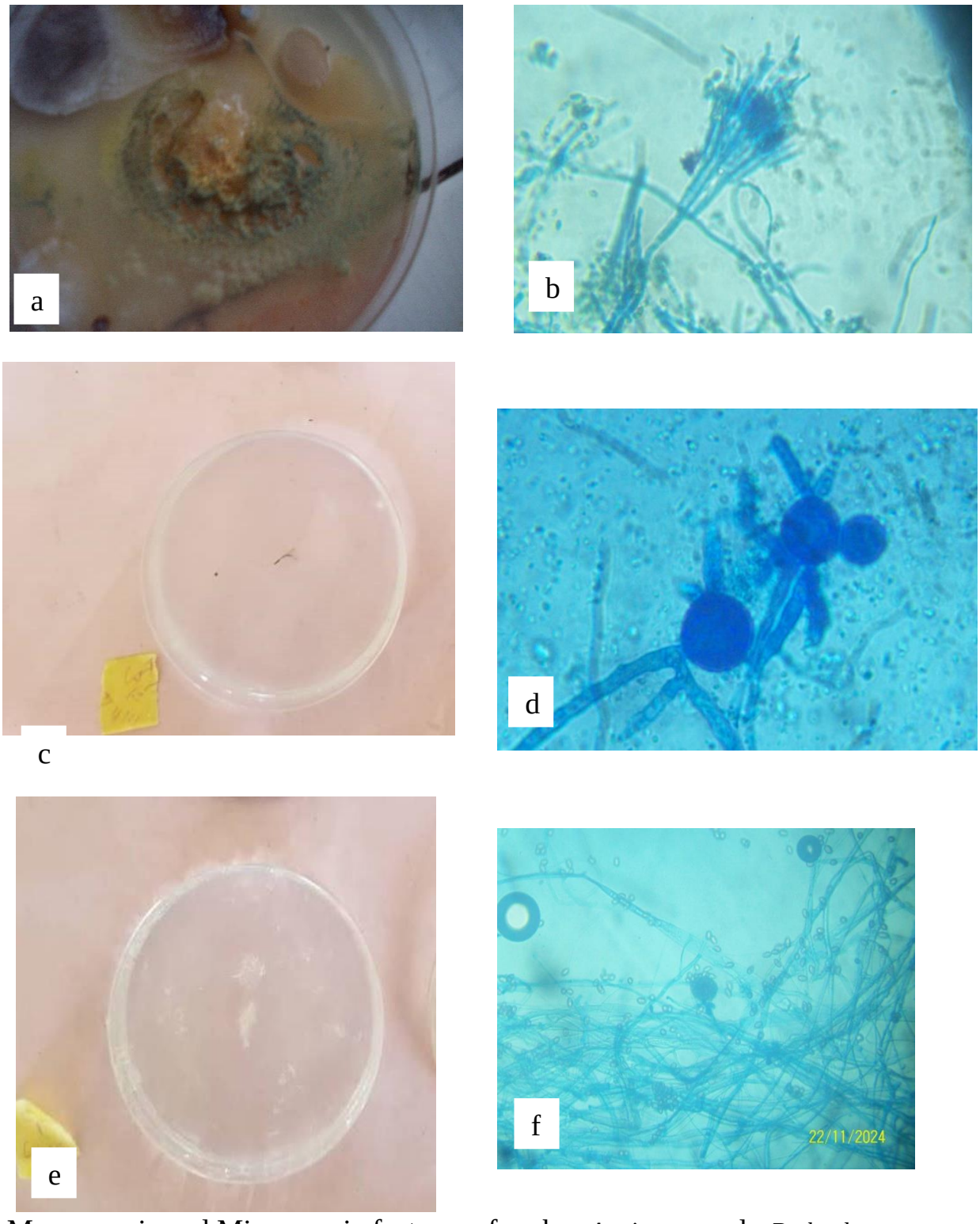


Plate 1: Macroscopic and Microscopic features of a - b = *A. niger*; c - d= *B. theobromae*; e - f = *F. oxysporium and* g-h = *G. candidum* X40

Varieties of microorganisms are responsible for fruit decay or spoilage with believed to cause majority of the spoilage (Ahmed & Al-Najada, 2018). The orange sample had four fungi showed that oranges are liable to colonization by fungi which could lead to post-harvest rot and loses. The presence of *F.oxysporium* and *Penicillum specie* has been reported as the most causative agents of orange spoilage (Bukar *et al*., 2009, Mukhtar *et al*., 2009). Bukar *et al.*, (2009) reported *Peniciullum spp* as one of the major contaminants of orange in Kano metropolis. They stated that economically these fungi poses as threat to the orange vendors, causing them financial loses.

Amenu *et al.*, (2024) identified five major fungi genera namely *Aspergilus, Mucor, Penicillum, Rhizopus* and *Fusarium* as major causative agents in sweet orange. *G.candidum,* has the highest percentage occurrence at (40%) followed by *B. theobromae* (30%), *P. citrinin and F.oxysporium* has (10%) occurrence. In pawpaw, the isolated fungi were similarly reported by previous researchers (Helal *et al.,* 2018., Hamim *et al.,* 2014., Awoite *et al*., 2013). The occurrence of *A. niger* which is believed to be present in the soil could be as a result of the fruit contact with the soil during harvesting, storage or display for sale. *Aspergillus* species have been identified as one of the most common fungi pathogen responsible for various degrees of rot and deterioration of fruits and vegetables after harvesting (Awoite *et al*., 2013; Bayewu & Amusa 1999, Chan 2013, Chukwuka *et al.,* 2013) and can lead to financial loses. Similarly, Tawose *et al.,* (2020) identified *A. flavus, Penicillum italicum, Rhizophus stolonifer, Mucor mucedo, P.notatum,* and *Fusarium solani* as pathogenic fungi associated with pawpaw fruit disease. In tomato, *A. niger* and *G. candidum* (33.33%) were the most occurring fungi isolates, followed by *F. oxysporium* (25%). *M. racemosus* (98.33%) occurred least. The presence of *G. candidum* has been allied to be associated with sour rot in fruits stored (Mbajiuka & Emmanuel, 2014). The organism is known for its ability to cause significant damage in fruits and vegetables with high water and sugar content. Furthermore, the isolates of these fungi was in concord with the findings of other authors who reported them in tomatoes (Onuorah & Orji, 2015; Eteb *et al*., 2013; Akinmusire,2011; Wogu & Ofuase, 2014; Mbajiuka & Enya, 2014).

