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Antifungal Activity of *Jatropha Curcas* Linn on *Candida Albicans* and *Candida Tropicalis* Associated with Neonatal and Infantile Infections in Yola, Nigeria

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Abstract: One hundred and eighty (180) stool samples collected of neonates and infants from three selected health facilities in Yola, Adamawa State Nigeria. The samples were subjected to both microscopic, biochemical test and cultural identification. Bromocresol green agar and Germ tube test was used to identify *Candida* species. Culture of the stool samples on SDA yielded 32 yeast cells with *Candida albicans* as the predominant (90.63%) organism isolated followed by *Candida tropicalis* (9.37%). Extraction and screening for phytoconstituents of *Jatropha curcas* Linn parts (stem bark, leave and sap) by hot maceration using water and methanol. Showed the presence of saponins, tannins, phenols, alkanoids, steroids, flavonoids, terpenoids and glycosides. Antifungal susceptibility testing on Mueller Hinton agar, showed yeast to be susceptible to the Methanol plant extract at 400-1000 µg/mL with highest diameters of zones of inhibition (20.00 mm for sap, 13.00 mm for stem bark and 11.00 mm for leave) than the aqueous plant extract. All the parts of *Jatropha curcas* Linn showed MIC range of 400-1200 µg/mL for both *Candida albicans* and *Candida tropicalis*. GC-MS study showed the presence of 11 most abundant components out of 52 compounds of the methanol leaves extract 46 compounds of methanol stem bark extracts respectively all of which demonstrated antimicrobial activity. Result also showed 12 most abundant components out of 56 compounds in sap of *Jatropha curcas* Linn with antimicrobial activity. Further study on the toxicity and pharmacological activity should be carried out, with a view to sourcing novel antibiotic substances for possible development of broad spectrum drugs against both bacteria and fungi.

Keywords: Antimicrobial Activity, *Candida* spp., *Jatropha curcas*, Phytochemical, Plant Extracts

Introduction

Paediatricians rendering primary health care are often faced with increase rate of fungal infection among infants and neonates. Infection due to previously uncommon hyaline and dematiaceous filamentous fungi are on increasing frequency, despite marked advances in antifungal therapy (Pappas, 2006). These opportunistic fungal infections (rare and emerging) continue to be associated with high mortality, high morbidity and poor patient outcomes in infants and neonates. There is also increased resistance to antifungal drugs commonly used for treatment of fungal infections (Romani, 2008). In addition, the rising incidences of antifungal drug resistance and the expensive nature of many antifungal drugs has resulted in many populations in the developing countries resorting to the more cheaper and readily available medicinal plants as alternatives for the treatment and control of diseases in the developing countries. Medicinal plants are the richest bio-resources of drugs for traditional medicinal systems, modern medicines, nutraceuticals, food supplements, folk medicines, pharmaceuticals and intermediate chemicals entitled for synthetic drugs, phytochemical analysis, free radical scavenging capacity and antimicrobial properties (Das *et al*., 2010; Anwer *et al*., 2013). The acceptance of traditional medicine in Nigeria as an alternative form of health care and the development of microbial resistance to available antimicrobials has led scientists to investigate the

antimicrobial activity of medicinal plants (Rahmoun *et al*., 2013). In many traditions in Nigeria, different medicinal plant parts are either used singly or in combination with other parts of the same plant or of different plants in the treatment of various diseases. The treatment and control of diseases by the use of available medicinal plants will continue to play significant roles in medical health care implementation in the developing countries (Ekundayo *et al*., 2011).

Few studies have been reported on fungal infections of infants and neonates in this part of the world. This study will provide data on the prevalence of some pathogenic yeast in the study area, the characterization of the pathogenic yeasts isolated as well as their susceptibility profiles to commonly used synthetic antifungal agents prescribed. The traditional use of the local herb *Jatropha curcas* Linn for the treatment of infants and neonates against some pathogenic yeast will also be authenticated. We therefore report the antifungal activity of *Jatropha curcas* Linn extracts on some pathogenic yeast associated with infantile and neonate infections in Yola, Nigeria.

Materials and Methods

Collection of Samples

Collection of Stool Samples

The health facilities selected for this study were State Specialist Hospital, Yola, Government General Hospital, Numan and the Local Government Clinic, Sangere, Girei Local Government, all in Adamawa State Nigeria. Stool samples were collected from infants and neonates attending these three selected health facilities. Thirty (30) stool samples were collected from Local Government Clinic, Sangere, Eighty (80) from State Specialist Hospital, Yola and Seventy (70) from Government General Hospital, Numan in sterile screw-caped wide-naked specimen bottles. The bottles were properly labelled for each sample and then transported to the Microbiology Laboratory, Department of Microbiology, Modibbo Adama University of Technology, Yola within 2-3 h of collection in a cooler packed with ice blocks for processing (Bhavan *et al*., 2010).

Collection of Plant Samples

The plant, *Jatropha curcas* Linn was collected from a garden in Dakanta, Numan Local Government, Adamawa State Nigeria and identified in the Plant Science Department of Modibbo Adama University of Technology, Yola.

Isolation and Identification of Yeasts

One gramme (1 g) of stool was diluted in 9 mL of sterile Phosphate-Buffered Saline (PBS) and a six-fold serial dilution from 10^{-1} to 10^{-6} was prepared in PBS. Each dilution was spread in duplicate on Sabouraud Dextrose Agar (SDA) (Sigma-Aldrich, Saint-Quentin Fallavier, France) supplemented with chloramphenicol (50 µg/mL). The SDA cultures were incubated aerobically at 37°C for 48 h and then examined for growth (Bhavan *et al*., 2010). The presumptive yeasts colonies were sub cultured on SDA slants for subsequent identification.

The yeast strains were firstly submitted to typical, micromorphological observation, culturally and biochemically. Identification of yeast cells was done the micromorphological characteristics such as cream coloured pasty colonial appearance on Sabouraud Dextrose Agar and blunt conical colonies with smooth edges and yellow to blue green colour or rough colonies, with either convex or cone shaped colonies on bromocresol green agar as presumptive for *Candida* species. Microscopical examination for Gram positive appearance (primary colour) after Gram staining was also used to further identify the isolates (Cheesbrough, 2005; Bhavan *et al*., 2010).

Biochemical Identification of Yeast Cells

Sugar fermentation tests as described by (Mpofu *et al*., 2008) and sugar assimilation test as described by (Tiwari *et al*., 2007) were used for the biochemical characterization of the presumptive yeast isolates.

For the sugar fermentation test, sugars such as raffinose, glucose, sucrose, trehalose, lactose, maltose and galactose, together with peptone from casein 1% in distilled water, distributed in separate standard assay tubes containing a Durham tube were employed as substrates in the sugar fermentation tests. A 1.5 mL aliquot of each sugar solution containing 6% sugar and sterilized by filtration was placed in each tube to produce a data set from seven different carbon sources for each sample. The samples were inoculated using a 200 µL aliquot in each tube, incubated at 37°C and readings taken after 48 h.

For the sugar assimilation test, Yeast Carbon Base (YCB-Difco Laboratories) was used and test performed in 20 mL aliquots per tube as described by the manufacturer (Difco Laboratories). Each yeast sample was previously streaked on 4% Sabouraud dextrose agar to evaluate cell viability. From each sample, 1 mL aliquot in saline solution (equivalent to 1 McFarland standard) were dispensed into empty Petri dishes and immediately covered with liquefied YCB then cooled to 50°C. After adding the medium, homogenizing and allowing to solidify, the carbon sources were applied at different sites on the medium and then incubated at 37°C for 3-7 days. Positive results for both samples were revealed by yeast growth at the sites of application.

