



INVESTIGATING THE ANTIMICROBIAL POTENTIAL OF EXTRACTS DERIVED FROM *CISSUS POPULNEA* STEMS

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ABSTRACT

Antimicrobial resistance poses a dire threat to public health, as it renders the once-effective antimicrobial agents ineffective against microbial infections and resistant pathogens can cause more severe and prolonged illnesses, leading to higher mortality rates and healthcare costs. *Cissus populnea* (Vitaceae) is used in traditional medicine to treat microbial infections, venereal diseases, infertility, and sore breast among others. The aim of the research is to investigate the antimicrobial potentials of *C. populnea* stem extracts against Methicillin-resistant *Staphylococcus aureus*, *Staphylococcus aureus*, Vancomycin-resistant *enterococcus*, *Escherichia coli*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Candida albicans*, *Aspergillus niger*, *Trichophyton rubrum* and *Trichophyton mentagrophyte*. The powdered stem of the plant was extracted with methanol and the resulting extract (MSE) was washed with hexane (HFS), chloroform (CFS), ethylacetate (EFS), n-Butanol (BFS) and methanol (MFS) to obtain the different fractions, respectively. Qualitative phytochemical screening of extract and fractions of *C. populnea* revealed the presence of various phytochemicals such as saponins, carbohydrates, tannins, flavonoids, anthraquinones, steroids and proteins which varies in the fractions. Agar well diffusion and broth dilution techniques were used to assess the antimicrobial activity of the extracts against the microorganisms; the extract and fractions of the plant exhibited zones of inhibition ranging from 19 – 24 mm against the test organisms with BFS being the most active fraction while HFS was the least active. This study validates the use of this plant in traditional medicine.

**Keywords:** antimicrobial resistance, *Cissus populnea*, extract, phytochemicals, Vitaceae.

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INTRODUCTION

Antimicrobial resistance (AMR) is a growing global health crisis, driven by the ability of microorganisms to develop resistance to antimicrobial agents, including antibiotics [1]. AMR poses a dire threat to public health, as it renders once-effective antimicrobial agents ineffective against bacterial infections and resistant pathogens can cause more severe and prolonged illnesses, leading to higher mortality rates and healthcare costs [2]. The urgency to address AMR has amplified the need for the discovery and development of new antimicrobial compounds. Novel antimicrobial agents are crucial to provide effective alternatives for treating infections caused by drug-resistant pathogens [3]. As microbes become increasingly resistant to existing treatments, the need for the discovery and development of new and effective antimicrobial compounds has become more urgent than ever.

Antimicrobials of plant origin have enormous therapeutic potential. They have been

used traditionally in the treatment of microbial infections among other ailments and have the advantage of being the cheapest and most effective alternative source of drugs with less side effects [4]. They are effective in the treatment of infectious diseases while simultaneously mitigating many of the side effects that are often associated with synthetic antimicrobials [5]. Any medicinal effects of plant materials typically result from the combinations of secondary products present in the plant. There are various medicinal plants which are traditionally used as antimicrobials.

*Cissus populnea* commonly known as food gum is a member of the Vitaceae family which consists of 14 genera with the genus *Cissus* being the largest. The plant is distributed across West Africa from the coast to the Sudan and Sahelian woodlands. Its geographical area spans Senegal, North and South Nigeria, to Sudan, Uganda and Mozambique. The plant is a woody climbing shrub, 8–10 cm long and 7.5 cm in diameter with a perennial root stock with jointed stems (Figure 1b), often with watery juice [6]. The plant is rich in bioactive compounds and widely used in West- African

traditional medicine [7]. The root extract of the plant is reportedly used for the management of skin diseases, boils, infected wounds [7], for the treatment of urinary tract infections [8], as an antidote for arrow poisoning and also as a cure for sore breast [9]. *C. populnea* is used in Niger, Kogi, Benue, Adamawa, Plateau and Kwara states of Nigeria for the postnatal stoppage of bleeding [10, 11]. The aqueous extract of the stem bark is used as a fertility enhancer in males in southern Nigeria [8]. A decoction of the stem with native natron is used in northern Nigeria to treat venereal diseases. Preparations from the root are used In Benin republic, it is used as a diuretic and in Ghana it is used as a post-harvest ethnobotanic protectant [12].