Research Question 2: Determine the pathogenicity on the three fruits

Table 2. Pathogenicity test on the three fruits

Sample	Treatment rot diameter (mm)	Control rot diameter (mm)
ORANGE		
Botryodiplodiatheobromae	6.50	2
Pencillium spp	4.57	2
Geotrichum candidum	8.30	2
Fusarium oxysporium	4.94	2
PAWPAW		
Aspergillus niger	7.5	2

Geotrichum candidum	0.00	2
Botrytis cinerea	6.5	2
TOMATOES		
Aspergillus niger	22.95	2
Fusarium oxysporium	25.45	2
Geotrichum candidum	27.35	2
Mucor racemosus	27.34	2

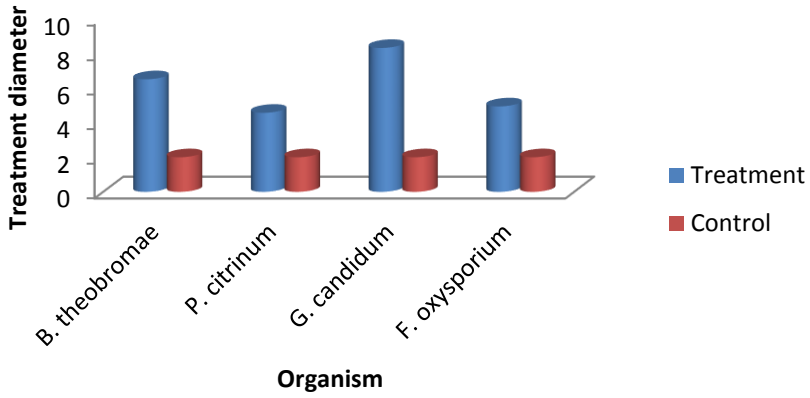


Figure1: Pathogenicity test on Orange

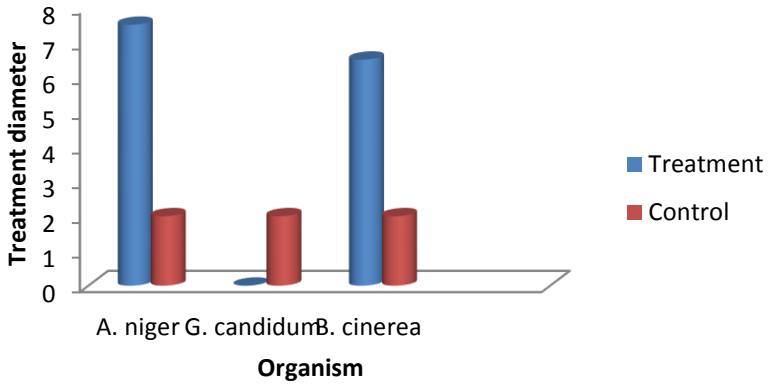


Figure 2: Pathogenicity test on Pawpaw

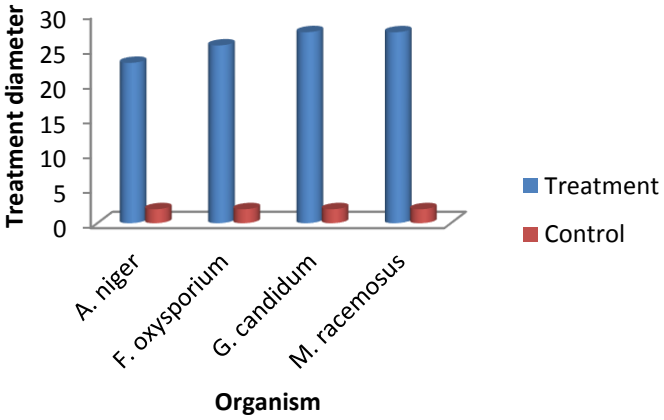


Figure 3: Pathogenicity test on Pawpaw

The pathogenicity test revealed that almost all the fungi isolates were responsible for rot observed in orange, pawpaw and tomato fruits. Symptoms such as colour change oozing of water, offensive odours and complete rot of the fruits were observed. The rot diameter in orange revealed that *B. theobromae* was 6.50mm, *P. oxysporum* 4.57mm, *Geotrichum candidum* 8.30mm and *F. oxysporum* 4.94mm (Table 2 and Fig1).

For pawpaw, *G. candidum* did not show rot effect, *A. niger* was measured at 7.5mm against the control of 2mm while *Botrytis cinerea* was 6.5mm (Table 2 and Fig 2). In tomato, *F. oxysporum G. candidum* and *Mucor racemosus* completely rot the tomato fruits while *A. niger* measured 22.95mm (Table 2 and Fig3).

The inoculations of healthy fruits of orange show that all the fungi isolate are capable of causing various degree of rot on the fruits. On orange *G. candidum* with 8.30mm diameter has the highest effects on the fruit, *B. theobromae* with 6.50mm was next was *F. oxysporium* 4.94mm followed closely by *P. citrinum.*For pawpaw, *A.niger* at diameter of 7.5mm has the highest pathogenic effects followed by *B. cinerea* at diameter of 6.5mm. *G. candidum* did not show any sign or symptoms of rot after four days of incubation. Therefore, not be pathogenic to pawpaw.

In tomatoes, all the four identified and isolated fungi showed sign of rot or decay. All the fruits inoculated with *F. oxysporium*, *G. candidum* and *M. racemosus* had total deterioration. The entire fruits were soft, producing whitish fluid and offensive odour. The pathogenic effect of these isolated pathogenic fungi is a threat to both human health and the socio-economic situation of Owerri. Some fungi pathogens when in contact with human can cause disease and even death if not properly treated. On the other hand, the fruit vendors stand

to lose their financial investments if adequate measures are not taken to mitigate the spread of these pathogens.