Chlamydospore Formation Test

Identification of the yeasts was carried out morphologically using chlamydoconidia and blastoconidia formation tests as described by (Jha *et al*., 2006; Bhavan *et al*., 2010). Briefly, one loopful of fungi was mixed with a 0.2 mL phosphate buffered solution to

create a dense fungal solution equivalent to approximately 10^6 cells/mL. Then, this was mixed with 1 mL broth to create a fungal suspension for incubation. Fifty microliter (50 µL) of the fungal solution was placed on a sterile glass slide and the glass slide placed in a wet Petri dish without a cover glass. The Petri dish was further sealed with a vinyl bag and the fungi were incubated at 37°C. After incubation, cultured specimens were collected and fungal morphology observed in an optical microscope for chlamydoconidia and blastoconidia formation.

Germ Tube Test

The germ tube test as described by (Matare *et al*., 2017) was used to further confirm the identity of yeasts in the samples. Briefly, to triplicate sets of test tubes containing 0.5-1.0 mL of pooled human serum were inoculated 2-3 colonies of each isolate and the tubes inoculated at 37°C for 3 h. After incubation, a drop of each suspension was placed on labeled microscope slides for examination of germ tubes. Confirmed yeast cells were subcultured onto plates of Sabouraud's Dextrose Agar and then preserved in a refrigerator at 4°C until use.

Plant Sample Preparation and Extraction of Active Phytoconstituents

Plant sample collected was washed thoroughly with tap water and then twice with distilled water, separated manually (the leaves and the stem bark), then allowed to dry for 5 days to constant weight at ambient temperature. The dried plant materials (leaf and stem bark) were crushed separately to powder with pestle and mortar. Twenty grammes (20 g) each of the stem bark powder and leaf was macerated in 250 mL of solvent (90% Methanol) and 250 mL of distilled water, placed in a conical flask and refluxed at 45°C for 60 min separately (Chen *et al*., 2007) and filtered using Whitman's filter paper (pore size 11 µm). The filtrate obtained was concentrated to dryness in water bath at 40°C and the crude extract was weighted and kept dry in desiccators.

Phytochemical Screening of the Aqueous Extracts of Jatropha curcas Linn

Qualitative and quantitative phytochemical screening of the aqueous extracts of *Jatropha curcas* Linn for the presence of secondary metabolites (tannins, saponins, flavonoids, terpenoids, steroids, phenols, alkaloids and glycosides) was carried out (Sofowora, 1996).

Antifungal Susceptibility Assay of Plant Extracts

Preparation of the Inoculum and Performance of Test

Sabouraud's Dextrose Agar was used to grow the yeast isolates and subcultured twice to ensure purity and viability. The yeast isolate was then suspended in 5 mL of sterile 0.85 NaCl. The turbidity of the suspension was measured spectrophotometrically at 530 nm and adjusted with sterile saline to 0.5 McFarland Standard (equivalent to 10^6 cells/mL).

Antifungal Susceptibility Test

Mueller Hinton agar was prepared according to Manufacturer's specification. The prepared medium was sterilized at 14°C for 15 min, dispensed in Petri dishes and allowed to solidity. Wells were then bored onto the solidified Mueller Hinton agar media using a sterile 6 mm depth cork borer (Obidi *et al*., 2013). Using sterile pipette, 0.1 mL of the culture suspension was inoculated on into the wells on the Mueller Hinton agar plates and a bent glass rod used to spread the yeast inoculums evenly on the surface of the media and the plate then allowed to dry. The wells were filled with the solution of the extract of approximately 100 µg/mL of various concentrations (200, 400, 600, 800 and 1000 µg/mL), taking care not to allow spillage of the solution to the surface of the agar medium. The plates were allowed to stand on the laboratory bench for 1 h to allow proper diffusion of the extract into the media. The culture plates were incubated at 37°C for 24 h and later observed for diameters of zones of inhibition. Nystatin suspension was used as a positive control (Esimone *et al*., 1998).

Determination of Minimum Inhibitory Concentration (MIC) and Minimum Fungicidal Concentration (MFC)

The MICs were determined according to the method of (Borman *et al*., 2017). To a series of broth cultures of *Candida* isolates (0.5 McFarland Standard) prepared in six different test tubes each containing 10 mL of Potato Dextrose Broth, 1.0 mL of various plant extract concentrations (200, 400, 600, 800, 1000 and 1200 µg/mL) was added respectively. A set of test tubes one containing broth *Candida* and broth alone (negative control) and the other containing culture broth and 30 µg/mL (positive control) were used as controls. All the broth cultures were incubated for 37°C for 24 h and then examined for growth. The lowest concentration without visible growth was taken as the MICs for the isolates. The lowest concentration without visible growth for the isolates from MIC above was sub-cultured on fresh plates of Sabouraud Dextrose Agar plates and incubated 37°C for 24 h. After incubation, the plates were examined visually for colonies and the plates with plant extract concentration that showed no visible growth were regarded as MFC of the isolates (Borman *et al*., 2017).

Gas Chromatography-Mass Spectrophotometry (GC-MS) Analysis of Jatropha curcas Linn Extracts

The chromatographic procedure was carried out using a 7890A GC system (Agilent Technologies), equipped with a Mass Selective injector (MSD) 5975 (Agilent Technologies), injector series model 7683B and HP-5MS capillary column

(30 m × 0.320 mm, 0.25 µm film thickness). The temperature of the column was maintained at 350°C for 1min. It was then raised at the rate of 100°C per min for a hold time of 3 min. Finally, the temperature of the injection port was maintained at 2200°C and that of the detector at 2500°C for 3 min hold time. This was adapted in order to prevent excess long chain fatty acids from accumulating on the GC column. Helium was the carrier gas. The following parameters were maintained: Pressure = 112.0 kPa, Total flow = 32.7 ml/min, Column flow = 1.90 mL/min, Linear velocity = 50 cm/sec. The chromatographic effluent was then analyzed by the MSD (Obidi *et al*., 2013).

Data Analysis

Data was analyzed using percentage and Chi-Squared Test(X^2) at P = 0.5 to compare the antifungal effect of standard antifungal drugs and extracts from *Jatropha curcas* Linn against yeast isolated from neonates and infants.

Results

Of the 80 (out of the total of 180 samples collected) stool samples from State Specialist Hospital Yola, 14 (17.8%) were positive for *Candida* species, for the 70 samples from Government General Hospital. Numan, 10 (14.29%) were positive for *Candida* species and of the 30 collected from Local Government Clinic, Sangere 8 (26.7%) were positive for *Candida* species (Table 1). The statistical analysis showed that there is no significant difference in the level of *Candida* species occurrence in the different sample sites at 5% level of significance.

The phytochemical analysis of plant extracts in this study revealed the presence of phenol, tannins, alkaloids, glycosides, steroids, flavonoids, terpenoids and saponins compounds with phenolic compounds having the highest concentration in the leave, stem bark and sap extracts of *Jatropha curcas* Linn (Tables 2 and 3). This agree with earlier works of (Akinpelu *et al*., 2009; Igbinosa *et al*., 2009; Nwala *et al*., 2013) who reported the presence of saponins, tannins, flavonoids, alkaloids and glycosides in the methanol leaf extracts of *Jatropha curcas* Linn.

