GC-MS, FTIR, Phytochemical Profiling and Antibiogram Pattern of *Ipomoea asarifolia* on Bacterial Strains from Wound

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This study aims to assess the GC-MS and FTIR profiles and secondary metabolites of *Ipomoea asarifolia* vis-a-vis its antibacterial action against bacteria, associated with wound infections. We conducted phytochemical screenings, GC-MS, and FTIR analyses on *I. asarifolia*. The antibacterial effects of the extracts were tested against *Staphylococcus aureus* and *Pseudomonas aeruginosa*. Reports indicated the presence of saponins (57.9, 13.81, 46 mg/g), phenolics (18.4, 4.14, 21.05 mg/g), and alkaloids (0.49, 0.62, 1.12 mg/g) in the leaf, stem, and whole plant, respectively. *I. asarifolia* contained eighteen (18 of 20) essential amino acids, including glycine, alanine, serine, and proline. We also found phytosterol, fatty acids, phospholipids, and vitamins (B, C, D, E, and K) in the samples. We detected distinctive absorption bands in the leaf and stem samples, corresponding to the stretching of O-H bonds. The absorption band at 3419.95 cm^{-1} was discovered in the leaf, while the absorption band at 3416 cm^{-1} was observed in the stem. A prominent adsorption peak at 1637.83 cm^{-1}, corresponding to the stretching of the alkene C=C bond in lignin, was detected in the leaf sample. The zone size inhibition for leaf and stem extracts ranges from 5 mm to 8 mm, depending on the extract concentration (0.625–5.0 mg/mL). *S. aureus* exhibited susceptibility to ciprofloxacin and norfloxacin but showed resistance to 15 other antibiotics. In contrast, *P. aeruginosa* displayed resistance to all tested antibiotics. The study provided confirmation and clarification of the traditional applications of *I. asarifolia*, a herbal plant that necessitates further investigation.

Keywords: wound bacteria; GC-MS; FTIR; phytochemicals; *Ipomoea asarifolia*; ethnomedicine

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1. INTRODUCTION

Plants in Africa, Asia, and Latin America have been used for medicinal purposes since ancient times (Aliyu et al., 2011; Karou et al., 2006). Researchers have repeatedly validated the effectiveness of these medicinal plants in the laboratory. Aliyu et al. (2011) and Fatope (2001) reported that approximately 80% of plants selected based on ethnomedicinal information demonstrate significant pharmacological activity. Medicinal plants are a cheap and renewable source of pharmacologically active substances. Plants remain a vital source of medicines for a large proportion of the world's population, particularly in developing countries (Gurib-Fakim, 2006). Falode et al. (2016) reported that researchers have isolated a number of modern drugs from plants that have been used for many years to treat various diseases worldwide. Currently, herbal medicine is widely accepted globally as a legal, alternative system of therapy for treating and curing various diseases and physiological conditions in traditional treatments in the form of pharmaceuticals (Falode et al., 2016; Gutteridge, 1984). *Ipomoea asarifolia* (Desr.) Roem. and Schult. (Convolvulaceae) is a glabrous succulent perennial plant trailing on the ground. It reproduces from seeds and stem shoots. It is a perennial, creeping or trailing, growing on sandy soil or wastelands. It is native to tropical America but is now pantropical. It occurs throughout West Africa, spanning from Cameroun to Senegal, Mali, the

Cape Verde Islands, and tropical Asia. It is a common weed in hydromorphic soils, low-lying and inland valleys, streams, and riverbanks (Jegede et al., 2009). In Nigeria, the traditional names include "Dumankada" in Hausa and "Gboroayaba" in Yoruba (Jegede et al., 2009). In Senegal, the plant is used for various gynecological purposes, including urinary problems during pregnancy, hemorrhage, as an ecbolic and abortifacient, and also in general for wound dressing and the treatment of ophthalmia, neuralgia, headaches, arthritic pains, and stomach aches. People in Ivory Coast mix the pulped-up leafy stem with citron and water and take it as an ecbolic. In some cases, people internally take leaf decoctions as a wash to alleviate feverish chills and rheumatic pains. In the middle belt region of Nigeria, people use the leaves to treat dysmenorrhea (painful menstruation). In northern Nigeria, people in the region apply a leaf poultice to guinea worm sores, steam their faces over a hot decoction of the plant along with husks of bulrush millet, and boil the flowers with beans to eat as a remedy for syphilis (Aliyu et al., 2011; Burkill, 1985; Jegede et al., 2009). The focus of this research was on GCMS and FTIR profiling and the quantification of phytonutrients in *I. asarifolia* and their effects on bacterial strains from wounds (*in vitro*).

2. MATERIALS AND METHODS

2.1. Study area

The study was carried out at the Microbiology laboratory of the Department of Microbiology, Federal University Oye-Ekiti, Nigeria and the Department of Biological Sciences, Joseph Ayo Babalola University, Nigeria.