Research Question 3: what is the percentage inhibitory effects of bitter leaf and Scent leaf extracts on isolated fungi species

Table 3. Percentage inhibitory effects of bitter leaf and Scent leaf extracts on isolated fungi species

Sample	Bitter leaf (%)	Scent leaf (%)	Bitter / Scent leaf (%)
ORANGE			
Botryodiplodiatheobromae	100	100	55.71
Pencillium spp	90.90	100	72.72
Geotrichum candidum	100	100	100
Fusarium oxysporium	78.57	100	47.14
PAWPAW			
Aspergillus niger	87.78	100	44.44
Geotrichum candidum	69.64	73.21	58.93
Botrytis cinerea	100	100	100
TOMATOES			
Aspergillus niger	38.89	100	25.56
Fusarium oxysporium	100	100	100
Geotrichum candidum	62.30	100	44.44
Mucor racemosus	100	100	100

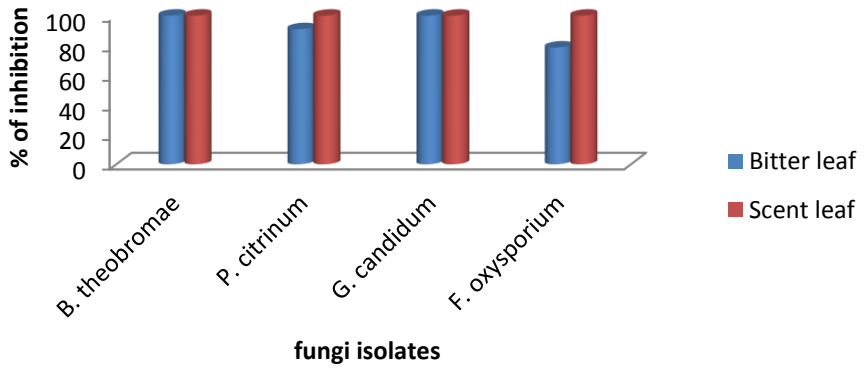
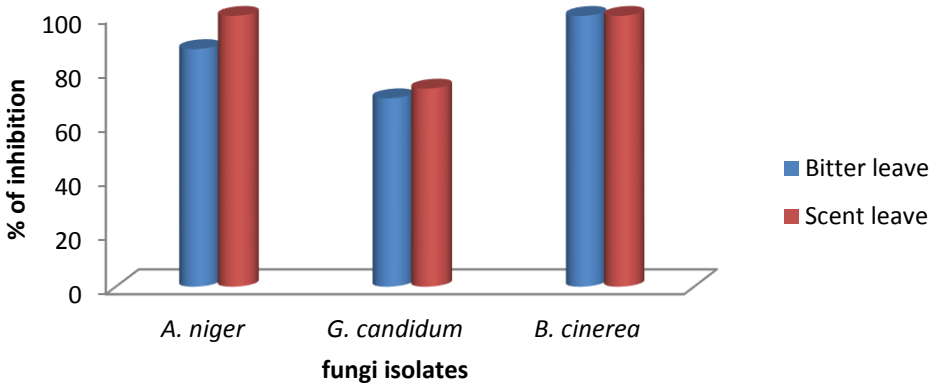


Figure.5: Percentage inhibition of bitter leaf and scent leaf ethanol extract in orange

Figure 6: Percentage inhibition of bitter leaf and scent leaf ethanol extract in Pawpaw



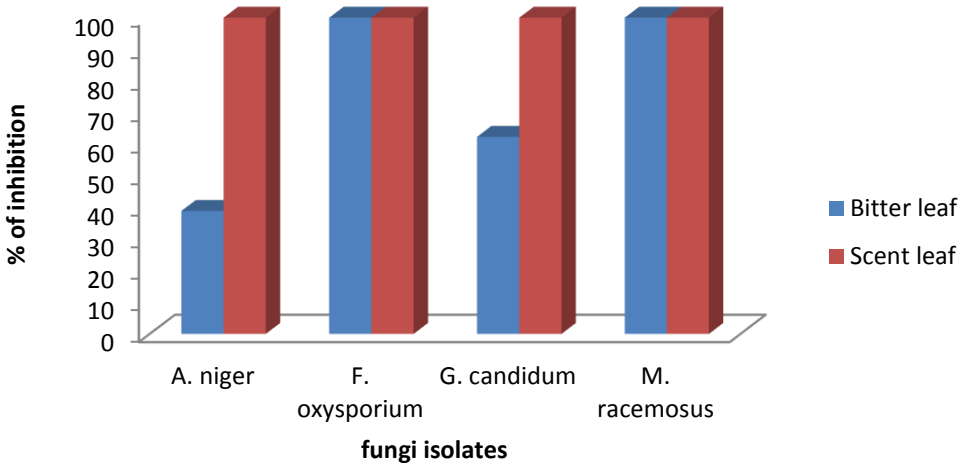


Figure.7: Percentage inhibition of bitter leaf and scent leaf ethanol extract in Tomatoes

The mean inhibitory effects of the leaf extracts showed that scent leaf has 100% inhibition on *Botryodiplodia P. citrinum*, *G. candidum* and *F. ozysporium* isolated from orange. Bitter leaf extract has (100%) inhibition on *B. theobromae* and *G. candidum*, (90%) inhibitory effect on *P. citrinum* while for *F. oxysporum*, (78.57%) effect. (Table 3). In *Pawpaw*, the inhibitory effect showed that scent leaf has (100%) effects on *A. niger* and *B. cinerea* but (73.21%) effect on *G. candidum* and (100%) effect on *B. cinerea*. In tomato, scent leaf extract has (100%) inhibitory effect on all the four fungi isolates; *A. niger, F. oxysporum*, *G. candidum* and *M. racemosus*. While for bitter leaf, its inhibitory effect was (38.89%) in *A. niger*, (62.30%) effect on *G. candidum* and (100%) on *F. ozysporium* and *M. racemosus* (Table 3).