Biological studies revealed that essential oil from the stem powder possess antimicrobial properties [13], aqueous extract of the stem bark possess antioxidant property [14] and also improves spermatogenesis [15], root have anti-sickling [16], anthelmintic [17] and antimicrobial [18] properties. The root, stem, leaves and stem bark are reported to contain various phytochemicals including saponins, tannins, flavonoids and alkaloids [10, 11]. Bergenin, daucosterol, stigmasterol and  $\beta$ -sitosterol have been isolated from the root of *C. populnea* [18] and  $\beta$ -sitosterol was reported to have been isolated from the leaf of *C. populnea* [19]. Also, Alex-Asaolu et al. [6] reported the isolation of Bis-(2-ethyloctyl)-phthalate) and a mixture of stigmasterol and  $\beta$ -sitosterol from the stem of the plant. In this paper, we investigated the antimicrobial potential of extracts derived from *C. populnea* stems.

## MATERIALS AND METHODS

### Collection, identification and preparation of plant material

The plant material of *C. populnea* stem and leaves were collected from Ejinya-Eheche in Kogi state, Nigeria. It was identified via taxonomic means at the Herbarium section, Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto and a voucher specimen number UDUH/ANS/0841 was prepared and deposited. The stems were washed, air dried, pulverized to fine powder and stored at room temperature for use.

### Test microorganisms

The test microorganisms were obtained from stock cultures of the Department of Medical Microbiology, Ahmadu Bello University Teaching Hospital, Zaria. They included Methicillin-resistant *Staphylococcus aureus*, *Staphylococcus aureus*, Vancomycin-resistant *enterococcus*, *Escherichia coli*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Candida albicans*, *Aspergillus niger*, *Trichophyton rubrum* and

*Trichophyton mentagrophyte*. The cultures were maintained on nutrient agar slants for the bacterial species and Sabiraud's dextrose agar slants for the fungal species. They were sub cultured in nutrient broth and Sabiraud's dextrose liquid medium respectively 24 hours prior to testing.

### Extraction and partitioning of plant material

The powdered stem (1.2 kg) was extracted exhaustively by maceration using 15 L of 90% methanol for 7 days with constant agitation, and the extract obtained was freed from the solvent by evaporation under pressure with the aid of a rotary evaporator at 65°C to yield a reddish-brown residue (98.0 g), subsequently referred to as the methanol stem extract (MSE). The methanol stem extract (90.0 g) was found to be insoluble in water and thus was successively washed with n-hexane (1.5 L), chloroform (1 L), ethylacetate (1 L), n-butanol (2 L) and methanol (2L) to afford n-hexane (HFS) 4.65 g, chloroform (CFS) 0.56 g, ethyl acetate (EFS) 0.64 g, n-butanol (BFS) 4.82 g and methanol fraction (MFS) 40.23 g, respectively.

### Preliminary phytochemical screening

The preliminary phytochemical screening was carried out on the methanol stem extract (MSE) and the different fractions in order to identify the secondary metabolites present. This was carried out according to the methods described below;

**Test for Alkaloids:** The extract (0.5 g) was stirred with 5 cm<sup>3</sup> of 1 % aqueous hydrochloric acid on a water bath and filtered; few drops of freshly prepared Mayer's reagent were added and observed [20].

### Test for Flavonoids:

#### a) Ferric chloride test

To the extract (0.2 g), distilled water was added. A drop of ferric chloride was added to a solution of the extract and observed [20].

#### b) NaOH test

The extract (0.2 g) was dissolved in 10% aqueous NaOH solution, dilute HCl was added and observed [21].