2.2. Study site

Fresh leaf, stem and whole plants of *I. asarifolia* were harvested from Oye-Ekiti and identified at the herbarium section of Ekiti State University, Ado-Ekiti, Ekiti State, Nigeria with UHAE2017/051.

2.3. Collection and identification of clinical strains

Clinical strains of *S. aureus* and *P. aeruginosa* of wound origin were obtained from the Drug Discovery & Infectious Diseases Research Group into freshly prepared nutrient broth and incubated overnight at 37 °C. The overnight broth culture was standardized with 0.5 McFarland turbidity standards before streaking on selective media (mannitol salt and cetrimide agar - oxoid) for confirmation and incubated at 37 °C for 24 h. We also performed other biochemical tests.

2.4. Processing of plants

Fresh leaf, stem and whole plants of *I. asarifolia* were properly washed in tap water, rinsed in sterile distilled water and left to air-dry for several weeks. An electric blender (Magic Blender, Nakai Japan; model number SG-KIPN) micronized the plants into powdered form. The pulverized plants were stored in air-tight containers until required.

2.4.1. Cold Extraction Method

A pulverized plant sample of 75 g was soaked in 500 mL of methanol as the extracting solvent and agitated manually. After allowing it to extract for 48 hours, we filtered each extract using Whatmann No. 1 filter paper. We evaporated the solvent using a rotary evaporator (Senco Technology Co. Ltd., model no. R205, SN 13605) under pressure for 15 min at 39–40 rpm. The extracts were stored until needed in amber vial tubes away from light (Gujjeti and Mamidala, 2013; Wang, 2020).

2.4.2. Microbe-free proof of the extracts

The extracts were tested for presence or absence of turbidity using the Millipore filtration technique by introducing 2 mL of these extracts into 10 mL of sterile Mueller-Hinton broth and incubated at 37 °C for 24 h. The absence of turbidity or clearness of the broth after the incubation period indicated a microbe-free extract (Ojo et al., 2017).

2.5. Phytochemical analysis

2.5.1. Qualitative Phytochemical screening

The qualitative phytochemical tests on the leaf, stem, and whole plant extracts were performed, and the different secondary metabolites were characterized with reference to the technical procedures as described by various authors. Test for flavonoid (Gul et al., 2017), test for tannins (Usman et al., 2010), test for saponins (Iqbal et al., 2015), test for alkaloids (Usman et al., 2010; Wadood, 2013), test for sterols and triterpenoids (Gupta et al., 2013), test for anthraquinones glycoside (Borntrager's test) (Iqbal et al., 2015), tests for glycosides (Gul et al., 2017), cardiac glycoside (Keller-Killiani test) (Iqbal et al., 2015), test for terpenoids (Salkowski test) (Iqbal et al., 2015), test for steroids and triterpenoids (Liebermann-Burchard test) (Iqbal et al., 2015), test for phlobatannins (Wadood, 2013), test for phenolics (Ferric Chloride test) (Banu and Cathrine, 2015), and cardenolides (cardiac glycosides and aglycones-The Kedee's test) (Jagessar and Allen, 2012) were performed.

2.5.2. Qualitative Phytochemical screening

The quantitative analyses were conducted as described by various authors: alkaloids (Gupta et al., 2013; Senguttuvan et al., 2014), flavonoids, phenols, tannins, saponins (Gupta et al., 2013), anthraquinone contents (Soladoye and Chukwuma, 2012).

2.6. Gas Chromatography Mass Spectrometry (GC-MS) analysis on Ipomoea asarifolia

2.6.1. Phytosterol extraction and analysis

This was carried out by following the modified official methods of AOAC (AOAC, 2005). We weighed 5 g of powdered sample, transferred it to a Stoppard flask, and soaked it with petroleum ether until the powder was fully saturated. The flask was shaken every hour for the first 6 h and then it was kept aside and shook after 24 h. This process was repeated for three days, and then the extract was filtered. The extract was collected and evaporated to a constant mass using a nitrogen stream. The extract of 0.5 g from the sample was added to the screw-capped test tube. The samples were saponified at 95 °C for 30 min by using 3 mL of 10% KOH in ethanol, to which 0.20 mL of benzene had been added to ensure miscibility. 3 mL of deionized water was added, and 2 mL of hexane was used in extracting the non-saponifiable materials, e.g., sterols. The extractions, each with 2 mL of hexane, were carried out for 1 h, 30 min and 39 min, respectively, to achieve complete extraction of the sterols. For gas chromatography analysis, we concentrated the hexane to 2 mL in an Agilent vial.