The synergistic effect of bitter leaf and scent leaf revealed that (55.71%) effect was recorded in *B. theobromae*, (72.72%) in *P. citrinum*, (100%) effect on *G. candidum* and (47.14%) on *F. oxyspiorum* in orange fruit (Table 3). In Pawpaw, the combination of both leaf extracts showed that their inhibitory effect was (44.44%) for *A. niger*, (58.93%) for *G. candidum* and (100%) on the *B. cinerea* (Table 3). The combination of both extracts for tomato showed that (25.56%) effect was recorded for *Aspergillus niger*, (100%) in both *Fusarium oxysporum* and *Mucor racemosus* while the effect was (44.44%) on *Geotrichum candidum*.

The antifungal analysis of ethanolic extracts of scent leaf and bitter leaf showed that they both have antifungal effects on some of the isolated fungi pathogens. In orange, ethanolic bitter leaf extract totally inhibited the growth of *B. theobromae,* and *G. candidum.* Bitter leaf extract showed (90.90%) inhibitory effect on *Penicillum citrinum* and (78.57%) inhibition effect on *F. oxysporium.* On the other hand, scent leaf ethanolic extract was able to completely inhibit the growth of all the four fungi isolated. These indicate that these leaves have phytochemical properties which possess antifungal quality. The inhibitory effect of bitter leaf extract observed in this study concurred with other research reports on *G. candidum* and *F. oxysporium.* John *et al*., (2016) and Onyeani *et al*., (2012) reported the antibiotic effect of bitter leaf extracts on *F. oxysporium* and *Rhizopus stolornifera.* It was observed that bitter leaf extract was able to inhibit the growth of *A. niger, G. candidum* and *B. cinerea* isolated from pawpaw fruits. There was (87.78%) inhibition on *B. cinerea.* Similarly, scent leaf extract showed (100%) fungitoxic effect on *A.niger* and *B. cinerea.* This indicates total elimination of the fungi and therefore scent leaf can be used as antifungal substance against both organisms. At (73.21%) inhibition, scent leaf extract can also be used as a regulator against a *G. candidum* infection of pawpaw. The use of botanicals in control of fungi infection of tomatoes has been widely reported. Various leaf extracts such as pawpaw leaf, bitter leaf, scent leaf, sida leaf have been employed to determine their efficacy in controlling or eradication of fungi pathogens responsible for tomato rot (Ogo-Oluwa and Kator, 2016). The antifungal effect revealed that bitter leaf extract has (38.89%) effect on mycelia growth of *A. niger,* (62.30%) effect on *G. candidum* but completely inhibited the growth of F. *oxysporium* and *M. racemosus.* The scent leaf extract was efficient in completely inhibiting the growth of mycelia of all the four fungi isolates.

The synergistic effect of both botanicals showed that there was significant inhibitory effect of their combination on the seven fungi isolates. Complete inhibitory effect was recorded in two fungi pathogen *B. cinerea* and *M. racemosus.* Also, there was significant inhibition on *B. theobromae* and *G. oxysporium.* Although in most cases, there seem to be a better effect when the extracts are administered alone than when combined. This could be as a result of dilution of one or two phytochemical components of either extract specially scent leaf. Therefore, for efficient and effective result, the administration of both leaf extract separately

will yield a better result. The ability of the synergistic mixture of both leaves is evident that it is possible to combine both leaf extracts.

Conclusion

The role of fruits to human nutrition cannot be over emphasized. The provide man with necessary minerals such as vitamins, fats and oil. Fruits have high quality sugar and nutritional substances with low pH level that made them susceptible for microbial attack and decay (Singh & Sharma 2007; Zanuddin 2020). This study has proven that plant extracts such as scent leaf extract and bitter leaf extract has the potential of inhibiting these microbes responsible for rot in orange, tomato and pawpaw with better effect at higher concentration of these extracts. Thus, supporting the use of plant extracts in tackling the post-harvest rot of fruits caused by bacteria and fungi.

Recommendations

To effectively implement the recommendations on the use of Ocimum gratissimum and Vernonia amygdalina for controlling pathogenic fungi in Citrus sinensis, Solanum lycopersicum, and Carica papaya in Relief Market, Owerri Municipal, the following recommendation were made:

1. Local Farmers and Produce Vendors should apply leaf extracts to fruits before and during storage. As they are the primary handlers of the produce and will directly benefit from reduced spoilage and increased shelf life.
2. Official of Imo State Ministry of Agriculture and Natural Resources should provide training and awareness programs for farmers on how to prepare and apply the extracts to support small-scale trials and encourage adoption through extension services.
3. Official of Imo State Ministry of Agriculture and Natural Resources could institutionalize the practice and support its integration into local agricultural policy.
4. Agricultural Extension Officers should disseminate the practical knowledge on extraction, dosage, and application, monitor outcomes and help adjust implementation based on field conditions. As they could serve as the link between research and practice, ensuring recommendations are adapted locally.
5. The management of the Federal University of Technology, Owerri could Conduct follow-up studies and help refine extract formulations, collaborate with farmers to test real-world efficacy and ensure safe usage.

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Principals' Demographics, Transformational Leadership Style and School Productivity

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Abstract
The study examined the influence of principals' demographic variables and transformation leadership on school productivity in public secondary schools in Akwa Ibom State, Nigeria. To achieve the purpose, seven research questions were raised and seven hypotheses were formulated to guide the study. The study adopted ex-post facto research design. The population of the study comprised of all the 274 schools with principals in public secondary schools in Akwa Ibom State from which a sample of 30 schools, with principals and 150 teachers were derived using purposive sampling technique. The instrument for data collection was a researcher's developed instrument entitled: "Principals' Demographics Questionnaire (PDQ), Transformational Leadership Questionnaire (PTLQ)" and Proforma entitled "Students' Academic Performance Proforma" (SAPP).These instruments were validated and tested for reliability. The collated data were analyzed using descriptive and inferential statistical tools. The formulated hypotheses were tested using factorial analysis of variance. Findings from the study revealed a significant different in school productivity based on principals' age and transformational leadership. However, the study found no significant difference in school productivity based on principals' gender and transformational leadership in public secondary schools in Akwa Ibom State. Based on the findings, the study concluded that age and transformational leadership interactively influence school productivity. It is recommended among others that the government and State Secondary Education Board should routinely organised targeted leadership training programs for principals to enhance their transformational leadership skills particularly in inspirational motivation.