### Test for Anthraquinones:

#### Bontrager's test

The extract (0.2 g) was stirred with 5 cm<sup>3</sup> of dilute hydrochloric acid and boiled on a water bath for 10 minutes. It was filtered, allowed to cool and shaken with chloroform for 5 minutes. The filtrate was shaken with equal volume of 10% ammonia and observed [22].

**Test for Saponins:** The extract (0.2 g) of the extract was shaken with distilled water in a test tube. It was allowed to stand for 10 minutes and observed [21].

**Test for Steroids and Triterpenes:**

**a) Liebermann-Burchard's test**

The extract (0.2 g) was dissolved in chloroform. Equal volume of acetic anhydride and concentrated  $\text{H}_2\text{SO}_4$  were added down the test tube and observed [21].

**b) Salkowski's test**

A small quantity of the extract was dissolved in 1  $\text{cm}^3$  chloroform and to it 1  $\text{cm}^3$  of concentrated  $\text{H}_2\text{SO}_4$  was added down the test tube and observed [23].

**Test for Tannin:**

**Lead Sub-acetate test**

The extract (0.2 g), distilled water was added; 3-5 drops of lead acetate solution was added and observed [21].

**Test for carbohydrates:**

**Molisch test**

To the extract (0.2 g), 2  $\text{cm}^3$  distilled water was added and mixed with a few drops of Molisch reagent, 1  $\text{cm}^3$  of concentrated  $\text{H}_2\text{SO}_4$  was carefully added down the side of the inclined test tube and observed [21].

**Fehling's test**

To the extract (0.2 g), 2  $\text{cm}^3$  distilled water was added followed by 2 drops of Fehling solution. It was boiled for 5 minutes and observed [21].

**Test for proteins:**

**Xanthoproteic test**

To the solution of the extract (0.2 g), 1  $\text{cm}^3$  of conc.  $\text{HNO}_3$  was added and mixed well and the solution was allowed to cool under tap water until it becomes yellow, after which 2  $\text{cm}^3$  of 40 % NaOH was added and orange color was observed [21].

**Antimicrobial Screening**

**Susceptibility test**

Antimicrobial activity of the methanol stem extract (MSE) and its n-butanol (BFS), methanol (MFS) and hexane (HFS) fractions was determined using Agar well diffusion method as described by Irshad *et al.* [24] and Yusuf *et al.* [25]. A quantity (0.05 g) each of the MSE, BFS, MFS and HFS was weighed and dissolved in 10  $\text{cm}^3$  of dimethyl sulfoxide (DMSO) to obtain a concentration of 5  $\text{mg}/\text{cm}^3$  each. This was the initial concentration used to determine the antimicrobial activity of the extracts and fractions. Mueller Hinton agar and Sabouraud dextrose agar was used as the growth media for the bacteria and fungi, respectively. The media were prepared according to the manufacturer's instructions, it was sterilized at 121°C for 15 minutes, poured into the sterile petri dishes and

were allowed to cool and solidify. The solidified medium was inoculated with 0.1  $\text{cm}^3$  of standard inoculum of the test microbe; the inoculum was spread evenly over the surface of the medium by the use of a sterile swab. Standard sterile cork-borer of 6 mm in diameter was used to bore a well at the center of each inoculated medium, the bottom of the wells was sealed with molten agar and allowed to solidify. The wells were filled with 0.1  $\text{cm}^3$  of the solution of the extract and allowed to diffuse for 1 hour. Incubation of the inoculated medium was made at 37°C for 24 hours for bacteria and at 30°C for 1-7 days for fungi. Ciprofloxacin, fulcin and fluconazole discs were used as reference antimicrobials. The tests were conducted in duplicates and the zones of inhibition around the wells were measured in millimeter and used as an assessment of antimicrobial activity.

