



***In Vivo* Management Of Fungal Diseases Of Carrot Using Ethanolic Seed Extracts Of *Azadirachta Indica*, *Ricinus Communis* and *Eucalyptus Camaldulensis* In Sokoto, Nigeria**

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ABSTRACT

Carrots are among the most important horticultural crops ranked among the top 10 vegetable crops worldwide. Carrot is attacked by a wide variety of pests and diseases. Its cultivation is generally more restricted by diseases than pest. Fungal diseases pose a significant threat to carrot production, and ecofriendly management strategies are urgently needed. Current management strategies rely heavily on synthetic fungicides, which pose environmental and health risk. Meanwhile, plant extracts have shown promise as eco-friendly and sustainable alternatives for managing fungal diseases. Carrot samples was collected from Moreh, Badageni and Ruggar Liman Fadama areas for fungi isolation and identification. Three medicinal plants (*Azadirachta indica*, *Eucalyptus camaldulensis* and *Ricinus communis*) was extracted and test against the fungal isolates. Ethanol, n-hexane and steeped water was used for the extraction. The disease incidence was assessed by dividing number of infected plant unit by total number of units assessed times hundred. The *in vivo* activity was determined using some agronomic parameters This study investigate the *in vivo* efficacy of seed extracts of *Azadirachta indica*, *Ricinus communis*, and *Eucalyptus camaldulensis* against fungal diseases of carrot in Sokoto, Nigeria.

Keywords: *A. alternate*, carrot, Steeped water, fungal isolates, activity.

1.0 INTRODUCTION

Carrots (*Daucus carota* L.) is herbaceous biennial plants belonging to the Apiaceae family. Carrot is a cool climate crop, with the taproot being the edible part of the plant. There are two types of cultivated carrots, Eastern or Asiatic carrots (*D. carota* ssp. sativus var. atropurpurea Alef.) and Western carrots (*D. carota* ssp. sativus var. sativus). Western carrots include the carrots with orange, red, or white color, while Eastern carrots include carrots of purple and yellow color (Ma *et al.*, 2017, 2018; Que *et al.*, 2019; Wang *et al.*, 2020). Currently, the most popular carrots are those with orange color. Carrots are among the most important horticultural crops ranked among the top 10 vegetable crops worldwide. Carrot annual worldwide production exceeds 40 million tons, with Asia being the leading continent regarding production followed by Europe, there is an increasing trend in worldwide carrot production over the last twenty years. Carrots are generally shallow rooted 4 to 6 inches. It is a biennial plant which grows a rosette of leaves in the spring and summer, while building up the shout taproot which stares large amount

of sugars for the plant to flower in second year. The flowering stem grows to about 1 meter (3 feet) tall, with an umbel of white flowers that produce a fruit called a mericarp by botanist, which is a type of schizocarp (Dalby, 2013).

A wide range of medically active agents have been isolated from different parts of plants as extracts in many countries and these have been used as sources of many potent and powerful drugs (Atanasov *et al.*, 2015) and for developing new pharmacologically active compounds (Vieira *et al.*, 2014). Some drugs that have been developed from plants and are still in use today include the analgesic drug aspirin, from *Filipendular ulmaria*; the antimalarial agent, quinine from *Cinchona* spp; antineoplastic alkaloid, vincristine from *Catharantus roseus* and *digitalis* leaf as remedy for congestive heart failure (Shukya, 2016).

2.0 MATERIALS AND METHODS

2.1 Identification of Plant Diseases

Fungal diseases of carrot was identified on the farms visited based on morphological signs and symptoms observed (Drost, 2010; Halvorsrud, 2022).

2.2 Collection of Carrot Diseased Samples

Samples was collected using purposive sampling method. They were collected from Sokoto metropolis during the 2025 dry season. Three different farms were randomly selected for sampling, namely: Moreh, Badageni and Ruggar Liman Fadama areas. Carrots was collected in sterile polythene bags from 2-3 months old plants. The samples was then be transported to the Mycology Laboratory of Usmanu Danfodiyo University Sokoto, for isolation and identification.