Keywords: Age, Gender, Leadership, School, Transformation, Productivity

Introduction

Secondary education in Nigeria is prominent because it serves as the platform for the transformation of learners' intellectual capital for the advancement in the development of self and the society. It is a social and learning institution that provides the environment in which a child is formally educated in order to attain enviable social status. The secondary school is very important and strategically positioned in Nigeria's educational system to provide the middle level manpower in the labour market, prepare individuals for better living and contribute to the overall economic growth of the nation.

In specific term, secondary education system provides all primary school leavers with the opportunity for education of a higher level, irrespective of sex, social status, religious or ethnic background; offers diversified curriculum to cater for the differences in talents, opportunities and future roles; provides technical knowledge and vocational skills necessary for agricultural, industrial, commercial and economic development; to provide trained manpower in the applied science technology and commerce at sub-professional grades (FRN, 2013). This is why the author placed emphasis on enhancing secondary school education to improve school performance and overall school productivity.

School productivity has been given various connotations by scholars. DeVries and Martinez (2019) refers school productivity as combining all the inputs (human, material and financial) in such appropriate and proficient manner to have quality output that satisfies the needs of the labour market or society. The authors equally considered it as the level of the success of operations in the management of these combining variables (students, teachers, administrators and infrastructures) that guarantees the realization of the goals and the objectives of education. School productivity is the ratio of educational outcomes achieved by a school to the resources utilized in the process (Gbesoevi, *et al.* 2023). On this note, it becomes necessary to state that school productivity indicators include but not limited to curriculum delivery (Adu, 2015); safe and orderly environment; positive home-school relation; and education results (high school graduation) (Weisz and Jivan 2014).In other words, the productivity of the school system revolves around the production of quality students that can compete favourably in skills, academic performance and values with contemporary in the society as well as become self-reliance, and qualify to further tertiary education. In the context of this study, school productivity is defined in terms of student academic achievement in National Examination Council Examination Senior Secondary Certificate Examination NECO & SSCE.

A student academic outcome in standardized examination such as the National Examination Council Examination Senior Secondary Certificate Examination has been a source of concern to teachers and other stakeholders in education. close observation of some secondary schools in Nigeria which Akwa Ibom State may not be exempted reveals an unacceptable level of students' failure in internal and external examination (Alordiah *et al.*, 2023), high level of students' attrition (UNICEF, 2023), students' repetition rate (Najimi, *et al.*, 2013 in Uwaezuoke, *et al.*, 2023), and high level of out of school rate (UNESCO, 2022; UNICEF, 2023). More worrisome is the insinuation that most of the schools leavers are without workable values (Alordiah *et al.*, 2023) while limited number of students are qualified to be admitted into tertiary institutions.

Notably, some scholars have attributed students' poor performance to lackadaisical attitude of teachers (Adu, 2015, Weisz and Jivan 2014); lack of administrative accountability (Banda, *et al*., 2017); inadequate teaching and learning infrastructure (DeVries and Martinez 2019); inappropriateness of school leadership approach and organizational culture (Thomas,

2023); and poor collaboration between teachers and the principals (Sari and Bukman, 2021). These observable challenges are common features of some schools in Akwa Ibom State, thus prompting the researcher to ask: could this unfortunate situation emanate from the disposition of the principals' management of schools? This question exudes from the fact that all these challenges fall under the administrative role of the principal. Besides, the principal is one of the human resource inputs that oversees and directs the operation of all other inputs in the school.

Demographic characteristics of school principals can shape their leadership style and effectiveness. Studies have shown that younger principals may be more inclined to embrace innovative leadership approaches, while more experienced principals tend to rely on traditional management techniques (Avolio & Yammarino, 2022). Similarly, gender differences may influence leadership behaviors, with female principals often demonstrating higher levels of transformational leadership traits such as emotional intelligence and participatory decision-making (Eagly & Carli, 2023). Educational qualification also plays a crucial role in shaping a principal's leadership approach, as those with higher academic credentials are more likely to adopt progressive educational strategies (Fullan, 2023). Examining how these demographic variables interact with transformational leadership can provide valuable insights into improving school productivity in Akwa Ibom State.

Scholars have explored the relationship between age and leadership from various perspectives, emphasizing its impact on cognitive flexibility, emotional intelligence, and problem-solving abilities (Leithwood & Sun, 2023). While younger leaders are often characterized by innovative thinking and technological adaptability, older leaders are associated with wisdom, stability, and a wealth of experience. The interaction between age and leadership effectiveness remains a subject of debate among researchers, as both younger and older leaders bring distinct strengths and weaknesses to organizational management. According to Leithwood & Sun (2023) younger principals are more inclined toward transformational leadership**,** which emphasizes motivation, collaboration, and professional development. Younger school leaders tend to inspire teachers and students through visionary leadership, fostering a culture of creativity and engagement. Conversely, older principals are more likely to adopt transactional leadership, which focuses on maintaining order, following established rules, and using rewards and punishments to manage teachers and students (Bass & Riggio, 2022). While transformational leadership is often associated with innovation and adaptability, transactional leadership ensures stability and discipline, which are equally vital in educational institutions.

The experience gained with age is another crucial factor in leadership effectiveness. Older principals' benefit from years of working within the education system, allowing them to understand institutional policies, manage conflicts, and build strong relationships with stakeholders (Hallinger & Wang, 2023). Another demographic variable that is highly contentious in terms of its influence on school leadership and administration is gender.

According to American Psychological Association (2020), Gender refers to the psychosocial and behavioral characteristics that distinguish males and females, encompassing the roles, expectations, and norms that society attributes to individuals based on their sex. It entails cultural responsibilities assign to the biological differences existing between male and female. These differences may depend on the ability of the gender to withstand stress; challenges; threat and be proactive in appraising situation independently and collectively. However, while few studies emphasized that gender varies in occupational maladjustment and performance with women better adjusted in workplace than men (Ayanwu, 2019; Owan, *et. al.*, 2021), being more democratic and attentive than their men counterparts (Adu, *et. al.*, 2014); others maintained a no disparity position, emphasizing that managerial capabilities is a function of skills, professionalism and experience (Arop, 2018; Onubuleze, 2018; Tu, 2019).