**Minimum inhibitory concentration (MIC)**

The minimum inhibitory concentration (MIC) for each microbial sample was determined by Broth dilution technique [25]. Mueller Hinton broth and Sabouraud's dextrose broth were prepared according to the manufacturer's instruction; the medium was dispensed in screw-capped test tubes and sterilized at 121°C for 15 minutes and allowed to cool. McFarland's turbidity standard scale number 0.5 was prepared by adding 0.05  $\text{cm}^3$  of a solution of 1.175% barium chloride dehydrate ( $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ ) to 9.95  $\text{cm}^3$  of 1 % sulphuric acid ( $\text{H}_2\text{SO}_4$ ). Normal saline was prepared by dissolving 9 g of sodium chloride (NaCl) in 1  $\text{dm}^3$  of distilled water, 10  $\text{cm}^3$  of the prepared solution was dispensed into sterile test tubes and the test microbes were inoculated and incubated at 37°C for 6 h. The cultures were standardized using 0.5 McFarland Standard. Two-fold serial dilution of the extract was done in the sterile broth to obtain concentrations of 5, 2.5, 1.25, 0.63 and 0.31  $\text{mg}/\text{cm}^3$  for the extracts and fractions. Having obtained the different concentrations of the samples in the sterile broth, 0.1  $\text{cm}^3$  of the standardized test microbe was then inoculated into the different samples. Incubation was made at 37°C for 24 h for the bacteria and at 30°C for 48 hours for fungi. The test tubes containing the inoculated broth were observed for turbidity (growth) the lowest concentration of the extract in the sterile broth which shows no turbidity was recorded as the minimum inhibition concentration.

**Minimum bactericidal/ fungicidal concentration (MBC/MFC)**

The minimum bactericidal/ fungicidal concentration was carried out to determine whether the test microbes were killed or only their growth was inhibited [25]. Mueller Hinton agar and Sabouraud dextrose agar were prepared, sterilized at 121°C for 15 minutes and transferred into sterile petri dishes to cool and solidify.

The contents of the MIC in the serial dilutions were sub-cultured into the prepared media and incubated at 37°C for 24 h and at 30°C, for 72 h for the bacteria and fungi respectively. The plates were observed for colony growth; the MBC/MFC was the plates with the lowest concentration of the extract in serial dilution without colony growth.

## RESULTS

### Qualitative phytochemical screening of *C. populnea* stem extracts

The preliminary phytochemical screening of crude methanol stem extract of *C. populnea*, and its n-butanol and hexane fractions of revealed various secondary metabolites as presented in Table 1.

**Table 1:** Qualitative phytochemical constituents of the *C. populnea* stem extracts

Test	Observation	MSE	Inference BFS	HFS	MFS
<b>Saponins</b> (Frothing)	Persistence of froth	+	+	+	+
<b>Carbohydrates</b> (Fehling's)	Reddish-brown precipitate	++	++	++	++
(Molisch)	Violet ring	++	+	+	+
<b>Tannins</b> (FeCl <sub>3</sub> )	Blue-green color	+	+	+	+
<b>Flavonoids</b> (FeCl <sub>3</sub> )	Yellow fluorescence	+	+	-	+
(Alkaline)	Deep-yellow colour which fade	++	++	-	+
<b>Alkaloids</b> (Mayer)	Creamy white precipitate	-	-	-	-
<b>Anthraquinones</b> (NH <sub>4</sub> OH)	Rose red colour	+++	++	-	++
<b>Steroids</b> (Salkowski)	Reddish ring	++	+	+	+
(Lieberman-Burchard)	Violet blue colour which changes to green	++	++	++	++
<b>Proteins</b> (Xanthoproteic)	Yellow to orange colour	+	+	-	+

**Key:** +++ = highly present, ++ = moderately present, + = present, - = absent, HFS= hexane fraction, BFS= n-butanol fraction and MSE= methanol stem extract

### Susceptibility test of *C. populnea* stem extracts against the test microbes

Susceptibility test results of the methanol stem extract *C. populnea* and its n-butanol, methanol and hexane fractions against the test microbes are presented in Table 2. Methicillin Resistant *Staphylococcus aureus*, *Bacillus subtilis*, *Pseudomonas aeruginosa* and *Aspergillus niger* were resistant while the others were susceptible.