2.3 Preparation of Potato Dextrose Agar (PDA)

Potato dextrose agar (PDA) was prepared according to manufacturer's instructions, 39g PDA was dissolved in 1000 ml of distilled water, the suspension was mix until completely homogenized and 1g of streptomycin was added to inhibit bacterial growth. The conical flask containing the media were plugged with cotton wool and capped with aluminum foil, sterilized using lender autoclave at 121^oC for 15 minutes, cooled for 45^oC and pouring in to sterile plates. The plates were kept at 30^oC (Cheesebrough, 2009; Geethalakshmi, 2021).

2.4 Isolation and Identification of Fungi

2.4.1 Inoculation and isolation of fungi

The infected leaves and roots was cut into small segments (3mm in diameter) with a sterilized blade, surface sterilized with 1% hypochlorite for 2 min, plated on media aseptically and then incubated at 28^oC for 5 days. A pure culture obtained was maintained by sub-culturing each of the different colonies that emerged onto the media plates and incubated at 28^oC for 5 days. As a control, each of the healthy root and leaves were sterilized with 75% ethanol. The sample was cut into small segments (3 mm in diameter) with a sterile blade, placed on the media and then incubated at 28^oC for 5 days (Mailafia *et al.*, 2017).

2.5 Preparation of slides and identification of fungi

This was done for the purpose of identifying the isolated fungi using their morphological and features.

2.6 Preparation of slides

Slides of the mycelium observed from the different isolates were prepared as follows: A portion of growing mycelium from the edge of the culture plate was picked with the help of inoculating needle and placed on a clean glass slide then a drop of sterile water was added followed by a drop of methylene blue, covered with coverslip and observe with the aid of binocular microscope.

2.7 Identification of fungal pathogens

Microscope MC30 in the Mycology Laboratory of Usmanu Danfodiyo University Sokoto was used to examine the colony characteristics to establish identity of the fungi. A sterile needle was used in taking a little portion of the hyphae containing spores on the sterile glass slide, stained with lacto phenol cotton blue and then examined under the microscope for fungal structures. The macroscopic/culture features and the microscopic characteristics observed was then compared with fungal identification atlas for identification of the fungi (Snowdon, 1990). The isolated fungus was identified based on colony and

morphological characteristics, such as color and shape observed with the microscope. The morphological characteristics and appearance of the fungi isolated were confirmed and authenticated (Paul *et al.*, 2024).

2.8 Collection of Plant Samples

Fresh samples of the seeds of *Eucalyptus camaldulensis* was obtained from Technical College Runjin Sambo. The sample was collected in the morning, packed separately in clean sterilized polythene bags and brought to the Herbarium of the Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto, Nigeria, for identification and authentication of the plant sample. Voucher number was prepared and deposited in the same herbarium (Kumar *et al.*, 2005). Voucher number is UDUH/ANS/0750.

2.9 Plant processing

The collected plant samples were processed into fine powder and stored in a polythene bag for further analyses. The processing involved separating the plant into parts before washing with clean tap water. The washed plant part was then cut into small pieces and shade dried at a temperature of $32^{\circ}\text{C}\pm 2$ for 3 days. The dried sample was then crushed using mortar and pestle, sieved through $0.28\ \mu$ mesh sieve before storing the fine powder in a polythene bag.

2.10 Extraction of plant Material

Portion (100g) of each plant was weighed and soaked in 1liter of ethanol and n-hexane in conical flasks and left for 24 hrs. The content of conical flask was filtered with whatman no. 1 filter paper and the filtrate was evaporated to dryness using hot oven at a temperature of 45°C for 24hrs. The extracts was collected and used for antifungal assay.

2.11 Preparation of plant extracts concentration

Stock solution was prepared by dissolving 0.1g, 0.4g, 0.7g and 1g of the solid plant extracts in 5mls of a sterilized distilled water, making a stock of 20 mg/ml, 80 mg/ml, 140 mg/ml and 200 mg/ml. The concentrations were used to test for the antifungal effect of the seeds extracts of *E. camaldulensis*. The stock of the extract was drawn using micropipette and each suspended in to a 6 mm hole.

2.12 Infected Soil Amended with Plant Extracts

In this phase the fungi with higher percentage of occurrence was used to test the effect of the selected plant extracts on the suppression of the pathogen.