Although scholars acknowledged the viability of this leadership model in enhancing participation; reinforcing commitment, and ensuring collaboration to achieve school target (Raharja, *et. al.*, 2022), few scholars maintained that it may decline the satisfaction of the teachers especially where the welfare of the personnel is not given utmost priority (Lin, *et al*., 2019; Chaplin-Cheyne, 2021). Nevertheless, whether the applicability of this transformational leadership model in secondary schools in Akwa Ibom State is effective and has the potency to guarantee school productivity becomes a vacuum to be filled. Despite the growing recognition of transformational leadership in education, empirical research on its impact within the Nigerian secondary school system remains limited. Previous studies have largely focused on general school leadership without adequately addressing the interplay between principals' demographic characteristics and their leadership effectiveness (Ubben *et al.*, 2023). Therefore, this study seeks to fill this gap by investigating the influence of principals' demographic variables and transformational leadership on school productivity in public secondary schools in Akwa Ibom State based on age, gender and transformational leadership on secondary school productivity in Akwa Ibom State, Nigeria.

Statement of the Problem

In an ideal school setting, public secondary schools in Akwa Ibom State would consistently produce excellent results in the National Examinations Council (NECO) Senior School Certificate Examination (SSCE). Principals would effectively utilize their leadership roles to foster a collaborative and productive environment that inspires teachers and students to achieve academic excellence. Transformational leadership practices, such as motivating staff, setting clear visions, and implementing innovative strategies, would ensure that schools achieve optimal productivity, reflected in students' academic performance. Additionally, demographic variables such as age, gender, qualifications, and years of experience would complement leadership efforts, providing diverse perspectives and approaches to addressing school challenges.

However, the current reality in Akwa Ibom State indicates that some public secondary schools struggle with low performance in the NECO-SSCE. Reports of poor student outcomes, particularly in core subjects such as Mathematics and English, highlight the inefficiencies in school administration and the inability of some principals to fully harness their leadership potential. Factors such as principals' lack of experience in adapting leadership skill to the situation in school and inadequate adaptation of transformational leadership strategies may have contributed to this decline in productivity. Moreover, the influence of principals' demographic variables and transformational leadership styles and their subsequent influence on students' academic performance has not been thoroughly examined, leaving a significant gap in understanding how these elements interconnect.

Efforts have been made to address these challenges through various interventions. The government has organized training programs and workshops aimed at equipping principals with modern leadership skills. Resources have also been allocated to improve infrastructure and teaching materials. However, these initiatives have yielded limited results, as they often fail to address the nuanced influence of principals' demographic factors and their leadership effectiveness. Furthermore, transformational leadership, which emphasizes innovation and collaboration, has not been adequately explored or implemented in many schools. This study was therefore necessary to examine the interplay between principals' demographic variables, their transformational leadership practices, on school productivity in Akwa Ibom State.

Purpose of the Study

The research examined the influence of principals' demographic variables and transformation leadership on school productivity in public secondary schools in Akwa Ibom State, Nigeria. Specifically, the objective of the study seeks to:

i. Examine the difference in school productivity based on principals' age and transformational leadership in public secondary schools in Akwa Ibom State.
ii. Ascertain the difference in school productivity based on principals' gender and transformational leadership in public secondary schools in Akwa Ibom State.

Research Questions

The following research questions were raised in the course of the study.

i. What is the difference in school productivity based on principals' age and transformational leadership in public secondary schools in Akwa Ibom State?
ii. What is the difference in school productivity based on principals' gender and transformational leadership in public secondary schools in Akwa Ibom State?

Research Hypotheses

To guide this study, the following null hypotheses were formulated and tested at 0.05 level of significance.

i. There is no significant difference in school productivity based on principals' age and transformational leadership in public secondary schools in Akwa Ibom State.
ii. There is no significant difference in school productivity based on principals' gender and transformational leadership in public secondary schools in Akwa Ibom State.

Methodology

The study used Ex-post facto design. The population of the study comprised all the 274 public secondary schools with their principals and 18062 students who registered for the 2024 NECO SSCE out of which 6022 registered science students was used which is 18 percent of the total student population who registered for the examination in Akwa Ibom State.

The researcher sampled 30 schools and principals and 150 teachers. To determine the participating schools and principals, Purposive sampling technique was used to select the schools where the principal have served not less than three years in three senatorial districts in Akwa Ibom State. This was done as guided by the Akwa Ibom State Secondary Education Board database. Based on this criterion, a total of 30 principals were selected as informed by the state secondary education board for inclusion in the study meanwhile, the NECO-SSCE results of science students in 2024 was used for the judgment of the school productivity based on students' academic performance.

For the selection of teachers to rate their principals, a purposive sampling approach was also adopted. Teachers were selected based on the criterion of having served under the same principal for at least three years. This selection criterion ensured that the teachers had a sufficient duration of interaction with the principal, providing them with a solid foundation for assessing the principal's transformational leadership style. A total of five teachers who met the criteria were randomly selected from each of the 30 schools, resulting in 150 teachers across the study.

To measure the school's productivity, the study used the performance of science students in the 2024 National Examination Council Senior Secondary Certificate Examination (NECO-SSCE). A pro forma was used to extract the NECO-SSCE results of science students from the principals' offices. The pro forma allowed for consistent and systematic collection of relevant student performance data

The instrument for data collection was a researcher's developed instrument entitled: "Principals' Demographics Questionnaire (PDQ), Principals' Transformational Leadership Questionnaire (PTLQ)" and Proforma entitled "Students' Academic Performance Proforma" (SAPP). PDQ elicited information from the principals on their demographic variables (age, gender, specialization, service experience, qualification and marital status). It was organized as follows: age (belo PTLQ elicited information on the principals' transformational leadership (intellectual stimulation, inspirational motivation, individualized consideration and idealized influence). The Principals' intellectual stimulation which has items 1-6, Principals' inspirational motivation which has items 7-12, Principals' individualized consideration which

has items 13-18 and Principals' idealized influence which has items 19-24). These items are designed on a four-point scale of Always (A), Most often (MO), Sometimes (ST) and Not at all (NAA) and would be responded by the teachers who have been in the school for not less than three years and worked with the principal of the school. The rating and scoring code of the instrument would be 4,3,2,1 points respectively. "Students' Academic Performance Proforma" (SAPP) was used to collect NECO-SSCE students result in the eight core subject areas of science used for this study. 40years, 40-50years,51-60years and above 60years) and gender (male, female). The data of the study were analyzed using descriptive and inferential statistical tools. Specifically, mean and standard deviation were used for answering research questions; while the formulated hypotheses were tested using factorial analysis of variance.