Result of antifungal susceptibility testing of the partially purified methanol fraction of aqueous leave and stem bark extracts showed that *Candida albicans* exhibited resistance against the extracts at 200-1000 µg/mL (Table 4a and 4b). The methanol fraction of aqueous leaves and stem bark aqueous extract of *Jatropha curcas* Linn, showed very low diameter of zone of inhibition (5.00 mm) at high 600, 800 µg/mL (7.00 mm) and 1000 µg/mL (10.00 mm). This is in agreement with the study of (Ishak *et al*., 2011) who reported that the methanol leaves and pericarp extracts possessed significant activities against some pathogenic fungi at high concentration than aqueous extracts. Result also showed that the sap extract of *Jatropha curcas* Linn, showed the highest antimicrobial activity than both Methanol and aqueous extracts of leave and stem bark with the highest diameter of zone of inhibition (21.00 mm) at 1000 µg/mL (Table 4b). This correlates with the observation previously reported by (Aransiola *et al*., 2014; Abubakar *et al*., 2016).

The result obtained for Minimum Inhibitory Concentration (MIC) and Minimum Fungicidal Concentration (MFC) (Table 5) showed that the MIC values of the sap extract, methanol stem bark extract, methanol leave extract, aqueous leave extract and aqueous stem bark extract was lower (400-1200 µg/mL) than those of MFC (800-1800 µg/mL). These findings correlate with the reports by (Joanne *et al*., 2008; Arekemase *et al*., 2011; Sundari and Selvaraj, 2011) that organisms varied widely in the degree of their susceptibility.

The Gas Chromatography Mass Spectroscopy (GC-MS) result obtained from methanol fraction of sap extract indicated the presence of 56 compounds (Table 6a) and the chromatogram (Fig. 1). The most abundant of these compounds included 1, 2-Benzenedicarboxylic acid, butyl 2-ethylhexyl ester (29.16% area percentage) and Quinolin-5(6H)-one, 7, 8-dihydro-2-hydroxy-4, 7, 7-trimethyl (4.08%) area percentage. The Gas Chromatography Mass Spectroscopy (GC-MS) result obtained from methanol fraction of methanol stem bark extract and the methanol fraction of methanol leave extract indicated the presence of 46 and 52 compounds respectively (Tables 6a to 6c) and the chromatogram (Figs. 2 and 3). The compounds that occurred in abundance were 2-(Octyloxycarbonyl) benzoic acid (13.32% area percentage), dichloroaceticacid, 2-pentadecyl ester (11.68% area percentage), 3-Chlorophenyl carbamic acid, 5,6,7,8-tetrahydronaphthalen-2-yl ester (9.78% area percentage) and 7, Oabicyclo[4.1.0]heptanes, 1,5-dimethyl (7.70% area percentage), which was also reported by (Ujjwal *et al*., 2008; El-Baz *et al*., 2015). The GC-MS result obtained from methanol fraction of methanol leaf extract are Ricinoleic acid (8.36% area percentage). Ujjwal *et al*. (2008) had earlier reported antifungal activity of these fatty acids detected in seeds *of Jatropha curcas* Linn (a hydroxyl group compound). Result also showed the presence of Pyrroledrel-ethyl-3,2' spiro-benzo-1-3 dioxalane (7.05% area percentage), Adipic acid, 2-ethylhexyl isobutyl ester (6.50% area percentage) and 2-Cyano-2-(3,4-dichloro-5(2H)-oxo-2-furyl) acetamine (5.10% area percentage). In accordance with the present work, (El-Baz *et al*., 2015; Kala *et al*., 2011) as well as (Youssef and Amin, 2010) reported the presence of these compounds in methanol, ethanol and aqueous leave and stembark extracts of *Jatropha curcas* Linn in their the GC-MS analysis. Many spiro compounds were also detected in sap, leaves and stem bark extracts of *Jatropha curcas* Linn in this study. Furthermore, result showed that the GC-MS of methanol fraction methanol stem bark, sap and leave extract showed the presence of Hexadecenoic acid, Z-11.

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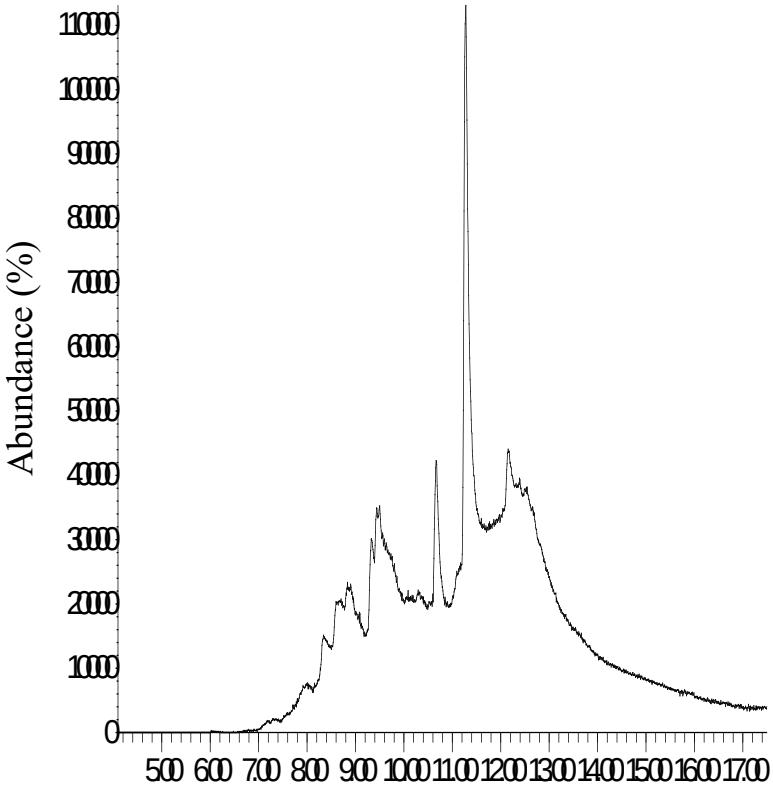

Fig. 1: Gas chromatogram of *Jatropha curcas* Linn sap

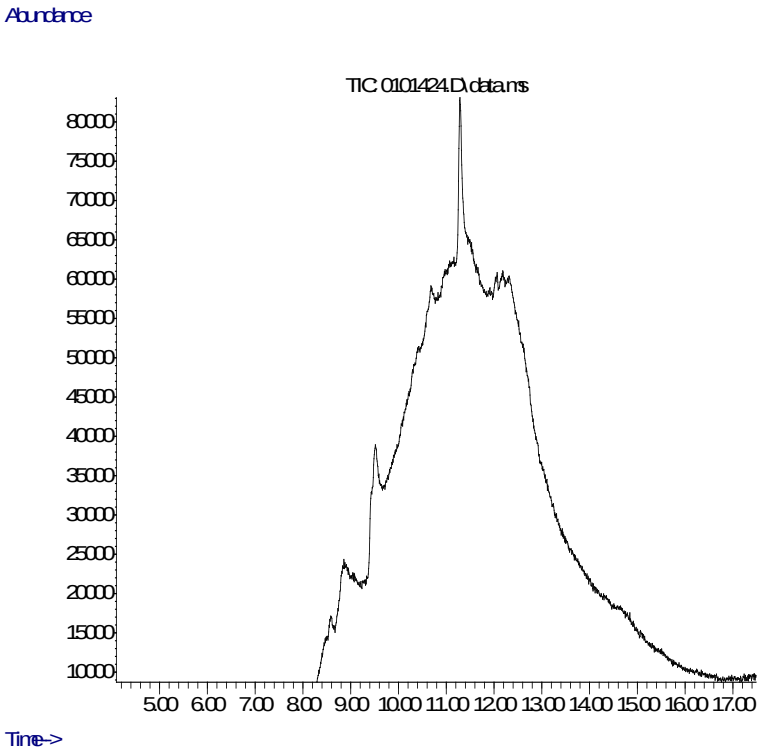

Fig. 2: Gas chromatogram of methanolic stem bark extract of *Jatropha curcas* Linn