2.13 Source of seeds and raising of seedlings

The seeds was sourced from Sokoto State Agricultural and Rural Development Authority (SARDA). Four hundred and twenty (420) polythene bags of (20 X 30 cm) were filled with 3.5 kg of autoclaved soil, which was arranged on a bench in green house conditions at $32^{\circ}\text{C}\pm 4^{\circ}\text{C}$. Three seeds per polythene bags were sown in the autoclaved soil and watered once daily.

2.14 Inoculation procedure and *in vivo* test of the plant extracts

The sporangia of *Fusarium oxysporum* was obtained from their seven days old culture plate. 10^{-1} dilution was used as the inoculum, therefore 50 ml of the pathogen was suspended into 450 ml of sterile distilled water. 10 ml of the sporangia suspension was employed as inoculum per polythene bag containing the three seedlings of the carrot plant. Similarly control plants was sprayed with SDW for comparison. After application of spore suspensions, the leaves of the inoculated seedlings was covered by plastic bag and kept for six days to create conducive condition with high relative humidity near to 95% and to ensure successful penetration and establishment of the test pathogen on the leaf and tissues of seedlings (Sreenivasaprasad and Talhinas, 2005). The plastic bags was removed after six days and plants were kept under greenhouse conditions and periodical observations were made regularly for the first appearance and development of symptom on the leaves. All treatments were replicated three times. The mean, minimum and maximum temperature in the greenhouse during the study period was 12°C and 30°C , respectively. After 21 days of inoculation plants was assessed and recorded for the percentage of disease incidence (Getachew *et al.*, 2014).

2.15 Assessment of disease incidence and disease severity

Disease incidence is the number of plant units infected; it was expressed as a percentage of the total number of units assessed,

$$\text{Disease Incidence (\%)} = \frac{\text{Number of infected plant units} \times 100}{\text{Total number of units assessed}}$$

2.16 Application of plant extracts

The plants in each replicate of 3 polythene bags were amended with 20 mg/ml, 80 mg/ml, 140 mg/ml and 200 mg/ml of each of the extracts and watered with 250ml daily. Another set up was made as inoculated but not amended which served as negative control, and another set up not inoculated, not amended which also served as positive control.

2.17 Plant height (cm)

The plants height was measured using meter rule. This was done by measuring from the base to the tip of each plant and the measurements was done at 10, 20, 30 and 40 days after the application of the extracts

2.18 Number of branches

The total number of branches in each polythene bag was counted and recorded at 10, 20, 30 and 40 days after the inoculation of the extracts.

2.19 Fresh weight of the carrot (g)

The fresh weight of each of the sample was weight using weighing balance (Mettler, 166AA).

2.20 Data Analysis

A computer statistical programmed SPSS was used to analyses the data. One way and three way analysis of variance (ANOVA) was used to test for significance, treatments effect. Means were compared using the Least Significance Difference (LSD). LSD was used to analyze the order of significant of interactions effects of the treatments.

3.0 RESULTS

3.1: *In Vivo* Activity of the Ethanol Extracts of *Azadirachta indica*, *Ricinus communis* and *Eucalyptus camaldulensis* on Height of the Carrot Plant

Table 1 is the results of comparative analyses of heights of FOA, FOR and FOE treated with ethanol extracts for different concentrations of 200mg, 140mg, 80mg and 20mg for 10 days, 20 days, 30 days and 40 days as well as the significant effects of different interactions between the factors (plant-types, concentrations and days). The result $F=625.617$ with $p\text{-value}= 0.000 < 0.05$ implies that there is significant difference between the height of treatments control positive, control negative, FOAE, FORE and FOEE at 5% level of significance. The result $F=28.324$ with $p\text{-value}= 0.000 < 0.05$ implies that there is significant difference between the height of treatments (control positive, control negative, FOAE, FORE and FOEE) for different levels of concentrations (200mg, 140mg, 80mg and 20mg) at 5% level of significance. That, is the larger the concentration, the higher the height of the treatments. Similarly, the result $F=116.699$ with $p\text{-value}= 0.000 < 0.05$ implies that there is significant difference between the height of treatments (control positive, control negative, FOAE, FORE and FOEE) for 10 days, 20 days 30 days and 40 days at 5% level of significance. That is, the height of the plants increases as the days increases. The results $F=0.789$, $p\text{-value}=0.627 > 0.05$ and $F=0.265$, $p\text{-value}=1.00 > 0.05$ for interaction effects "Concentrations*Days" and "Plants*Concentrations*Days" show that the interaction effects of "Concentrations*Days" and "Plants*Concentrations*Days" are not statistically significant at 5%. However, the results of interaction effects "Plants*Concentrations" and "Plants*Days" with values $F=5.93$, $p\text{-value}=0.000 < 0.05$ and $F=38.627$, $p\text{-value}=0.000 < 0.005$ respectively revealed that the interaction effects of "Plants*Concentrations" and "Plants*Days" on the heights of the treatments (control positive, control negative, FOAE, FORE and FOEE) are statistically significant at 5% level of significance.