Results

Research Question 1: What is the difference in school productivity based on principals' age and transformational leadership in public secondary schools in Akwa Ibom State?

Table 1 Summary of Mean Difference in School Productivity Based on Principals' Age and Transformational Leadership in Public Secondary Schools

Age	Transformational Leadership	Mean of school productivity	SD	N
Below 40	High	5.32	.091	2
	Moderate	5.22	.00.	1
	Low	3.27	.00.	1
	Total	4.78	1.01	4
40-50yrs	High	5.20	.08	3
	Moderate	5.43	.12	2
	Total	5.29	.15	5
51-60yrs	High	5.41	.06	7
	Moderate	5.36	.11	6
	Low	3.04	.09	2
	Total	5.07	.83	15
Above 60yrs	High	5.47	.14	3
	Moderate	4.79	.54	3
	Total	5.13	.52	6
Total	High	5.37	.12	15
	Moderate	5.21	.36	12
	Low	3.12	.14	3
	Total	5.08	.71	30

Source: Field Work (2024) N = Number of Principals

Table 1 shows the mean differences in school productivity based on principals' age and transformational leadership style categorized as high, moderate and low. Among principals aged below 40 who practice high, moderate and low transformational leadership style have a school productivity mean of: 5.32, 5.22 and 3.27 respectively. The overall mean for this age

group is 1. Among principals aged 40 to 50 years, the mean of school productivity for high use of transformational leadership was 5.20, moderate use was 5.43. Notably, there is no reported case of low use in this age group. The overall mean score for principals within this age range was 5.29. For principals aged 51-60 years, the mean of school productivity for high, moderate and low use of transformational leadership was 5.41, 5.36 and 3.04. The total mean for this age group was 5.07. Among principals aged above 60 years, the mean score of school productivity for high and moderate use of transformational leadership was 5.37, and 4.79. There is no reported case of low use in this age group. The total mean for this age group was 5.13. Principals aged 40 -50 years have the highest overall school productivity mean of 5.29.

Research Question 2: What is the difference in school productivity based on principals' gender and transformational leadership in public secondary schools in Akwa Ibom State?

Table 2 Summary of Mean of school Productivity based on Principals' Gender and Transformational Leadership in Public Secondary Schools

Gender	Transformational Leadership	Mean of School Productivity	SD	N
Male	High	5.43	.09	8
	Moderate	5.26	.31	6
	Total	5.36	.22	14
Female	High	5.30	.13	7
	Moderate	5.17	.43	6
	Low	3.12	.14	3
	Total	4.84	.89	16
Total	High	5.37	.12	15
	Moderate	5.21	.36	12
	Low	3.12	.14	3
	Total	5.08	.71	30

Source: Field Work (2024) N = Number of Principals

Table 2 shows the mean differences in school productivity based on principal's gender and transformational leadership style categorized as high, moderate and low. Among male principals who practice high, moderate and low transformational leadership style reported a mean of school productivity mean of 5.43 and 5.26. Notably, there is no reported case of low use among male principals. The overall mean was 5.36.

Among Female principals who practice high, moderate and low transformational leadership style reported school productivity mean of 5.30, 5.17and 3.12. The overall mean for this age group was 4.84. Male principals recorded the higher overall school productivity mean of 5.36.

Testing of Hypotheses

Research Hypothesis One: There is no significant difference in school productivity based on principals' age and transformational leadership in public secondary schools in Akwa Ibom State.

Table 3: Summary of Factorial Analysis of Variance of the difference in school productivity based on principals' age and transformational leadership in public secondary schools

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	13.997[a]	9	1.555	39.947	.000
Intercept	381.347	1	381.347	9795.041	.000
Age	.168	3	.056	1.436	.262
Transformational Leadership	10.121	2	5.061	129.984	.000
Age * Transformational Leadership	.699	4	.175	4.489*	.009
Error	.779	20	.039		
Total	791.103	30			
Corrected Total	14.776	29			

(I) Age	(J) Age	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Below 40	40-50yrs	-.5110*	.13236	.010	-.9145	-.1075
	51-60yrs	-.2943	.11103	.104	-.6329	.0442
	Above 60yrs	-.3483	.12737	.089	-.7366	.0400
40-50yrs	Below 40	.5110*	.13236	.010	.1075	.9145
	51-60yrs	.2167	.10189	.243	-.0940	.5273
	Above 60yrs	.1627	.11948	.612	-.2016	.5269
51-60yrs	Below 40	.2943	.11103	.104	-.0442	.6329
	40-50yrs	-.2167	.10189	.243	-.5273	.0940
	Above 60yrs	-.0540	.09531	.955	-.3446	.2366
Above 60yrs	Below 40	.3483	.12737	.089	-.0400	.7366
	40-50yrs	-.1627	.11948	.612	-.5269	.2016
	51-60yrs	.0540	.09531	.955	-.2366	.3446

***significant at P< .05 level Source: Field Work (2024)**

The result in Table 3 shows that the Factorial Analysis of Variance of the difference in school productivity based on principals' age and transformational leadership in public secondary schools. The F and p-value are 4.489 and.009 respectively at 4 and 20 degrees of freedom. The result is significant at .05 therefore, the null hypothesis which claimed a no significant difference in school productivity based on principals' age and transformational leadership in public secondary schools in Akwa Ibom State is rejected. In other words, the results indicate a significant difference in school productivity based on principals' age and transformational leadership in public secondary schools in Akwa Ibom State. Since the

result in Upper Table 3 is significant, the Scheffe post hoc test was conducted to determine where the difference lies. Therefore, the results in the lower Table 3 shows that the p-value of school productivity differ significantly at below 40 years and between ages 40-50 years (p-value .010<0.05).