2.6.2. The GC–MS analysis

GC-MS analysis remains one of the most accurate techniques to identify different volatile and semi-volatile bioactive constituents in organic and inorganic materials (Al-Huqail et al., 2018; Deshpande and Kadam, 2013; Payum, 2016). The GC–MS analysis of bioactive compounds from *I. asarifolia* was done using Agilent Technologies GC systems with GC-7890A/MS-5975C model (Agilent Technologies, Santa Clara, CA, USA) equipped with HP-5MS column (30 m in length × 250 mm in diameter × 0.25 mm in thickness of film). Spectroscopic detection by GC–MS involved an electron ionization system which utilized high energy electrons (70 eV). Pure helium gas (99.995%) was used as the carrier gas with flow rate

of 1mL/min. The initial temperature was set at 50 °C –150 °C with increasing rate of 3 °C /min and holding time of about 10 min. Finally, the temperature was increased to 300 °C at 10 °C/min. One microliter of the prepared 1% of the extracts diluted with respective solvents was injected in a splitless mode. Relative quantity of the chemical compounds present in each of the extracts of *I. asarifolia* was expressed as percentage based on peak area produced in the chromatogram(Casuga et al., 2016). The content of the extract was analyzed by GC-MS to identify various compounds using NIST library (Sheik Uduman et al., 2016).

2.7. Fourier transform infrared (FTIR) spectroscopy of leaves and stem of Ipomoea asarifolia

The pulverized form of the leaves and stem were separately subjected to Fourier transform infrared (FTIR) spectroscopy (mid-IR spectra) on a Perkin-Elmer FTIR. Dried powder sample (10 mg) was encapsulated in 100 mg of KBr pellet as so to prepare translucent sample discs. The measurements were carried out at 25–27 °C within the spectra range of 4000 to 400 cm^{-1}. The peak frequencies were compared to the reference literature to determine the functional groups present.

2.8. Antibacterial Susceptibility Test

2.8.1. Determination of Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC)

MICs for the *S. aureus* and *P. aeruginosa* strains were determined by the macro-dilution method recommended by CLSI (CLSI, 2008). Macro-dilution test tubes were dispensed with 5mL of Mueller-Hinton (MH) broth containing 1 mL of the appropriate plant extracts concentrations (0.0625, 1.25, 2.5 and 5.0 mg/mL) and a final concentration of 10^5 CFU/mL of the test strains. After an incubation of 24 h at 35 °C, test tubes were examined for turbidity, indicating growth or absence of turbidity. The MBCs were determined by plating out 0.1mL of the test tubes indicated to have MIC on MH agar incubated at 35 °C for 24 h. Reference type *S. aureus* strain (ATCC 29523) was included.

2.8.2. Disk diffusion method

The *S. aureus* strain obtained were cultured on cation adjusted Mueller–Hinton agar and incubated at 35 °C while *P. aeruginosa* was cultured on Mueller–Hinton agar and incubated at 37 °C. The antibacterial disk diffusion susceptibility profiles of the isolates were determined and used as positive control (CLSI, 2008). Reference-type strains of *Staphylococcus aureus* ATCC 25923 were also included. Paper disks of 5 mm in size were impregnated for 30 min in different concentrations of methanol extract of *I. asarifolia* before being aseptically placed on the cultured agar plate.

2.9. Statistical Analysis

SPSS version 20 software was used for the statistical analysis of the data using one-way ANOVA. A p-value of less than or equal to 0.05 was considered to be statistically significant ($p \leq 0.05$).

3. RESULTS

3.1. Phytochemicals in Ipomoea asarifolia

The findings on the qualitative phytochemicals revealed the presence of secondary metabolites among the different parts of the plant under study (Table 1). Table 1 shows that the leaf contains certain phytochemicals (anthraquinones and flavonoids) that are absent in the stem.

Table1. Qualitative phytochemical constituents of *Ipomoea asarifolia*

Phytochemical constituents	Leaf	Stem	Whole plant
Anthraquinones	+	-	+
Saponins	+	+	+
Phenolics	+	+	+
Triterpenes	-	-	-
Flavonoids	-	+	+
Tanins	+	+	+
Alkaloids	+	+	+
Glycosides	-	-	-
Phlabotaninns	-	-	-
Terpenoids	-	-	-
Steroids	-	-	-
Cardiac Glycoside	-	-	-
Cardenolides and Dienolides	-	-	-

Key: + = present; - = not present

Table 2 revealed that the phenolic content in the whole plant was 48.3% (21.05 mg/g) higher than the leaf content of 18.40 mg/g (42.2%), while the stem part had a significantly lower content of 4.14 mg/g (9.5%). The stem part of the plant contained 4.34 mg/g (24.5%) of flavonoid content, while the whole plant was rich in flavonoid with 13.39 mg/g (75.5%). The leaf was in abundance of saponin with 57.90 mg/g (49.2%) when compared with the whole plant at 46 mg/g (39.1%), but very low in the stem part at 13.82 mg/g (11.7%). Overall, the whole plant contains the highest concentrations of phytochemicals, followed by the leaf and the stem, respectively (Table 2).

Table 2. Quantitative phytochemical constituents present in *Ipomoea asarifolia*

Phytochemical constituent	Leaf (mg/g)	Stem (mg/g)	Whole Plant (mg/g)
Alkaloid	0.49	0.62	1.12
Flavonoid	ND	4.34	13.39
Phenolics	18.40	4.14	21.05
Tannin	8.56	3.94	9.45
Saponin	57.90	13.82	46.00
Anthraquinones	2.08	ND	1.49

Key: ND = Not Determined since absent in qualitative phytochemical

3.2. Antibacterial Susceptibility Pattern

The zone size inhibition of methanol extract of *I. asarifolia* showed that for the leaf and stem, no antibacterial activity was detected, whereas the whole plant, for all the concentrations tested, had an 8-mm zone size diameter (Table 3).