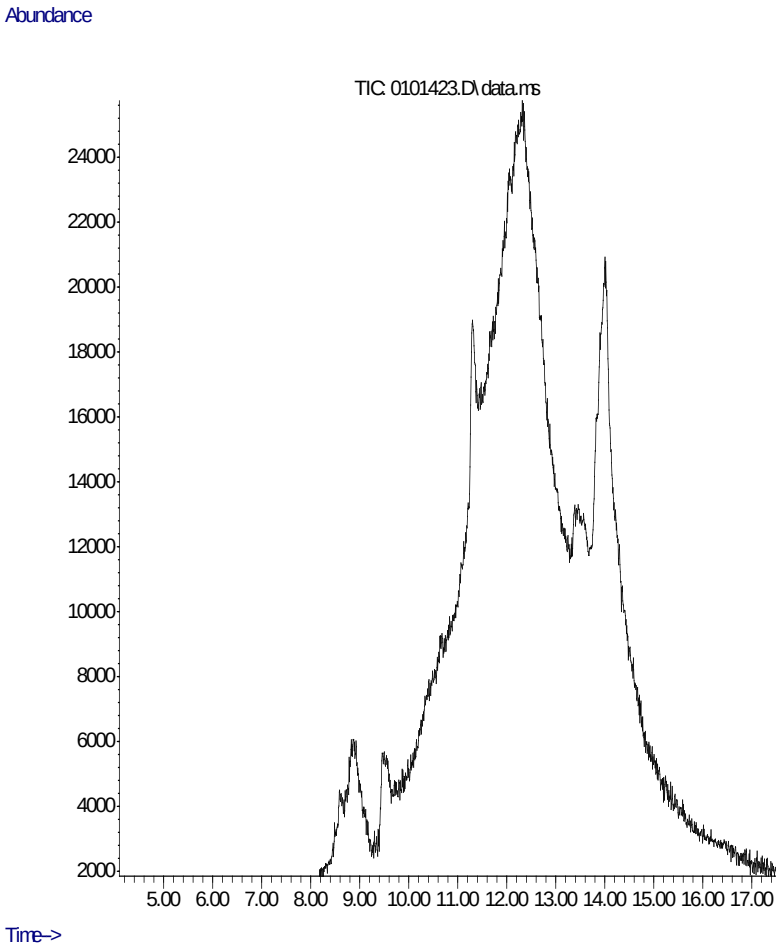

Fig. 3: Gas chromatogram of methanolic leaves extract of *Jatropha curcas* Linn

Table 1: Distribution of stool samples collected and occurrence of *Candida* spp from study area

Sample site	No. of samples collected	No. + ve for Candida	Percentage X^2
Specialist Hospital Yola	80	14(17.5)	X^2 Cal < X^2 tab
			X^2 Cal = 2.21
General Hospital Numan	70	10(14.29)	X^2 *Tab* = 5.99
Sangere Clinic	30	8(26.67)	
Total	180	32	

Key: + ve = positive

Table 2: Qualitative phytochemical composition of *Jatropha curcas* Linn extracts

	Solvent extracts				
Phytochemicals	ML	Sap	MS	AL	AS
Saponins	+	+	+	+	+
Flavonoids	+	+	+	+	+
Terpenoids	+	+	+	-	-
Alkaloids	+	+	+	+	+
Steroids	+	+	+	+	+
Tannins	+	+	+	+	+
Phenols	+	+	+	+	+
Glycosides	+	+	+	-	-

MS = Methanolic Stem bark extract, ML = Methanolic Leaves extract, AS = Aqueous Stem bark extract, AL = Aqueous Leaves extract
Sap = Sap of *Jatropha curcas* Linn, - = Negative, + = Positive

Table 3: Quantitative phytochemical composition of *Jatropha curcas* Linn extracts

	Composition (%) of components in extracts				
Phytochemicals	ML	Sap	MS	AL	AS
Saponins	0.48	0.26	1.24	0.20	0.12
Flavonoids	1.63	3.14	0.82	0.52	1.00
Terpenoids	0.15	2.04	0.12	-	-
Alkaloids	3.13	4.11	4.53	1.34	1.53
Steroids	1.85	3.76	2.95	0.78	1.34
Tannins	4.07	6.78	2.80	1.43	1.98
Phenols	14.12	15.42	14.56	7.65	8.02
Glycosides	2.01	4.21	1.74	-	-

MS = Methanolic Stem bark extract, ML = Methanolic Leaves extract, AS = Aqueous Stem bark extract, AL = Aqueous Leaves extract
Sap = Sap of *Jatropha curcas* Linn, - = Negative, + = Positive

Table 4a: Mean values of antimicrobial activity of methanol fractions of different parts of *Jatropha curcas* Linn on yeast isolates after purification