Research Hypothesis Two: There is no significant difference in school productivity based on principals' gender and transformational leadership in public secondary schools in Akwa Ibom State.

Table 4: Factorial Analysis of Variance of the Difference in School Productivity based on Principals' Gender and Transformational Leadership in Public Secondary Schools

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	13.152[a]	4	3.288	50.628	.000
Intercept	516.532	1	516.532	7953.288	.000
Gender	.088	1	.088	1.358	.255
Transformational Leadership	11.133	2	5.567	85.713	.000
Gender * Transformational Leadership	.002	1	.002	.029*	.866
Error	1.624	25	.065		
Total	791.103	30			
Corrected Total	14.776	29			

***Not significant at P< .05 level Source: Field Work (2024**

The result in Table 4 shows that the Factorial Analysis of Variance of the difference in school productivity based on principals' gender and transformational leadership in public secondary schools. The F and p-value are .029and.866 respectively at 1 and 25 degrees of freedom. The result is not significant at .05 therefore, the null hypothesis which claimed a no significant difference in school productivity-based principals' gender and transformational leadership in public secondary schools in Akwa Ibom State is accepted. In other words, the results indicate that there is no significant difference in school productivity based on principals' gender and transformational leadership in public secondary schools in Akwa Ibom State.

Discussion of Findings

The results of the testing hypothesis one indicates a significant difference in school productivity based on principals' age and transformational leadership in public secondary schools in Akwa Ibom State. The post hoc test revealed that principals below age 40 and those between 40 to 50 years old provided the significant influence on school productivity, particularly in NECOSSCE performance. This means that these two age groups demonstrated transformational leadership practices that contributed more effectively to student achievement compared to other age groups. The significance of these age groups may stem from the fact

younger principals may bring enthusiasms, openness to innovation, allowing them to implement transformational leadership strategies more effectively. Also principals' age 40 to 50 years old may likely leverage their experience on transformational leadership approaches to inspire and motivate teachers and student contributing to improved school productivity. This implies that age disparity and transformational leadership models utilized do significantly influence the productivity of the school measured with the students' academic performance. The finding is closely similar with the assertion of Eagly and Carli (2023), that even younger principals who actively seek mentorship and continuous professional development could bridge this experience gap, making them more effective leaders over time. This may be the situation of a difference based on age and transformational leadership.

The findings aligned with the position of Leithwood and Sun (2023) who found that younger principals are more inclined towards transformational leadership, which emphasizes motivation, collaboration, and professional development. Younger school leaders tend to inspire teachers and students through visionary leadership, fostering a culture of creativity and engagement. The finding also corroborates the findings of *Onubuleze (2018) on the relationship between principals' demographic factors, and the performance of principals in the task areas of management of secondary education in Nsukka Education Zone which the results revealed that there is a positive relationship between principals' age and performance in management service in secondary school;* Meanwhile, the findings contradicted the position of Hallinger and Wang (2023) who found that older principals benefit from years of working within the education system, allowing them to understand institutional policies, manage conflicts, and build strong relationships with stakeholders. Numa (2018) in his study on the principals' leadership styles and academic achievement of students in external examinations also found no significant difference to leadership style and student achievement in external examinations based on age.

The tested hypothesis results also indicated no significant difference in school productivity based on principals' gender and transformational leadership in public secondary schools in Akwa Ibom State. The fact that principals are female or male and utilized whatever transformational leadership model did not contribute significantly to the school productivity. The findings perhaps could be an indicator that teachers rather play more significant roles in actualizing the blueprint of the school in terms of school productivity irrespective of gender. After all, gender may not be a factor in the constitution of intelligence quotient of an individual in transferring or communicating basic blueprint of the school to students to guarantee their good academic performance.

The finding is supported by the study done by Barter in Ofeimu, *et al.* (2018) on the relation between sex and styles of management, which the author found that male and female principals rated equal in ability and personal qualities. This equally is affirmed by the study of Mukinya (2013) which revealed that gender does not significantly affect principals' performance of appraisal duties in Kenya. In a more recent study, it was indicated that gender did not affect significantly principal's leadership

behaviour (Tu, 2019). Similarly, it was revealed that in public high schools, there was no huge effect of the gender of principals on their implementation of discipline (Arop, 2018). It was also discovered that principals' gender does not statistically influence their strategic decision-making to a significant extent (Campos-García and Zúñiga-Vicente, 2020).

The finding is equally supported by the study of Ofeimu *et al.* (2018) on the influence of principals' sex, experience and age on choice of leadership styles in managing students' indiscipline in public secondary schools in Edo North Senatorial District, Nigeria which revealed that there is no significant difference existed between male and female principals in their choice of leadership styles in managing students' indiscipline. This was similar to the results obtained by Matheri et al. (2015) on the effects of principals' gender on management effectiveness in secondary schools in Mtito-Andei Division, Kenya which found that there was no significant relationship between the principles gender and their effectiveness in personnel management, student management and financial management.

In the aspect of the leadership model, the findings contradicted the Bass and Riggio, (2022) study that revealed that female principals are more inclined toward transformational leadership because it aligns with their tendency to nurture and inspire their subordinates while male principals may focus more on contingent rewards, setting clear expectations and providing incentives for performance. The findings opposed the *Adu* et al. *(2024)* study on the demographic variables (gender, qualification, experience, school type, and locational disparity) as determinants of principal managerial efficiency in Alimosho and Oshodi/Isolo Local Government Areas of Lagos State which revealed that gender were significant and reliable predicators of managerial efficiency.

Conclusion

The study concluded that age of principals' and transformation leadership interactively influence school productivity in public secondary schools in Akwa Ibom State, Nigeria. Howver, principals' gender and transformational leadership interactively had no influence school's productivity in Akwa Ibom State.

Recommendations

The following recommendations were made based on the findings of this study.

1. The government and the State Secondary Educational Board should prioritise leadership training programmes that enhance transformational leadership qualities especially for principals below age 40 and those between 40 and 50 years old as they have shown the most significant influence on school productivity.
2. The government and State Secondary Education Board should ensure gender equality is encouraged in principalship. Policies that prevent gender-based biases in leadership selection and promotion process should be developed and implemented.

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