Table 3. Diameter of zones of inhibition (mm) of *Ipomoea asarifolia* methanolic extract against test isolates.

Test organism	Zones of inhibiton (mm)/concentration(mg/mL)												
	Leaf				Stem				Whole Plant				NCTR
	0.625	1.25	2.5	5.0	0.625	1.25	2.5	5.0	0.625	1.25	2.5	5.0	
Staphylococcus aureus	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	8.0	8.0	8.0	8.0	5.0
Pseudomonas aeruginosa	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	8.0	8.0	8.0	8.0	5.0

Key: NCTR = Negative control (5% DMSO); - = No zone of inhibition

The MIC value obtained from Table 4 (0.625 mg/mL) indicated no bactericidal activity (MBC) at all tested concentrations.
Only ciprofloxacin and norfloxacin effectively inhibited *S. aureus* in the antibiotic sensitivity (positive control) test, whereas *P. aeruginosa* was resistant to all the antibiotics (Table 5).

3.3. Phytonutrients present in the extract

The GC-MS findings of *I. asarifolia* revealed that it is very rich in phytoconstituents. *I.asarifolia* has 18 essential amino acids, which can be seen in Figure 1 and Table 6. These are glycine, alanine, serine, proline, valine, threonine, isoleucine, leucine, and cystine.
Figure 2 also showed the presence of some bioactive phytosterols, including cholesterol, cholestanol, ergosterol, campesterol, stigmasterol, savenasterol, and sitosterol.

Table 4. Minimum inhibitory and bactericidal concentration of *Ipomoea asarifolia* against test isolates

Test isolates	Leaf (mg/mL)		Stem (mg/mL)		Whole Plant (mg/mL)	
	MIC	MBC	MIC	MBC	MIC	MBC
Staphylococcus aureus	0.625	G	0.625	G	0.625	G
Pseudomonas aeruginosa	0.625	G	0.625	G	0.625	G

Key: NCTR = Negative control (5% DMSO); - = No zone of inhibition

Table 5. Antibiotic susceptibility of test isolates against commercially available antibiotics (Positive control)

	Antibiotics (mm)																
Test Isolates	CPX	NB	CN	AML	SY	RD	E	CH	APX	LEV	OFX	PEF	AU	CEP	NA	SXT	PN
Staphylococcus aureus	24S	22S	5R	5R	5R	8R	5R	5R	5R	5R	5R	5R	5R	5R	5R	5R	5R
Pseudomonas aeruginosa	5R	5R	5R	5R	7R	5R	5R	5R	5R	5R	5R	5R	5R	5R	5R	5R	5R

Key: OFX- Ofloxacin, PEF- Pefloxacin, CPX- Ciprofloxacin, AU- Augmentin, CN- Gentamicin, SY- Streptomycin, CEP-Ceporex, NA-Nalixidic acid, SXT-Septrin,PN-Ampicillin, NB-Norfloxacin, AML-Amoxil, RD-Rifampicin, E-Erythromycin,CH-Chloramphenicol, APX-Ampiclox, LEV-Levofloxacin. S – Sensitive; R - Resistant