	Mean diameters of zones of inhibition (mm) for the various extracts (µg)											
	MFMS		MFML		MFAL		MFAS		MFS		N	
Sample	200 µg	400 µg	200 µg	400 µg	200 µg	400 µg	200 µg	400 µg	200 µg	400 µg	200 µg	400 µg
1.	2.00	3.00	0.60	0.92	0.00	0.00	0.00	0.09	7.00	8.00	8.00	6.00
2.	4.00	4.00	2.66	3.16	0.00	0.10	1.02	1.22	9.33	9.63	9.66	8.66
3.	2.00	3.10	2.33	2.33	0.00	0.00	2.00	2.00	7.00	5.60	6.66	6.33
4.	2.00	2.20	1.60	2.60	0.00	0.30	1.33	1.84	8.33	8.03	8.00	8.33
5.	2.60	3.20	3.33	4.01	0.00	0.00	1.66	1.68	9.00	9.50	9.66	7.13
6.	1.66	3.66	0.00	0.00	0.00	0.00	0.06	0.96	8.66	8.96	10.00	6.33
7.	0.00	1.56	0.00	0.91	0.00	1.00	0.00	0.60	2.00	3.90	0.00	4.00
8.	3.66	4.76	3.00	3.99	0.00	0.00	2.00	2.10	9.00	9.50	10.33	11.00
9.	4.00	4.90	3.66	4.54	0.00	0.50	3.00	3.09	8.20	9.20	10.33	7.33
10.	1.66	1.96	0.00	0.72	0.00	0.00	0.10	0.10	4.90	3.90	4.66	4.00
11.	4.00	4.60	0.00	2.12	0.00	0.40	0.33	2.03	5.66	5.66	4.33	7.66
12.	3.60	2.60	2.33	2.99	0.00	0.00	0.01	1.11	6.33	6.33	6.00	6.66
13.	3.26	4.06	3.32	4.01	0.00	0.00	1.00	1.90	8.00	9.00	9.33	8.33
14.	3.00	3.80	0.00	0.33	0.00	2.00	1.33	1.93	6.33	6.53	6.66	7.00
15.	3.53	3.90	1.66	2.16	0.00	0.00	1.00	1.80	9.01	10.01	10.33	12.00
16.	4.60	5.01	3.33	3.54	0.00	0.00	2.00	2.09	10.33	9.33	8.23	9.66
17.	4.30	4.39	4.00	4.63	0.00	0.00	1.66	1.68	10.93	12.43	11.00	13.00
18.	3.10	3.91	0.00	1.00	0.00	0.00	2.66	3.00	9.00	9.00	8.33	11.66
19.	2.66	3.66	0.00	0.94	0.00	1.01	1.33	3.33	9.00	9.20	9.33	8.00
20.	2.66	3.66	1.33	1.84	0.00	0.00	0.00	3.00	8.00	8.50	9.00	9.00
21.	4.00	4.70	2.00	2.74	0.00	0.01	0.66	2.66	8.66	8.06	8.00	9.33
22.	3.00	3.92	0.00	1.01	0.00	0.00	0.06	1.06	9.00	11.90	9.00	10.33
23.	3.06	4.16	0.00	2.00	0.00	0.20	0.00	1.90	8.66	6.06	9.33	5.66
24.	5.76	6.01	3.00	3.30	0.00	0.00	1.03	1.83	8.99	9.09	8.33	9.66
25.	4.26	4.71	2.00	2.12	0.00	0.00	0.10	2.00	8.00	7.50	8.00	8.00
26.	3.33	4.91	2.00	2.91	0.00	1.00	0.20	0.20	5.66	5.06	5.33	7.00
27.	3.13	5.13	4.00	4.67	0.00	0.00	1.00	1.67	6.00	6.50	6.33	7.00
28.	3.00	3.20	2.00	3.10	0.00	0.00	0.00	0.99	8.66	8.99	9.00	9.20
29.	4.00	5.01	1.33	2.43	0.00	0.10	0.06	0.09	7.50	7.59	8.00	8.00
30.	4.01	5.00	3.00	3.56	0.00	0.00	1.06	2.16	9.33	9.00	8.00	8.66
31.	3.56	3.76	0.00	0.92	0.00	0.01	1.00	1.90	9.33	9.45	9.00	9.66
32.	3.43	5.00	0.00	1.40	0.00	0.00	0.00	2.00	6.33	6.33	7.60	8.33

MFMS = Methanol Fraction Methanolic Stem bark extract, MFML = Methanol Fraction Methanolic Leaves extract, MFAS = Methanol Fraction Aqueous Stem bark extract, MFAL = Methanol Fraction Aqueous Leaves extract, MFS = Methanol Fraction Sap, N = Nystatin suspension

Table 4b: Mean values of antimicrobial activity of methanol fractions of different parts of *Jatropha curcas* Linn on yeast isolates after purification

	Mean diameters of zones of inhibition (mm) for the various extracts (µg)											
	MFMS		MFML		MFAL		MFAS		MFS		N	
Sample	400 µg	800 µg	400 µg	800 µg	400 µg	800 µg	400 µg	800 µg	400 µg	800 µg	400 µg	800 µg
1.	7.30	9.33	8.00	10.20	3.000	5.00	4.00	7. 00	10.00	12.50	11.00	13.00
2.	6.00	11.40	6.30	8.30	2.100	4.90	4.00	4.50	13.00	14.30	11.00	15.33
3.	6. 30	7.60	7.00	6.00	3.000	3.30	5.60	5.60	18.30	19.30	14.00	10.66
4.	8.10	10.00	6. 60	9.20	2.200	6.00	4.00	6.30	17.00	18.30	15.00	15.00
5.	11.10	11.00	9.30	10.00	1.000	5.20	3.00	5.00	15.00	13.20	17.00	15.00
6.	6.00	5.66	6.60	5.00	3.000	1.20	4.00	4.00	10.00	11.00	11.00	10.50
7.	6.50	7.90	6.00	7.10	2.300	3.30	5.00	6.60	10.00	10.00	12.00	12.00
8.	7.00	10.10	7.60	8.00	2.300	5.00	3.40	8.00	12.00	13.00	11.60	13.30
9.	9.10	5.90	6.00	5.00	1.990	3.43	2.60	5.50	10.30	11.00	11.60	12.00
10.	6.30	5.90	7.00	5.30	2.230	2.10	5.70	6.00	10.00	11.60	12.00	11.00
11.	7.80	7.60	8.00	5.30	2.330	2.00	3.00	7.00	18.00	20.70	16.60	21.00
12.	7.20	8.99	6.00	7.30	0.300	2.00	4.10	6.00	10.60	10.00	9.30	9.00
13.	7.40	10.00	6.00	8.00	1.660	3.70	2.33	4.00	15.33	17.00	17.66	20.00
14.	8.33	9.10	8.00	8.00	3.100	5.60	3.66	7.00	11.33	13.00	12.00	13.00
15.	7.66	10.10	5.00	9.20	2.100	5.11	5.33	2.50	11.00	14.00	12.00	13.00
16.	8.93	7.00	8.00	6.20	0.600	4.30	6.60	5.00	12.30	12.00	14.00	15.00
17.	9.00	9.73	8.33	9.30	1.000	4.50	4.99	6.00	12.00	11.00	13.33	13.00
18.	11.50	10.20	9.00	10.60	2.530	5.00	3.00	6.00	14.30	15.00	16.66	17.00
19.	9.76	11.00	7.00	10.00	2.600	4.30	5.50	5.00	18.66	19.00	17.00	20.00
20.	8.66	8.90	7.00	10.00	0.500	2.90	3.03	1.00	12.33	14.00	15.60	16.00
21.	9.70	9.70	8.00	10.00	3.000	5.00	4.43	6.00	14.33	15.00	17.00	17.00
22.	9.20	9.00	7.33	9.00	5.400	5.30	3.99	6.00	14.00	13.00	14.00	15.00
23.	10.03	8.97	6.00	9.00	4.100	3.00	4.66	4.60	11.00	11.00	12.00	12.00
24.	8.06	11.10	7.66	10.00	3.500	5.00	5.00	5.00	10.33	19.30	13.33	20.00
25.	6.90	8.10	8.00	8.00	2.200	2.00	3.33	7.00	16.00	11.00	18.60	12.00
26.	9.00	9.30	6.33	9.00	1.100	5.00	4.00	4.00	11.33	12.00	12.60	11.00
27.	7.21	8.20	6.00	8.00	2.100	6.00	3.60	5.00	11.30	12.00	13.00	14.00
28.	8.99	10.00	7.00	9.00	0.300	3.40	3.00	3.00	13.00	12.00	12.00	13.00
29.	8.00	10.30	6.00	10.00	4.200	4.00	5.00	3.50	12.30	13.00	14.00	14.00
30.	9.00	10.60	7.00	10.00	3.700	6.00	6.00	7.00	15.00	15.00	13.60	14.00
31.	6.49	10.00	5.33	9.00	3.030	6.10	7.00	5.00	13.00	13.00	12.00	14.00
32.	8.45	6.00	5.60	6.00	4.000	4.00	3.00	5.00	12.33	10.00	7.00	8.00