### Zone of inhibition of *C. populnea* stem extract against the test organisms

The mean zones of inhibition of *C. populnea* stem extracts against the test microorganisms are presented in Table 3. The extract and fractions of the plant exhibited zone of inhibition ranging from 19 – 24 mm against the test organisms with n-butanol fraction as the most active fraction (20-24 mm) while hexane fraction was the least active (19-23 mm). The standard drugs, Ciprofloxacin had 27 – 37 mm while Fluconazole and Fulcin exhibited zone of inhibition ranging from 34 mm and 29 – 32 mm, respectively.

### MIC of *C. populnea* stem extracts against the test organisms

The minimum inhibitory concentration of the crude methanol stem extract *C. populnea* ranges from 1.25 – 2.5 mg/cm<sup>3</sup>; the n-butanol and methanol fractions had an MIC value of 1.25 mg/cm<sup>3</sup> while that of hexane fraction ranges from 1.25 – 2.5 mg/cm<sup>3</sup> (Table 4).

### MBC and MFC of *C. populnea* extracts against the test organism

The minimum bactericidal/fungicidal concentration of the crude methanol stem extract, n-butanol and hexane fraction ranges from 2.5 – 5 mg/cm<sup>3</sup> while the methanol fraction had an MBC/MFC value of 5 mg/cm<sup>3</sup> (Table 5).

**Table 2:** Susceptibility test of *C. populnea* stem extracts against the test microbes

Test Organism	MSE	BFS	MFS	HFS	Cipro	Fluco	Fulcin
Methicillin Resistant <i>Staphylococcus aureus</i>	R	R	R	R	R	R	R
<i>Staphylococcus aureus</i>	S	S	S	S	R	R	R
Vancomycin resistant <i>enterococci</i>	S	S	S	S	S	R	R
<i>Escherichia coli</i>	S	S	S	S	S	R	R
<i>Bacillus subtilis</i>	R	R	R	R	R	R	R
<i>Pseudomonas aeruginosa</i>	R	R	R	R	S	R	R
<i>Candida albicans</i>	S	S	S	S	R	S	R
<i>Aspergillus niger</i>	R	R	R	R	R	R	S
<i>Trichophyton rubrum</i>	S	S	S	S	R	R	S
<i>Trichophyton mentagrophyte</i>	S	S	S	S	R	R	S

KEY: S=Sensitive; R= Resistant; Cipro=Ciprofloxacin; Fluco=Fluconazole

**Table 3:** Zone of Inhibition of *C. populnea* stem extract against the Test organism

Test Organism	MSE	BFS	MFS	HFS	Cipro	Fluco	Fulcin
Methicillin Resistant <i>Staph aureus</i>	0	0	0	0	0	0	0
<i>Staphylococcus aureus</i>	20	21	20	23	0	0	0
Vancomycin resistant <i>enterococci</i>	22	20	21	19	29	0	0
<i>Escherichia coli</i>	23	20	21	20	37	0	0
<i>Bacillus subtilis</i>	0	0	0	0	0	0	0
<i>Pseudomonas aeruginosa</i>	0	0	0	0	27	0	0

<i>Candida albicans</i>	20	24	22	19	0	34	0
<i>Aspergillus niger</i>	0	0	0	0	0	0	29
<i>Trichophyton rubrum</i>	19	22	20	19	0	0	32
<i>Trichophyton mentagrophyte</i>	20	21	23	19	0	0	30

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KEY: Cipro=Ciprofloxacin; Fluco=Fluconazole