On the interaction effects "Plants*Concentrations", control positive had the highest average height (22.92 ± 4.62)mg, followed by FOAE (200mg) with average height (19.17 ± 3.24)mg as second, followed by FOAE (1400mg), FORE (200mg), FORE (140mg), FORE (80mg) and FOEE (200mg) as third with average heights of (17.08 ± 4.08)cm, (18.67 ± 3.08)cm, (17.17 ± 4.39)cm, (17.00 ± 3.05)cm and (17.25 ± 3.08)cm respectively. Interaction effects FOAE (80mg), FORE (20mg), FOEE (140mg) and FOEE (80mg) emerged fourth position with average heights (15.25 ± 2.56)cm, (15.08 ± 2.07)cm, (14.75 ± 3.04)cm and (14.00 ± 2.39)cm respectively while interaction effects FOAE (20mg) and FOEE (20mg) emerged fifth position with average heights (13.08 ± 2.71)cm and (13.33 ± 2.77)cm respectively. Control negative has the least with average height of (6.33 ± 3.12) cm.

On the interaction effects “Plants*Days”, control positive had the highest average height (22.92±4.62)cm, followed by FOAE (40 days) and FORE (40 days) with average height (19.58±3.32)cm and (19.67±2.96)cm respectively as second, followed by FOEE (40 days) as third with average height of (18.33±1.78)cm. Interaction effects FOAE (30 days), FORE (30 days), FORE (20 days) and FOEE (30 days) emerged as fourth with average heights of (17.58±2.84)cm, (17.58±2.97)cm, (17.42±2.39)cm and (16.33±1.78)cm respectively while FOAE (20 days) emerged as fifth position with average height of (15.08±2.57)cm. Interaction effects FORE (10 days) and FOEE (20 days) emerged sixth position with average heights (13.25±1.54)cm and (13.67±1.23)cm while FOAE (10 days) and FOEE (10 days) with average heights (12.33±2.27)cm and (11.00±1.81)cm respectively emerged seventh position. Control negative has the least with average height of (6.33±3.12) cm.

Table 1 also revealed that the results of R-Squared= 0.956 (95.6%) and Adjusted R-Square=0.935 (93.5%) for the ANOVA model (see eqn (1)) used for the analysis and the results show over 90% goodness of fit. This results imply that over 90 % of changes in the heights of the treatments (control positive, control negative, FOAE, FORE and FOEE) are due to the factors (plant-types, concentrations and days) considered in the study

$$height (ethanolic) = \mu + \alpha + \beta + \gamma + \alpha\beta + \alpha\gamma + \beta\gamma + \alpha\beta\gamma + e \quad (1)$$

Where

μ = grand mean,

α = plants effects,

β = concentartions (ethanolic) effects,

γ = days effects,

$\alpha\beta$ = interaction effects of plants and contrations,

$\alpha\gamma$ = interaction effects of plants and days,

$\beta\gamma$ = interaction effects of concentartions and days,

$\alpha\beta\gamma$ = Interaction effects of Plants,Concentrations and days,

e = random effects

Table 1: In Vivo Activity of the Ethanol Extracts of *Azadirachta indica*, *Ricinus communis* and *Eucalyptus camaldulensis* on Height of the Carrot Plant