MFMS = Methanol Fraction Methanolic stem bark extract, MFML = Methanol Fraction Methanolic leaves extract, MFAS= Methanol Fraction Aqueous stem bark extract, MFAL = Methanol Fraction Aqueous leaves extract, MFS = Methanol Fraction Sap, N = Nystatin suspension

Table 5: Determination of Minimum Inhibitory Concentration (MIC) and Minimum Fungicidal Concentration (MFC) of Crude Extract of Different Part of *Jatropha curcas* Linn

Yeast isolates	*Jatropha curcas* Linn extract	MIC value (µg/ml)	MFC value (µg/ml)
Candida albicans	MS	500	1000
	ML	800	1200
	AS	1000	1400
	AL	1200	1600
	S	400	800
Candida tropicalis	MS	600	1000
	ML	800	1200
	AS	1000	1400
	AL	1400	1800
	S	400	800

MS = Methanolic Stem exract, ML = Methanolic Leaves extract, AS = Aqueous Stem extract, AL = Aqueous Leaves extract, S = Sap extract

Table 6a: Compounds detected in sap of *Jatropha curcas* Linn by GC-MS

S/N	Constituent	Area %	RT (min)	S/N	Constituent	Area %	RT (min)
1	5-Hepten-3-yn-20one,6-methyl-5-(1-methyllethyl)	7.131	0.03	29.000	4H- Benzo(def) carbazole, 4- methyl-	0.92	9.672
2	Benzoic acid, 2,4,5-trimethyl	0.13	7.183	30.000	1H- Pyrazole, 1,1'- cyclohexylidenebis-	1.17	9.702
3	Morpholine, 2,6,-dimethyl	0.23	7.361	31.000	Quinolin- 5 (6H) - one, 7, 8 - dihydro – 2 - hydroxyl - 4, 7, 7 -trimethyl-	2.14	9.739
4	Pentaflouropropionic acid, octyl ester	0.01	7.457	32.000	3-Methyl-6,7-methylenedioxyisoquinoline -1,4-dione	1.51	9.805
5	Bicyclo[3.3.0.]octane-2-one, 7 -isopropylidene	0.15	7.635	33.000	4-(1-methylpropylthio)pyrido[3,2-c]pyridazine	0.82	10.057
6	(4z)-5-chloro-3,4-dimethyl-2,4-heptadiene	34.00	0.140	7.709	Levamisole	0.82	10.057
7	0-Nitrobenzaldoxine-0-methyl-ether	0.11	7.776	35.000	4-Quinolinol, 4-(3-buten-1-ynyl)decahydro -2-methyl-,(2.Alpha.,4.beta., 4a. alpha., 8a.beta.)-	1.07	10.087
8	Benzoic acid, 2-amino, 2-propenyl ester	0.84	7.924	36.000	1H -Indole -2 - carboxylic acid, 3- formyl-5-methoxy	0.72	10.168
9	N-(4-methoxyphenyl)-2-hydroxyimino-acetamide	0.38	7.991	37.000	N-(2-Acetylcyclopentylidene)-p-anisidine	0.82	10.301
10	5-Methylthiophene-2-sulfonamide	0.69	8.013	38.000	[1,3] Dioxolo [4,5-g] quinoline - 7 -carboxamide, 6 -amino	0.43	10.324
11	N(.alpha.methyl-4-nitrobenzylidene) -0-(phenylcarbamoyl)hydroxylamine	0.21	8.161	39.000	Aniline, N-benzylidene-p-chloro	0.46	10.524
12	Methyl tetradecamoate	3.60	8.346	40.000	Adipic acid, 2-ethylhexyl isobutyl ester	6.50	10.672
13	6-Chloro-8-quinolinemethanol	0.44	8.457	41.000	Benzo(a)acridine	0.63	11.101
14	1,2,4-Triazolo[4,3-b]pyridazin-8 -o 1,7-ethyl-6-methyl	0.36	8.487	42.000	5H-Dibenz[b,f]azepine, 3-chloro-10, 11-dihyro	0.64	11.168
15	(1R,9aS,Z)-1-methyl-3-propylideneoctahydro-1H* quinolizine	0.37	8.516	43.000	1,2-Benzenedicarboxylic acid, butyl 2-ethylhexyl ester	29.16	11.279
16	Trimellitic acid anhydride	2.02	8.605	44.000	Phenol, 2-(1,1-dimethylethyl)-4-methyl	0.75	11.598
17	Oxazole,2,5-dihydro-2,2, dimethyl-4,5-diphenyl	0.87	8.628	45.000	Benzene, 1-isothiocyanato-2-methyl	0.42	11.635
18	Cyclohexanecarbonitrile,1-(1-piperidinyl)	1.44	8.679	46.000	2-Piperidinone, N-[4-bromo-n-butyl]	0.88	11.657
19	3,4-Dihydro-4,4-dimethylthiocoumarin	0.82	8.702	47.000	9-Oxabicyclo [6.1.0]nonane	0.34	11.731
20	Oxazole, 2,5-dihydro-2,2 -dimethyl-4,5-dimethyl	1.56	8.731	48.000	2-Propionyloxytetradecane	0.65	11.753
21	Pyridine-3-carbonitrile, 1,2- dihydro-5 -acetylamino-4-methyl-2-oxo	2.55	8.835	49.000	Acetic acid, trichloro-, nonyl ester	0.92	11.857
22	3,4-Dihydrocoumarin, 6- amino-4,4-dimethyl	0.72	8.872	50.000	Myristoleic acid	0.70	11.916
23	Phthalic acid, 2-bromo-2 flourophenyl cyclohexyl ester	3.19	8.909	51.000	1-Eicosanol	0.40	12.012
24	2-Cyano-2-(3,4-dichloro-5 (2H)-oxo-2-furyl) acetamine	5.10	9.331	52.000	Oxalic acid, cyclobutyl heptadecyl ester	0.62	12.049
25	3-Mercapto-4-phenyl-5-ethyl-1,2,4-triazole	3.57	9.442	53.000	2((pent-4-enyloxycarbonyl)benzoic acid	4.86	12.153
26	Quinolin-5(6H)-one, 7,8- dihydro -2-hydroxy-4,7,7-trimethyl	4.08	9.502	54.000	Phthalic acid, butyl 2-(2-nitrophenyl) ethyl ester	1.12	12.316
27	7-Methoxy-3,4,5,6-tetramethyl-2-1 benzisoxazole	1.44	9.568	55.000	1,2-Benzeneicarboxylic acid, dipropyl ester	1.17	12.398
28	Bicyclo[4.1.0]hepta-1,3,5- triene-7- carbonitrile, 7-(phenylmethyl)-	3.19	9.598	56.000	2H-1,3-Benzimidazol-2-one, 5-amino-1,3-dihydro	0.62	12.501

Table 6b: Compounds detected in methanolic extract of stem bark of *Jatropha curcas* Linn by GC-MS