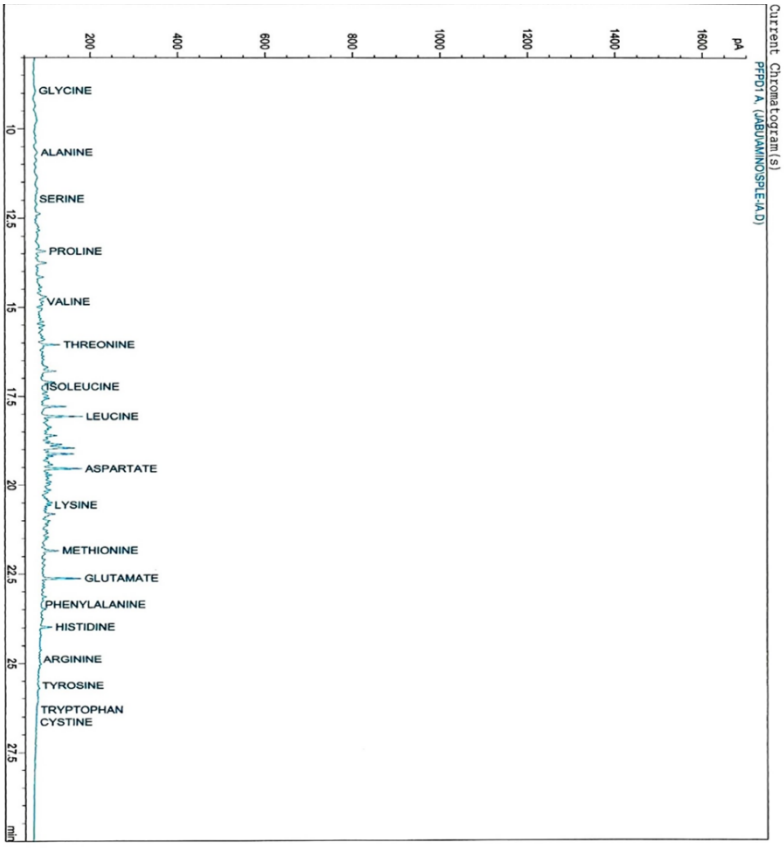

Fig 1. Chromatogram of bioactive amino-acids present in *Ipomoea asarifolia*

Table 6: Amino acid composition in *Ipomoea asarifolia*

Ret. Time (min)	Area (pA*s)	Amount (g/100 g of P)	Name
8.927	71.93903	5.83846	Glycine
10.657	99.26823	6.16317	Alanine
11.954	25.44103	6.59447	Serine
13.430	117.92834	6.89387	Proline
14.846	106.18715	5.20593	Valine
16.049	200.50868	4.81622	Threonine
17.237	63.92682	5.21033	Isoleucine
18.425	115.44450	7.37385	Leucine
19.532	384.54706	11.10560	Aspartate
20.548	124.42369	2.05546	Lysine
21.831	282.02722	$8.31015e^{-1}$	Methionine
22.614	342.46295	13.72507	Glutamate
23.357	60.85301	4.00780	Phenylalanine
23.975	151.49039	2.93474	Histidine
24.884	52.81997	5.80350	Arginine
25.625	54.71838	3.64856	Tyrosine
26.307	23.11975	1.54162	Tryptophan
26.646	30.86706	3.49211	Cystine
Total		**97.24176**	

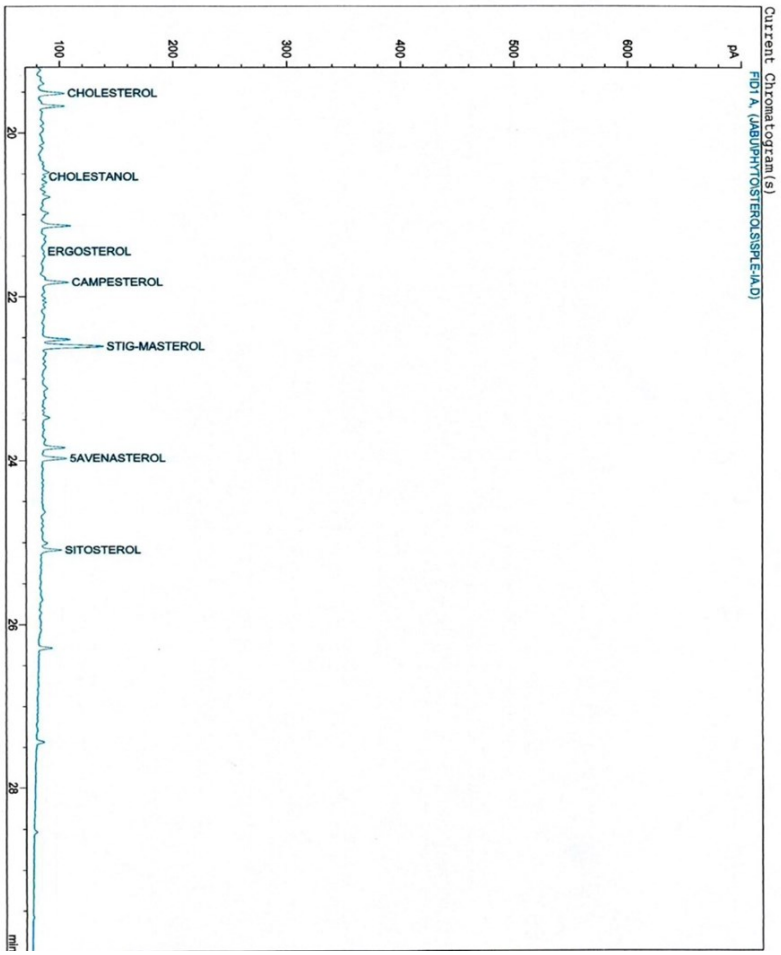

Fig 2. Chromatogram of bioactive phytosterol in *Ipomoea asarifolia*

The fatty acid compositions shown in Figure 3 are caproic acid, carpylic acid, decanoic/carpic acid, lauric acid, myristic acid, tetradecanoic acid, palmitic acid, and stearic acid.
Figure 4 shows that phospholipids are made up of phosphatidylethanolamine, phophatidylcholine, phophatidylserine, lysophophatidylcholine, and phophatidylinositol.
Figure 5 displays the vitamins that are present, which are vitamins A, B1, B2, B3, B4, B6, B9, B12, C, D, E, and K.