	Height (cm)		
	Plants(Concentrations)	Plants(Days)	
Control Positive	22.92±4.62 ^a	Control Positive	22.92±4.62 ^a
FOAE (200mg)	19.17±3.24 ^b	FOAE (40 days)	19.58±3.32 ^b
FOAE (140mg)	17.08±4.08 ^c	FOAE (30 days)	17.58±2.84 ^d
FOAE (80mg)	15.25±2.56 ^d	FOAE (20 days)	15.08±2.57 ^e
FOAE (20mg)	13.08±2.71 ^e	FOAE (10 days)	12.33±2.27 ^g
FORE (200mg)	18.67±3.08 ^c	FORE (40 days)	19.67±2.96 ^b
FORE (140mg)	17.17±4.39 ^c	FORE (30 days)	17.58±2.97 ^d
FORE (80mg)	17.00±3.05 ^c	FORE (20 days)	17.42±2.39 ^d
FORE (20mg)	15.08±2.07 ^d	FORE (10 days)	13.25±1.54 ^f
FOEE (200mg)	17.25±3.08 ^c	FOEE (40 days)	18.33±1.78 ^c
FOEE (140mg)	14.75±3.04 ^d	FOEE (30 days)	16.33±1.78 ^d
FOEE (80mg)	14.00±2.89 ^d	FOEE (20 days)	13.67±1.23 ^f
FOEE (20mg)	13.33±2.77 ^e	FOEE (10 days)	11.00±1.81 ^g
Control Negative	6.33±3.12 ^f	Control Negative	6.33±3.12 ^h
FACTORS	Standard Error	F-Value	P-Value
Plants	10.3201	625.617	0.000*
Concentrations	2.9285	28.324	0.000*
Days	5.9441	116.699	0.000*
Plants*Concentration	0.335	5.93	0.000*
Plants*Days	0.855	38.627	0.000*
Concentration*Days	0.163	0.789	0.627
Plants*Concentration*Days	0.237	0.265	1.00

R-Square=0.956

Adjusted R-Square =0.935

Means followed by the same letter along the columns are not significantly different

* = significant at 5%, Values=Mean \pm SD, SD= Standard deviation, S.E= Standard ErrorFOAE= *Fusarium oxysporum* with ethanolic extracts of *A. indica*, FORE= *Fusarium oxysporum* with ethanolic extracts of *R. communis*, FOEE= *Fusarium oxysporum* with ethanolic extracts of *E. camaldulensis*

3.2: In Vivo Activity of the Ethanol Extracts of *Azadirachta indica*, *Ricinus communis* and *Eucalyptus camaldulensis* on Number of Branches of the Carrot Plant

Table 2 showed the results of comparative analyses of number of branches of FOAE, FORE and FOEE treated with ethanol extracts for different concentrations of 200mg, 140mg, 80mg and 20mg for 10 days, 20 days, 30 days and 40 days as well as the significant effects of different interactions between the factors (plant-types, concentrations and days). The result $F=306.884$ with $p\text{-value}= 0.000 < 0.05$ implies that there is significant difference between the number of branches of treatments (control positive, control negative, FOAE, FORE and FOEE) at 5% level of significance. The result $F=9.869$ with $p\text{-value}= 0.000 < 0.05$ implies that there is significant difference between the number of branches of treatments (control positive, control negative, FOAE, FORE and FOEE) for different levels of concentrations (200mg, 140mg, 80mg and 20mg) at 5% level of significance. That, is the larger the concentration, the higher the number of branches of the treatments. Similarly, the result $F=46.825$ with $p\text{-value}= 0.000 < 0.05$ implies that there is significant difference between the number of branches of treatments (control positive, control negative, FOAE, FORE and FOEE) for 10 days, 20 days 30 days and 40 days at 5% level of significance. That is, the number of branches of the plants increases as the days increases. The results $F=0.675$, $p\text{-value}=0.731 > 0.05$ and $F=0.408$, $p\text{-value}=0.999 > 0.05$ for interaction effects "Concentrations*Days" and "Plants*Concentrations*Days" respectively show that the interaction effects of "Concentrations*Days" and "Plants*Concentrations*Days" are not statistically significant at 5%. However, the results of interaction effects "Plants*Concentrations" and "Plants*Days" with values $F=2.352$, $p\text{-value}=0.008 < 0.05$ and $F=21.429$, $p\text{-value}=0.000 < 0.005$ respectively revealed that the interaction effects of "Plants*Concentrations" and "Plants*Days" on the number of branches of the treatments (control positive, control negative, FOAE, FORE and FOEE) are statistically significant at 5% level of significance.