S/N	Constituent	Area %	RT (min)	S/N	Constituent	Area %	RT (min)
1	2H-pyran, 2-(3-butylnyloxy)tetrahydro	0.02	7.354	24	2-Chloroethyl vinyl sulfide	0.23	9.176
2	3,4-Furandiol, tetrahydro, cis	0.05	7.435	25	Desulphosinigrin	0.25	9.213
3	11-(2-cyclopenten-1-yl)undecanoic acid, (+)	0.03	7.480	26	Acetamide, 2-amino-N-phenyl-2-thioxo	0.28	9.265
4	Cyclobut-1-enylmethanol	0.03	7.517	27	7,Oabicyclo[4.1.0]heptanes, 1,5-dimethyl	7.70	9.524
5	Cyclobutanone, 2-methyl-2-oxiranyl	0.03	7.546	28	8-Hexadecenal, 14-methyl-, (z)	3.80	9.865
6	3,3'-Iminobispropylamine	0.03	7.621	29	Dichloroacetic acid, 2-pentadecyl ester	11.68	10.302
7	2H-Pyran, tetrahydro-2-(2,2,2-triflouroethoxy)	0.03	7.665	30	Aspidospermidin-17-ol, 1-acetyl-19, 21-epoxy-15,16-	1.69	10.354
8	2¬-Hexene, 1-chloro	0.04	7.695	31	Hexadecenoic acid, z-11	3.40	10.428
9	Pent-3-enylamine	0.06	7.902	32	Pentadecanoic acid	1.57	10.783
10	2(3H)Furanone	0.02	7.976	33	Cis-9-Hexadecenoic acid	1.67	10.828
11	4-Chloro-3-n-butyltetrahydropyran	0.21	8.087	34	9-Oxabicyclo[6.1.0.]nonane	2.45	10.902
12	Heptamethylene diacetate	0.12	8.169	35	Oxacyclotetradecan-2-one	3.29	10.976
13	(s)(+)-z-13-methyl-11-pentadecen-1-ol acetate	0.07	8.220	36	5-Octadecenal	1.26	11.005
14	2-Allyl-2-methyl-1,3cyclopentanedione	0.54	8.398	37	E-11-Tetradecenoic acid	1.76	11.050
15	Acetamide, N-isoxazolo[5,4-b] pyridine-3-yl	0.68	8.487	38	9-Hexadecenoic acid	1.19	11.079
16	Spiro {6,6-dimethyl-2,3-diazobicyclo [3.1.0] hex-2-ene-4,1'-cyclopropane}	3.23	8.509	39	Methyl 12-oxo-9-dodecenoate	0.96	11.102
17	5. alpha.-Androstan-16-one, cyclicethylene mercaptole	2.62	8.591	40	Myristoleic acid	3.72	11.161
18	Citral	0.21	8.657	41	2-(Octyloxycarbonyl) benzoic acid	13.32	11.287
19	(3-Chlorophenyl) carbamic acid, 5,6 ,7,8-tetrahydronaphthalen-2-yl ester	9.78	8.865	42	Acetic acid, trichloro-, nonyl ester	0.07	11.916
20	Benzene, 1-isocyanato-3-methoxy	0.39	8.87	43	1-Decanol, 2-octyl	1.44	12.035
21	Benzene, 2[(2-methyl-2-propennyl) oxy]	0.56	8.909	44	2-Propenoic acid, tridecyl ester	2.47	12.190
22	Propane, 1,3-bis(propylthio)	0.80	8.939	45	Oxalic acid, cyclobutyl hexadecyl ester	0.47	12.250
23	Spiro[azetidin-2-one-4,2'-tricyclo (3,3,1,1(3,7)decane]	1.91	9.043	46	1,2-Benzenedicarboxylic acid, bis (2-ethylbutyl) ester dimethoxy-	2.88	12.316

Table 6c: Compounds detected in methanolic leave extract of *Jatropha curcas* Linn by GC-MS

S/N	Constituent	Area (%)	RT(min)	S/N	Constituent	Area (%)	RT (min)
1	2H-pyran, 2-(3-butylnyloxy)tetrahydro	0.23	8.220	27	Cyclohexanone, 4- hydroxy-	0.62	10.791
2	Cyclopentanone	0.27	8.332	28	9- Octadecenal, (z)-	0.69	10.835
3	6, 7- Dimethyl- triazolo (4, 3-b) (1,2,4) –triazine	1.41	8.591	29	Dodecyl isobutyl carbonate	1.37	10.998
4	5. Alpha. -Androstan- 16 -one, cyclc ethylene marcaptole	0.34	8.620	30	8- Hexacenal, 14-methyl-, (z)-	1.80	11.072
5	10- Azido - 1 -decanethiol	0.28	8.650	31	Z- 7- Tetradecenoic acid	1.20	11.124
6	Paromomycin	0.71	8.731	32	E- 11- Tetradecenoic acid	0.59	11.161
7	2- Furancarbaxaldehyde, 5- methyl-	0.28	8.761	33	5- methyl- 7- amino- s – triazolo(1,5-a)pyrimidine	7.79	11.302
8	Hydroquinone, acetate	1.96	8.80	34	Decanoic acid, 2,3- dihydroxypropyl ester	1.77	11.390
9	s- Triazolo [4,3-a] pyrazine, 5,8- dimethyl-	1.05	8.931	35	cis- 9- Hexadecenoic acid	1.65	11.450
10	9- Oxabicyclo[6.1.0]none- 4 –one	0.68	9.465	36	10- Octadecenal	1.23	11.479
11	Allyl methallyl ether	0.45	9.502	37	Ricinoleic acid	8.36	11.679
12	E- 1, 6- Undecadiene	1.00	9.546	38	2- Piperidinone, N- [4- bromo- n – butyl]-	2.37	11.731
13	1- Nitro -.beta. - d- arabinofuranose, tetraacetate	0.26	9.887	39	4- Octadecenal	2.44	11.827
14	Acetic acid, 10- chlorodecyl ester	0.33	9.983	40	7- Hexadecenal, (Z)-	3.03	11.879
15	Acetic acid, 1- methylcyclopentyl ester	0.43	10.094	41	Heptadecyl heptafluorobutyrate	1.98	11.931
16	Hexadecane, 1,1- bis(dodecyloxy)-	0.24	10.117	42	Oxirane, tetradecyl-	2.81	11.953
17	Vinyl lauryl ether	0.27	10.161	43	L- Homoserine lactone, N,N- dimethyl	7.44	12.057
18	Oxacyclotetradecan- 2-one, 13- methyl-	0.58	10.250	44	17- Pentatriacontene	3.49	12.161
19	Myristoleic acid	1.36	10.383	45	Oxalic acid, allyl hexadecyl ester	6.45	12.250
20	Dodenoic acid, 1- methylethyl ester	0.35	10.413	46	7- methylthieno[3,2- b] pyridine	5.94	12.324
21	2- Tridecenal, (E)-	0.30	10.442	47	Phthalic acid, ethyl 4- methylpent- 2- yl ester	7.59	12.361
22	cis- Hexadecenoic acid	0.67	10.487	48	6- Bromohexanoic acid, octyl ester	0.44	13.390
23	E-9- Tetradecenoic acid	0.39	10.524	49	d- Glucitol, 1, 5- hexyl-1- thio	0.23	13.420
24	5- Octadecenal	0.32	10.554	50	7- Hydroxy-3- (1, 1-dmethylprop-2- enyl)coumarin	0.44	13. 464
25	7- Hexadecenal, (z)-	0.81	10.679	51	d- Mannitol, 1- thiooctyl- 1- deoxy-	1.04	13.827
26	1- Hentetracontanol	0.68	10.753	52	Pyrrolidine, 1- methyl- 3,2'-spiro - benzo-1, 3-dioxolane	7.05	14.005

This compounds were reported to have antihistaminica, antiacne, antiandrogenic, antiarthritic and anticoronary activities. In addition, the compound is of 5-Alpha reductase inhibitor Insectifuge. (3-Chlorophenyl) carbamic acid, 5,6,7,8-tetrahydronaphthalen, dichloroacetic acid and 2-pentadecyl ester is also known to have anti-inflammatory, diuretic and antimicrobial activity (Lingen *et al*., 1959; Yayli *et al*., 2006; Muthulakshmi and Mohan, 2012).