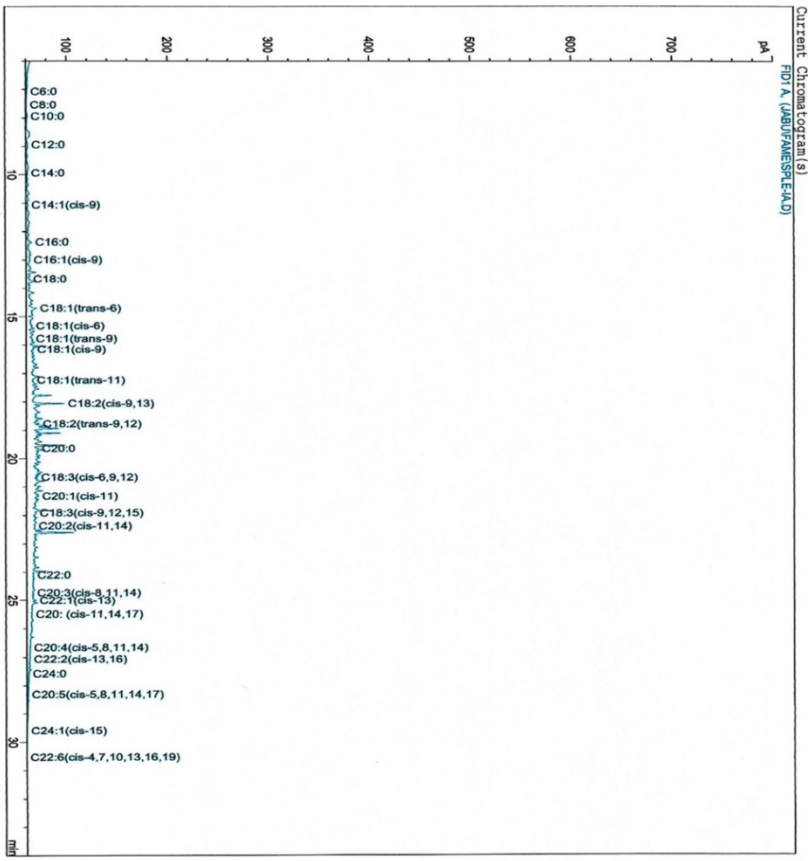

Fig 3. Chromatogram for bioactive fatty acids present in *Ipomoea asarifolia*

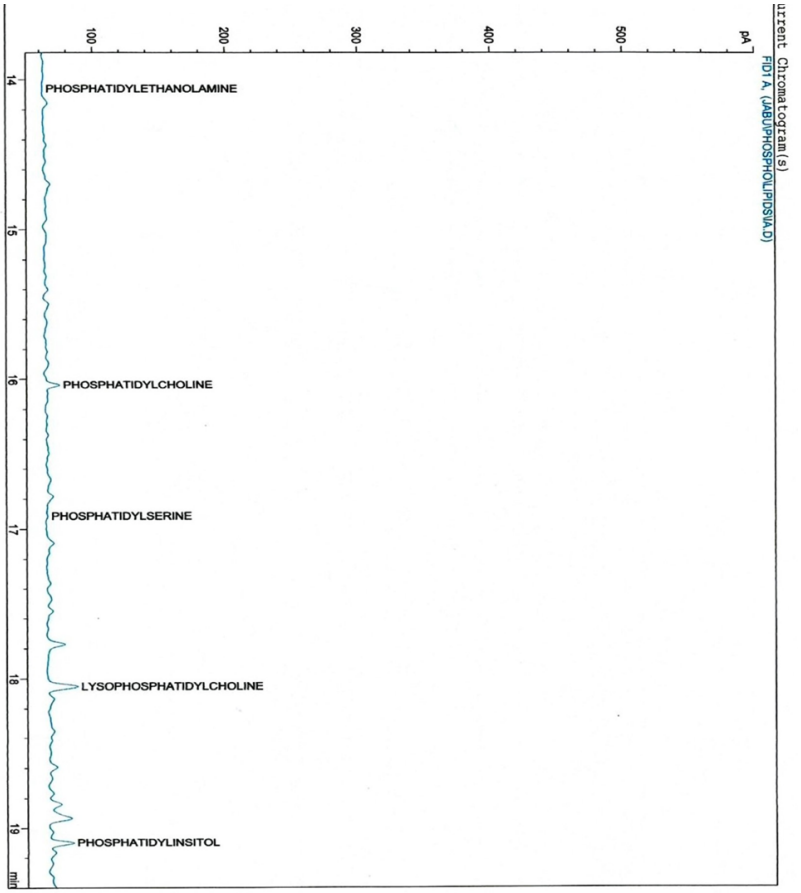

Fig 4. Chromatogram for phospholipid present in *Ipomoea asarifolia*

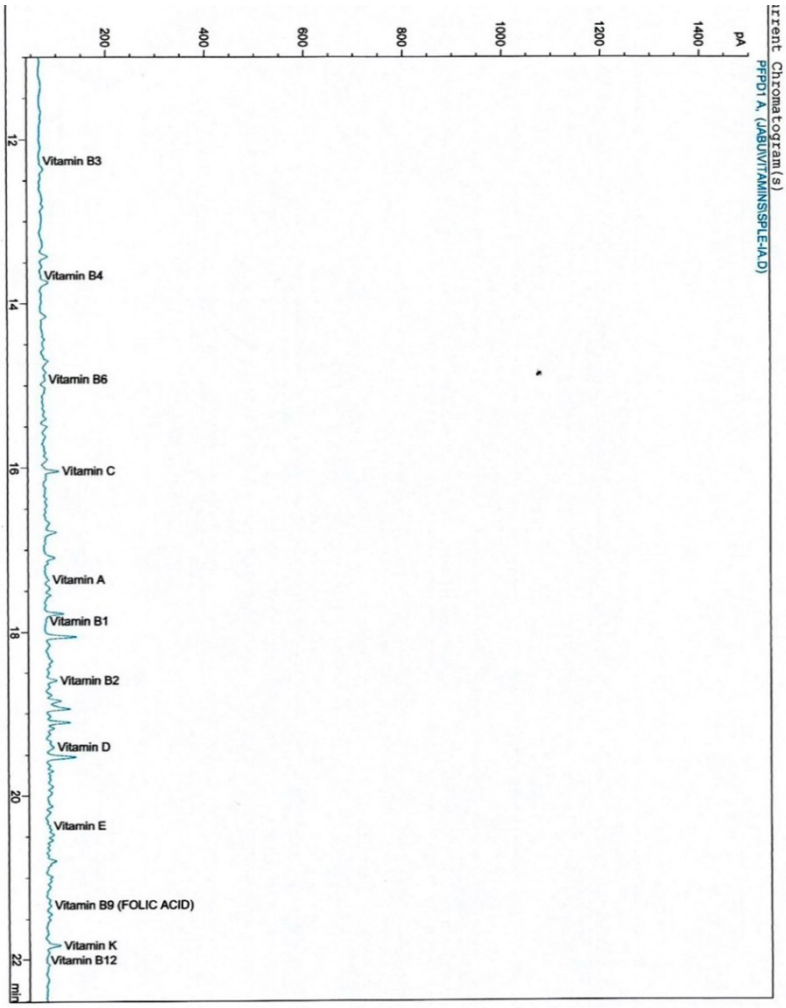

Fig 5. Chromatogram for bioactive vitamins present in *Ipomoea asarifolia*

4. DISCUSSION

The results obtained from this research work have clearly shown that the methanol extract of *I. asarifolia* (leaf, stem and whole plants) contain certain secondary metabolites such as saponin, tannin, flavonoids, phenol and alkaloids, which was earlier corroborated (Jegede et al., 2009). However, the presence of anthraquinones in the leaf of *I. asarifolia* from our study does not agree with Jegede et al. (2009). Phytochemical qualitative reports from Aliyu et al. (2011), on *I. asarifolia* leaf had similar results with our study except phenols, which were not reported in their study. In contrast to previous authors, this study reported the quantitative values of the phytochemicals. Leaf contains 0.49 mg/g, stem contains 0.62 mg/g, and whole plants contain 1.12 mg/g of alkaloids, whereas phenolics are 18.40 mg/g in leaf, 4.14 mg/g in stem, and 21.05 mg/g in whole plants.

Secondary metabolites in plants are responsible for their therapeutic activity, as reported by Cowan (1999) and Sibanda and Okoh (2007). Thus, the lower antibacterial activity of *I. asarifolia* observed can be attributed to the metabolites present. It is worth noting that the low antibacterial activity in this study could be due to the lower concentrations assayed as compared to works on medicinal plants using high concentrations.