On the interaction effects "Plants*Concentrations", control positive had the highest average number of branches as (6.42 ± 0.77) , followed by FOAE (200mg) and FOAE (140mg), with average number of branches (5.50 ± 1.00) and (5.83 ± 1.80) respectively as second, followed by FOAE (80mg), FORE (200mg) and FORE (140mg) as third with average number of branches of (5.00 ± 1.13) , (5.17 ± 0.94) and (5.25 ± 1.14) respectively. Interaction effects FOAE (20mg), FORE (20mg), FOEE (200mg), FOEE (140mg) and FOEE (80mg) emerged fourth position with average number of branches (4.42 ± 0.99) , (4.25 ± 1.06) , (4.67 ± 0.98) , (4.50 ± 1.09) and (4.17 ± 0.94) respectively while interaction effects FOEE (20mg) emerged fifth position with average number of branches (4.08 ± 0.99) . Control negative has the least with average number of branches of (2.00 ± 1.01) .

On the interaction effects "Plants*Days", control positive and FOAE (40 days) had the highest average number of branches as (6.42 ± 0.77) and (5.50 ± 1.00) respectively, followed by FORE (40 days) with average number of branches and (6.08 ± 0.67) as second, followed by FOAE (30 days) and FOEE (40 days) as third with average number of branches of (5.50 ± 1.00) and (5.16 ± 0.49) respectively. Interaction effects FOAE (20 days), FORE (30 days), FORE (20 days) and FOEE (30 days) emerged fourth position with average number of branches (4.75 ± 0.75) , (5.00 ± 0.74) , (4.75 ± 0.87) and (4.58 ± 0.51) respectively while interaction effects FOAE (10 days), FORE (10 days), FOEE (20 days) and FOEE (10 days) emerged fifth position with average number of branches (3.92 ± 0.67) , (3.75 ± 0.45) , (3.67 ± 0.49) and (3.50 ± 0.52) respectively. Control negative has the least with average number of branches of (2.00 ± 1.01) .

Table 2 also revealed that the results of R-Squared= 0.898 (89.8%) and Adjusted R-Square=0.849 (84.9%) for the ANOVA model (see eqn (2)) used for the analysis and the results show over 80% goodness of fit. This results imply that over 80 % of changes in the number of branches produced by the

treatments (control positive, control negative, FOAE, FORE and FOEE) are due to the factors (plant-types, concentrations and days) considered in the study

$$\text{Number of branches (ethanolic)} = \mu + \alpha + \beta + \gamma + \alpha\beta + \alpha\gamma + \beta\gamma + \alpha\beta\gamma + e \quad (2)$$

where

μ = grand mean,

α = plants effects,

β = concentrations (ethanolic) effects,

γ = days effects,

$\alpha\beta$ = interaction effects of plants and concentrations,

$\alpha\gamma$ = interaction effects of plants and days,

$\beta\gamma$ = interaction effects of concentrations and days,

$\alpha\beta\gamma$ = Interaction effects of Plants, Concentrations and days,

e = random effects

Table 2: In Vivo Activity of the Ethanol Extracts of *Azadirachta indica*, *Ricinus communis* and *Eucalyptus camaldulensis* on the Number of Branches of Carrots Plant