**Table 4:** Minimum Inhibitory Concentration of *C. populnea* extract against the test microorganisms

Test Organism	MSE					BFS					MFS					HFS				
	5mg/cm <sup>3</sup>	2.5mg/cm <sup>3</sup>	1.25mg/cm <sup>3</sup>	0.63mg/cm <sup>3</sup>	0.31mg/cm <sup>3</sup>	5mg/cm <sup>3</sup>	2.5mg/cm <sup>3</sup>	1.25mg/cm <sup>3</sup>	0.63mg/cm <sup>3</sup>	0.31mg/cm <sup>3</sup>	5mg/cm <sup>3</sup>	2.5mg/cm <sup>3</sup>	1.25mg/cm <sup>3</sup>	0.63mg/cm <sup>3</sup>	0.31mg/cm <sup>3</sup>	5mg/cm <sup>3</sup>	2.5mg/cm <sup>3</sup>	1.25mg/cm <sup>3</sup>	0.63mg/cm <sup>3</sup>	0.31mg/cm <sup>3</sup>
<i>S. aureus</i>	-	-	0*	+	++	-	-	0*	+	++	-	-	0*	+	++	-	-	0*	+	++
<i>VRE</i>	-	-	0*	+	++	-	-	0*	+	++	-	-	0*	+	++	-	0*	+	++	++
<i>E. coli</i>	-	-	0*	+	++	-	-	0*	+	++	-	-	0*	+	++	-	-	0*	+	++
<i>C. albicans</i>	-	-	0*	+	++	-	-	0*	+	++	-	-	0*	+	++	-	0*	+	++	++
<i>T. rubrum</i>	-	0*	+	++	++	-	-	0*	+	++	-	-	0*	+	++	-	0*	+	++	++
<i>T. mentagrophyte</i>	-	-	0*	+	++	-	-	0*	+	++	-	-	0*	+	++	-	0*	+	++	++

**Key:** - = No turbidity (no growth); 0\*=MIC; + = Turbid (light growth); ++ = Moderate turbidity; +++ = High turbidity. MSE = Crude methanol stem extract of *C. populnea*; BFS = n-Butanol fraction; MFS = Methanol fraction; HFS = n-Hexane fraction.

**Table 5:** Minimum Bactericidal and Fungicidal Concentration of the *C. populnea* extract against the test microorganisms

Test Organism	MSE					BFS					MFS					HFS				
	5mg/cm <sup>3</sup>	2.5mg/cm <sup>3</sup>	1.25mg/cm <sup>3</sup>	0.63mg/cm <sup>3</sup>	0.31mg/cm <sup>3</sup>	5mg/cm <sup>3</sup>	2.5mg/cm <sup>3</sup>	1.25mg/cm <sup>3</sup>	0.63mg/cm <sup>3</sup>	0.31mg/cm <sup>3</sup>	5mg/cm <sup>3</sup>	2.5mg/cm <sup>3</sup>	1.25mg/cm <sup>3</sup>	0.63mg/cm <sup>3</sup>	0.31mg/cm <sup>3</sup>	5mg/cm <sup>3</sup>	2.5mg/cm <sup>3</sup>	1.25mg/cm <sup>3</sup>	0.63mg/cm <sup>3</sup>	0.31mg/cm <sup>3</sup>
<i>S. aureus</i>	0*	+	++	++	++	0*	+	++	++	++	0*	+	++	++	++	-	0*	+	++	+++
<i>VRE</i>	0*	+	++	++	++	0*	+	++	++	++	0*	+	++	++	++	0*	+	++	++	++
<i>E. coli</i>	-	0*	+	++	+++	0*	+	++	++	++	0*	+	++	++	++	0*	+	++	++	++
<i>C. albicans</i>	0*	+	++	++	++	-	0*	+	++	+++	0*	+	++	++	++	0*	+	++	++	++
<i>T. rubrum</i>	0*	+	++	++	++	0*	+	++	++	++	0*	+	++	++	++	0*	+	++	++	++
<i>T. mentagrophyte</i>	0*	+	++	++	++	0*	+	++	++	++	0*	+	++	++	++	0*	+	++	++	++

**Key:** - = No Colony Growth; 0\* = MBC/MFC; + = Scanty colonies growth; ++ = Moderate colonies growth; +++ = Heavy colonies growth. MSE = Crude methanol stem extract of *C. populnea*; BFS = n-Butanol fraction; MFS = Methanol fraction; HFS = n-Hexane fraction.