Discussion

The intractable problems of antimicrobial resistance and poverty has led to the resurgence of interest in herbal products as sources of novel compounds, to suppress or possibly eradicate the ever increasing problems of emergence of newer diseases (Wurochekke *et al*., 2008; Ekundayo *et al*., 2011). Traditionally, different parts of *Jatropha curcas* Linn have been used in treatment of different forms of infection (Namuli *et al*., 2011). Like findings of this study, *Candida* species have earlier been reported as the most frequently isolated invasive fungal pathogen in humans, with the majority of infections being localized to the urogenital or oropharyngeal tracts of the patient (Fidel and Sobel, 1996).

Phytochemicals such as alkaloids, terpenoids, saponins and phenolics are considered as strong antimicrobial agents that can aid in solving the problem of antibiotic resistance (Gupta *et al*., 2011). Tannins and alkaloids showed high amount next to phenol in this study Tannins have been found to form irreversible complexes with prolinerich protein (Shimada, 2006). Alkaloids which are one of the largest groups of phytochemicals in plants having amazing effects on humans and this has led to the development of powerful pain killer medications as reported by (Kam and Liew, 2002; Doughari, 2012). The absence of alkaloids in *Jatropha curcas* Linn leaf extracts had also been reported by (Kubmarawa *et al*., 2007; Akinpelu *et al*., 2009). In this study however alkaloids were present in *Jatropha curcas* Linn stem bark, sap and leaves extracts respectively. These compounds have been associated with medicinal uses for centuries and were reported as the most efficient and therapeutically significant plant substance (Njoku and Akumefula, 2007).

The methanol extracts of stem bark and leaves (crude and methanol fraction), showed low antimicrobial activity at 200 µg/mL (Table 4a). But with increase in concentration to 1000 µg/mL, highest antimicrobial activity of (13.00 mm diameter of zone of inhibition) was observed (Table 4b). Different parts of methanol extract of *Jatropha curcas* Linn had the highest activity against both bacterial and fungal isolates and the least was observed in the water extract. Methanol is believed to be suitable solvent for extraction, because of high polarity to extract relatively high percentage phytochemical, such as phenols and terpenoids than the aqueous solvent, (Srinivasan *et al*., 2001; Caunii *et al*., 2012). The ability of the methanol extracts of the leaf and stem bark of *Jatropha curcas* Linn to inhibit growth of the test organism more than the aqueous extracts are an indication of their antimicrobial potency which may be employed in treatment of microbial infections (Ekundayo *et al*., 2011).

In their separate studies, (Aransiola *et al*., 2014; Abubakar *et al*., 2016) had earlier reported that *Jatropha curcas* Linn sap have varied antibacterial and antifungal activities against bacteria and *Candida* species which suggests that, the sap of this plant has broad spectrum of activities. Also (Srinivasan *et al*., 2001) reported that different solvents have different extraction capacities and different spectrum of solubility for the phyto-constituents. The inhibitory activity of plant extracts is also largely dependent on the concentration, parts of the plant used and the microbe tested (Kalimuthu *et al*., 2010). Results also showed that the aqueous extracts of *Jatropha curcas* Linn leaf and stem bark had lower inhibitory activity compared to its organic extracts. This study however is in disagreement with the findings of (Dada *et al*., 2014) that aqueous extract of *Jatropha curcas* Linn leaves showed potent antibacterial activities on coliforms than methanol and acetone extracts. The organic extracts provided denaturation and increase the permeability of cell membranes in microorganism (Farag *et al*., 1989).

MIC and MFC values are measures of efficacy of an antimicrobial agent (Doughari, 2012). It can therefore be seen that the various extracts of Jatropha *curcas* Linn have potential efficacy against *Candida albicans*. The different compounds isolated from various parts of *Jatropha curcas* in this study have earlier been reported to be effective antimicrobial agents. Hence, the potential antibacterial activity and antifungal activity of *Jatropha curcas* Linn against microorganisms may be explained on the basis of the presence of these bioactive phytoconstituents (Kim *et al*., 2009; Volpicella *et al*., 2011).

The GC-MS result from the sap extracts is in agreement with the study by (Akinpelu *et al*., 2009; Igbinosa *et al*., 2009) who also reported the presence of flavonoids, phenols and alkaloids in the sap extracts. Flavonoids, phenols and alkaloids have antibacterial, antifungal, antimalarial, analgesic anti-inflammatory and antiviral effects (Oksana *et al*., 2007). The compounds are reported to have very promising biological activities as anticancer, anticonvlsant, antituberculosis, antialzheimer's, pain relief, antidermatitis and antimicrobial agents (Youssef and Amin, 2010). Recently spiro compounds have been also used as antioxidants (Sarma *et al*., 2010). Tetradecanoic acid and squalene have the property of antioxidant activity (Kala *et al*., 2011). Deconoate salt and esters of various drugs are available. Since decanoic acid is a fatty acid, forming a salt or ester with a drug will increase its lipophilicity and its affinity for fatty tissue compounds found in the methanol leaves extract of *Jatropha curcas* Linn are being used for the pharmacological work (Kala *et al*., 2011). The antimicrobial activity of *Jatropha curcas* may be related to the inhibition of the enzymes catalytic action *via* formation of stoichiometric complex with the target enzymes resulting in the blocking or alteration of their active sites (Lingen *et al*., 1959; Yayli *et al*., 2006; Muthulakshmi and Mohan, 2012). These therefore, account for the antimicrobial activity of *Jatropha curcas* Linn and its local application to treat different ailments.

Conclusion

From this present study, it can be concluded that *Jatropha curcas* Linn has demonstrated antifungal activity against *Candida albicans* and *Candida tropicalis* associated with neonatal and infantile infections, justifying its traditional use by herbalists as health remedy in infants. *Jatropha curcas* Linn., therefore possesses the potential of being processed in to drugs for human consumption against neonatal and infantile infections as well. However, further research needs be conducted to determine the chemical structure and respective roles of various phytoconstituents identified in the plant parts in respect of antimicrobial activity with the view to purifying them for drug development. Toxicological studies to determine their safety to humans and effect of the plant against a wider range of fungi and bacteria should also be explored.

Declarations:

- No funding was received for conducting this study
- The authors have no conflicts of interest to declare that are relevant to the content of this article
- Ethics Approval and Consent to Participate

Manuscripts reporting studies involving human participants, human data or human tissue must:

- Ethics approval and consent to participate no. ADHM/EC/2019/R00271 was obtained from the Ethics Committee, Adamawa State Ministry of Health, Yola, Nigeria
- Include a statement on ethics approval and consent (even where the need for approval was waived)

Consent for Publication

Manuscript does not contain any individual person's data in any form (including individual details, images or videos), that requires consent to publish.

Availability of Data and Material

"Data sharing not applicable to this article as no datasets were generated or analyzed during the current study."

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Authors' Contributions

James Hamuel Doughari: Designed the research plan, organized the study, edited, proof read and approved the manuscript.

Martha Abraham: Participated in all experiments, coordinated the dataanalysis and contributed to the writing of the manuscript.

Conflict of Interest

"James Hamuel Doughari and Martha Abraham declare that they have no conflict of interest."

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