Number of Branches			
Plants(Concentrations)		Plants(Days)	
Control Positive	6.42±0.77 ^a	Control Positive	6.42±0.77 ^a
FOAE (200mg)	5.50±1.00 ^b	FOAE (40 days)	6.58±1.24 ^a
FOAE (140mg)	5.83±1.8 ^c	FOAE (30 days)	5.50±1.00 ^c
FOAE (80mg)	5.00±1.30 ^d	FOAE (20 days)	4.75±0.75 ^d
FOAE (20mg)	4.42±0.99 ^e	FOAE (10 days)	3.92±0.67 ^e
FORE (200mg)	5.17±0.94 ^c	FORE (40 days)	6.08±0.67 ^b
FORE (140mg)	5.25±1.14 ^c	FORE (30 days)	5.00±0.74 ^d
FORE (80mg)	1.92±0.99 ^c	FORE (20 days)	4.75±0.87 ^d
FORE (20mg)	4.25±1.06 ^d	FORE (10 days)	3.75±0.45 ^e
FOEE (200mg)	4.67±0.98 ^c	FOEE (40 days)	5.16±0.49 ^c
FOEE (140mg)	4.5±1.09 ^d	FOEE (30 days)	4.58±0.51 ^d
FOEE (80mg)	4.17±0.94 ^d	FOEE (20 days)	3.67±0.49 ^e
FOEE (20mg)	4.08±0.99 ^e	FOEE (10 days)	3.50±0.52 ^e
Control Negative	2.0±1.01 ^f	Control Negative	2.0±1.01 ^f
FACTORS	Std Error	F-Value	P-Value
Plants	2.8128	306.884	0.000*
Concentrations	0.6725	9.869	0.000*
Days	1.4647	46.825	0.000*
Plants*Concentration	0.0820	2.352	0.008*
Plants*Days	0.2477	21.429	0.000*
Concentration*Days	0.05858	0.675	0.731
Plants*Concentration*Days	0.01138	0.408	0.999
R-Square		Adjusted R-Square	

Means followed by the same letter along the columns are not significantly different

* = significant at 5%, Values=Mean ± SD, SD= Standard deviation, S.E= Standard Error

FOAE= *Fusarium oxysporum* with ethanolic extracts of *A. indica*, FORE= *Fusarium oxysporum* with ethanolic extracts of *R. comunis*, FOEE= *Fusarium oxysporum* with ethanolic extracts of *E. camaldulensis*

4.0 DISCUSSION

The in vivo activity of the plant extracts shows higher activity in the *Azadirachta indica* of n hexane extracts in the plants height at higher concentration (200 mg/ml). The higher the concentration the higher the height. This has been supported by Odeja *et al.* (2015), who showed ethanol and n hexane to be very effective for extraction of phytochemicals and that n hexane extract show high antimicrobial activity against some fungal organisms. Similarly, the height of the plants increase with the increased in number of days. Positive control had higher activity in all the tested extracts and the negative control recorded the least. The interaction between plant and concentrations, plant and days have significant difference in all the tested extracts at 5% level of significance. There is no significance difference at the interaction between concentrations and days and also between plants, concentrations and days at 5% level of significance in all the tested extracts. The n hexane extracts of *Eucalyptus camaldulensis* in the plant heights recorded the least activity apart from the negative control at the lower concentration of 20 mg/ml. The activity in the number of branches revealed that steeped water extracts of *A. indica* had higher activity with the increase in the number of branches in higher concentration of (200 mg/ml) at forty days after the application of the extracts. The least activity was also recorded in the same extracts in *E. camaldulensis* at 20 mg/ml.

The in vivo activity of the extracts on the fresh weight shows that, the ethanol extracts recorded higher activity in *A. indica* at higher concentration and the steeped water extracts recorded the least activity in *E. camaldulensis* at lower concentration. Control positive had significantly higher activity in all the tested extracts and negative control recorded the least. There is also significant deference in plants, concentrations and also the interaction between the plants and the concentration at 5% level of significance.

4.1 CONCLUSION

The results of the in vivo activity also recorded that, the ethanol, n hexane and steeped water extracts of *A. indica* at 200 mg/ml were effective in the management of fungal diseases of carrot. The interaction between plant and concentrations, plant and days have been found to have a significant difference in all the tested extracts at 5% level of significance. There is no significance difference at the interaction between concentrations and days and also between plants, concentrations and days at 5% level of significant in all the tested extracts.