The antibacterial activity of *I. asarifolia* methanol leaf extract as reported by Aliyu et al. (2011) using varying concentrations (12.5, 25, 50, 100, and 200 mg/mL) against *E. coli*, *S. aureus* and *P. aeruginosa* revealed the zone size inhibition ranging between 6.0 and 17.5mm against *S. aureus* (at 12.5, 25, 50, 100 mg/mL), zone size inhibition against *E. coli* ranges between 6.0 mm and 14.0 mm (at 200 mg/mL) while the zone size inhibition against *P. aeruginosa* was 6.0 mm on all the concentrations. This study had a similar trend using lower concentrations of the methanol extract of the leaf, and stem. However, in the present study, we observed that the whole plant had a zone-size antibacterial activity of 8 mm against *S. aureus* and *P. aeruginosa* for all the concentrations used which were not reported elsewhere.

As shown in Figure 6, the spectra of the leaves and stem are similar, with few variations. Characteristic absorption bands in the leaves and stem identified various functional groups. Strong absorption bands are seen in the leaves at 3419.95 cm^{-1} O–H stretch (Stuart, 2005), medium absorption bands are seen at 2923.53 cm^{-1} C–H stretch. These are asymmetrical stretching vibrations of methylene groups in lipids (Stuart, 2005; Zeier and Schreiber, 1999).