## DISCUSSION

The preliminary phytochemical test revealed the presence of saponins, carbohydrates, tannins, flavonoids, anthraquinones, steroids and proteins in the crude methanol stem extract and n-butanol fraction of *C. populnea*, while the hexane fraction indicated the presence of saponins, carbohydrates, tanins and steroids. The constituents were with similar to those reported for other related species [26]. These secondary metabolites are responsible for the pharmacological action of medicinal plant species [27, 28, 29].

The results obtained from this study showed that the crude methanol stem extract of *C. populnea* and its various fractions possess good antibacterial and antifungal activities against *Staphylococcus aureus*, Vancomycin resistant *enterococci*, *Escherichia coli*, *Candida albicans*, *Trichophyton rubrum*, *Trichophyton mentagrophyte*. The extract and fractions of *C. populnea* exhibited varying degree of antimicrobial effect against the test organisms. The susceptibility tests result showed inhibition range of 19-24mm against *Staphylococcus aureus*, Vancomycin-resistant *enterococcus*, *Escherichia coli*, *Candida albicans*, *Trichophyton rubrum* and *Trichophyton mentagrophyte*. BFS was the fraction with the highest activity with *C. albicans* as the most sensitive organism (MIC 24 mm) while HFS was the least active fraction with the lowest MIC value (19 mm) for VRE, *C. albicans*, *T. rubrum* and *T. mentagrophyte*. However, HFS had the best activity against *S. aureus* than the other fractions. No activity was observed against MRSA, *B. subtilis*, *P. aeruginosa* and *Aspergillus niger*. This concurs with the result of an earlier study on the antimicrobial activity of the essential oil from the plant as reported by [13]; however, the oil did not show activity against *Candida albicans*. Related species, such as *Cissus quadrangularis* have also been reported to exhibit good antimicrobial activity [30, 31]. The standard antibacterial drug Ciprofloxacin had inhibitory activity against three of the tested bacteria species; *S. aureus*, *E. coli* and *P. aeruginosa*. The standard antifungal drugs fluconazole inhibited only *C. albicans* while fulcin inhibited three fungi species tested; *Aspergillus niger*, *T. rubrum* and *T. mentagrophyte*. The minimum inhibitory concentration (MIC) range of the crude methanol stem extract and the hexane fraction was 1.25 – 2.5 mg/cm<sup>3</sup> while the n-butanol and methanol fractions had an MIC value of 1.25 mg/cm<sup>3</sup>. The low MIC values suggest good activity of the extract against the test organisms. The Minimum Bactericidal/Fungicidal Concentration (MBC/MFC) range was 2.5 – 5 mg/cm<sup>3</sup> for the crude methanol stem extract, n-butanol and hexane fractions while the methanol fraction had an MBC/MFC value of 5 mg/cm<sup>3</sup> against the test organisms. This further established that

the extract has antimicrobial activity against the susceptible organisms. *S. aureus*, a Gram-positive bacterium which can cause superficial skin lesions, localized abscesses and other infections such as pneumonia, sepsis, and toxic shock syndrome [32] was resistant to the standard antibacterial drug ciprofloxacin but was sensitive to *C. populnea* stem extract and all its fractions. *E. coli*, is a causative agent for stomach cramps, bloody diarrhea and vomiting [33]. Likewise, *C. albicans* can cause candidiasis [34] and trichophyton is a potential cause of chronic fungal wound infection [35]; The broad antimicrobial activity recorded in this study may be due to the presence of potent secondary metabolites detected in the plant [36, 37]. These phytochemicals have been demonstrated in several literatures to exert antimicrobial activities via a number of diverse mechanisms like intercalation of DNA, destruction of cell membrane, inactivation of microbial adhesions and enzymes [5, 38, 39].

## CONCLUSION

In conclusion, the stem of *Cissus populnea* contains bioactive secondary metabolites such as saponins, carbohydrates, tannins, flavonoids, anthraquinones, steroids and proteins with antimicrobial activity. *C. Populnea* exhibited good antimicrobial activity against the test organisms and thus, the plant can be studied further in order to isolate and characterize the bioactive compounds responsible for the observed effect.

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