REFERENCES

- Atanasov, A. G., Waltenberger, B., Pferschy-Wenzig, E. M., Linder, T., Wawrosch, C., Uhrin, P, and Stuppner, H. (2015). Discovery and resupply of pharmacologically active plant-derived natural products: A review. *Biotechnology advances*, **33**(8), 1582-1614.
- Baiyewu, R. A., Amusa, N. A., Ayoola, O. A. and Babalola O.O. (2007). Survey of the postharvest diseases and aflatoxin contamination of marketed pawpaw fruit (*Carica papaya* L.) in south western Nigeria. *African Journal of Agricultural Research*, **2**(4): 178-18
- Chessbrough, M. (2009). *Districts Laboratory Practice in Tropical Countries*. 2nd Edition, Cambridge University Press, Pp33-34.
- Dalby, S. M, (2013). Total Synthesis of (-) Rhizopodin. *Angewandte Chemie International Edition*, **52**(25), 6517-6521.
- Drost, D. (2010). Peppers in the garden. Utah State University Cooperative Extension. Compendium of Pepper Diseases. *American Phytopathological Society Press*. Available at: <http://www.apsnet.org/apsstore/shopapspress/Pages/43003>.
- Geethalakshmi, V., Jasmine, K. A., JOHN, A. P., and PRATHAP, P. (2021). Effectiveness of Sabouraud's Dextrose Agar and Dermatophyte Test Medium in Detection of Candidiasis and Dermatophytosis in Superficial Skin Lesion. *Journal of Clinical and Diagnostic Research*, **15**(8).
- Getachew, N., Chebude, Y., Diaz, I., and Sanchez-Sanchez, M. (2014). Room temperature synthesis of metal organic framework MOF-2. *Journal of Porous Materials*, **21**: 769-773.

- Halvorsrud, M. (2022). *Prevalence of tip rot and carrot supply chain actors' awareness about the disease in Norway* (Master's thesis, Norwegian University of Life Sciences, Ås).
- Kumar, M. (2017). A review on phytochemical constituents and pharmacological activities of *Ricinus communis* L. *Plant. International Journal of Pharmacognosy and Phytochemical Research*, **9**(4): 466-472.
- Ma, J., Li, J., Xu, Z., Wang, F., and Xiong, A. (2018). Transcriptome profiling of genes involving in carotenoid biosynthesis and accumulation between leaf and root of carrot (*Daucus carota* L.). *Acta Biochimica et Biophysica Sinica*, **50**(5), 481–490..
- Ma, J., Xu, Z., Tan, G., Wang, F., and Xiong, A. (2017). Distinct transcription profile of genes involved in carotenoid biosynthesis among six different color carrot (*Daucus carota* L.) cultivars. *Acta Biochimica et Biophysica Sinica*, **49**(9): 817–826.
- Mailafia, S., Okoh, G. R., Olabode, H.O.K., and Osanupin, R. (2017). Isolation and identification of fungi associated with spoiled fruits vended in Gwagwalada market, Abuja, Nigeria, *Veterinary World*, **10**(4): 393-397.
- Que, F., Hou, X. L., Wang, G. L., Xu, Z. S., Tan, G. F., Li, T., Xiong, A. S.. (2019). Advances in research on the carrot, an important root vegetable in the Apiaceae family. *Horticulture Research*, **6**(1): 69.
- Shakya, A. K. (2016). Medicinal plants: Future source of new drugs. *International journal of herbal medicine*, **4**(4), 59-64.
- Snowdon, A. L. (1990). A colour atlas of post-harvest diseases and disorders of fruits and vegetables. *General introduction and fruits*. Wolfe Scientific Ltd, London, UK. English language, **1**: pp. 302.
- Sreenivasaprasad, S., Jacob, I., and Talhinhos, P. (2005). Genotypic and phenotypic diversity in *Colletotrichum acutatum*, a cosmopolitan pathogen causing anthracnose on a wide range of hosts. *Molecular plant pathology*, **6**(4), 361-378.
- Vieira, D. R., Amaral, F. M., Maciel, M. C. Nascimento, F. R., Libério, S.A. and Rodrigues, V.P. (2014). Plant species used in dental diseases: ethnopharmacology aspects and antimicrobial activity evaluation. *Journal of Ethnopharmacology*, **155**(3): 1441-1449.
- Wang, Y. H., Li, T., Zhang, R. R., Khadr, A., Tian, Y. S, and Xu, Z. S. (2020). Transcript profiling of genes involved in carotenoid biosynthesis among three carrot cultivars with various taproot colors. *Protoplasma*, **257**(3), 949–963.