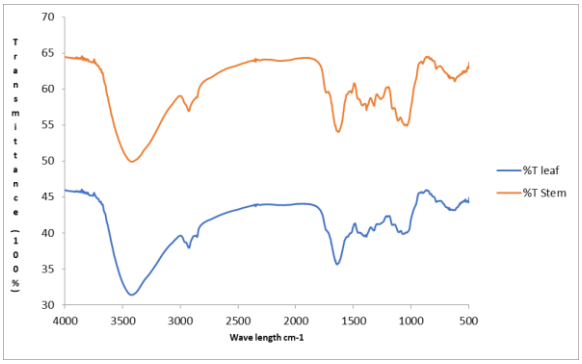

Fig. 6. FTIR spectra of leaf and stem of *Ipomoea asarifolia.*

The strong absorption band at 1637.83 cm^{-1} alkene C=C stretch indicates lignin (Morán et al., 2008), at 1384.64 cm^{-1} of methyl CH_3 group representing saturated aliphatic alkyl molecules. One type of OH in the bend plane is either a primary or secondary alcohol. Another type is linked to the C-O stretching mode of the C-OH groups of serine, threosine, and tyrosine in proteins (Fujioka et al., 2004). Finally, the C-F stretch is of aliphatic organohalogen compounds at 1064.03 cm^{-1}. The 892.65 cm^{-1} C-H is an out-of-plane bend for aromatics, while the 781.26 cm^{-1} and 620.60 cm^{-1} of C-Cl and C-Br stretch correspond to aliphatic organohalogen compounds (Nandiyanto et al., 2019). The spectrum of the stem shows absorption bands at 3416 cm^{-1} O-H stretch (Stuart, 2005), 2924.58 cm^{-1} C-H asymmetric and symmetric stretch of methylene groups in lipids (Stuart, 2005; Zeier and Schreiber, 1999), and 1627.33 cm^{-1} is indicative of oleifinic unsaturation in C=C bond stretching vibration (Morán et al., 2008). At 1384.30 $cm^{-1}$the methyl (CH_3) corresponds to a saturated alkyl group, while at 1318.47 cm^{-1}, the OH in the bend plane is a hydroxyl group of primary or secondary alcohol (Coates, 2000). At 1156 cm^{-1} is the C-N stretching in secondary amino acids of protein molecules (Coates, 2000). The fingerprint regions showed characteristic absorption bands at 1156.5 cm^{-1} C-N stretching of secondary amino acids, while 1053.9 cm^{-1} is indicative of C-O stretching coupled with C-O bending of the C-OH of carbohydrates (Wang et al., 1997). The weak absorption band at 895.58 cm^{-1} signifies C-H out of the plane bend of vinylidene compounds. Other absorption bands at 778.32 $cm^{-1}$and 618.89 cm^{-1} are C-Cl stretch and C-Br stretch, respectively, signifying the presence of aliphatic organohalogen compounds (Nandiyanto et al., 2019). The absorption band at 1731 cm^{-1} in the stem implies the presence of a carbonyl compound associated with the ester bond, while aldehyde is absent in the leaf (Coates, 2000). The presence of C-N stretch at 1200 cm^{-1} which is peculiar to tertiary amine in the leaf is however absent in the stem. Non-detection of absorption in the region 2300–1990 cm^{-1} of both samples implies the absence of nitrogen compounds such as cyanides (nitriles), cyanates, isocyanates, thiocyanates, and diazo compounds in the stem and leaf. The appearance of moderate to intense absorption bands within the range of 1600–1300, 1200–1000, and 800–600 cm^{-1} indicates a high amount of hydroxyl group compounds in the stem and leaf of *I. asarifolia* (Coates, 2000). The identified compounds revealed and confirmed that *I. asarifolia* is a very rich medicinal plant, and many of the compounds present have been verified in the literature to have great biological activities like anti-inflammatory, antidiabetic, anticancer, antimicrobial, antifungal, and antioxidant activities, among others (Asha et al., 2017). Owing to the paucity of information on this plant, further research into the use of purified bioactive compounds, their toxicological effects, and mechanisms of action on the host immune system should be considered.

5. CONCLUSION

The biological activities of compounds present in *Ipomoea asarifolia* leaf, stem and whole plant extracts form the basis for application of this plant in treating wound infection. The study revealed major bioactive compounds, vitamins and other phytonutrients present in the different parts of the plant extracts. Identification of these essential compounds, form the basis in determining possible health benefits of the plant, leading to further biologic and pharmacologic studies.

Significance Statement

This study discovered essential amino acids and phytonutrients that are necessary for human growth and development, can be beneficial for wound therapy, and serve as a good alternative to orthodox medicine. This study will help the researchers uncover the critical areas of mechanism of action, therapeutic dose, and toxic dose of *I. asarifolia*. Thus, the researchers can inevitably discover a new drug for animal and clinical trials.

ETHICAL APPROVAL

The authors wish to appreciate the University ethical committee for approving this study under the guidance of the Department of Plant Science and Biotechnology, Federal University Oye-Ekiti.

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CONFLICT OF INTEREST

The authors wish to declare that there is no conflict of interest on this study.

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