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Phytochemical Distribution and Antimicrobial Sensitivity of *Sapium ellipticum* (Hochst.) Pax Leaf Extracts

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Authors' contributions

This study was collectively carried out by all authors listed. Authors OMI and OAA designed the study and researched the analytical methods used in the study. Authors OMI, JAP and SAA were actively involved in the analyses of the study. The first and final draft of the manuscript was written by author OMI and was approved by all authors.

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ABSTRACT

In this study, different extract fractions (aqueous, ethanol, methanol, hexane, diethyl ether and chloroform) of *Sapium ellipticum* (SE) leaf obtained by cold extraction method were screened for phytochemicals, and antimicrobial sensitivity. The percentage yield of extract was highest in methanol fraction (22.8%) and lowest in chloroform (3.64%). Flavonoids, steroids, tannins, glycosides, terpenoids, alkaloids, phenols, anthraquinones and cardiac glycosides were collectively observed in the fractions. More phytochemicals were observed in ethanol fraction than other fractions. Quantitative estimation of the powdered leaf sample showed 10.8±0.54% flavonoids, 9.24±0.12% alkaloids, 7.26±1.01% tannins, 1.63±0.14% glycosides and 74.2±3.12mgGAE/g total phenols. Eight human pathogenic microbes (four bacteria, three fungi and yeast) were used to evaluate the antimicrobial sensitivity of the different extract fractions using agar well diffusion

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method. A broad spectrum antimicrobial efficacy was observed in the relatively more polar fractions (ethanol, methanol and aqueous), with ethanol having the highest potency (minimum inhibitory concentration range of 6.25-50 $mgmL^{-1}$) on the microorganism strains for which the fractions were reactive. Conversely, the less polar fractions (diethyl ether, chloroform and hexane) were largely resisted by the microbial isolates. Only methanol and ethanol fractions were effective against yeast growth. Except for *penicillin camemberti* which was slightly sensitive to ethanol extract, the fungal isolates generally resisted the investigated fractions. Overall, findings from this study indicates that polar solvents extracts of *Sapium ellipticum*, particular ethanol fraction are rich in arrays of phytochemicals, and are capable of eliciting strong antibacterial activities, as much as 113-375% potency in comparison to Sensitive Disk Test (SDT) containing known antimicrobial drugs such as Ofloxacine (OFL), Gentamycin (GEN), Chloramphenicol (CHL), Ciprofloxacin (CIP) and cephalexin (CXC).

Keywords: Phytochemicals; antimicrobial; Sapium ellipticum; pathogenic microbes; sensitive disk test.

1. INTRODUCTION

Appreciable number of plant materials locally acclaimed to possess medicinal significance have been investigated and ascertained to be effective in the treatments of ailments to which several orthodox drugs have been impotent or less active. The efficacy, relatively lower cost and reduced incidence of major side effects associated with the use of herbs have greatly encouraged the screening of more plants for medicinal usefulness. *Sapium ellipticum* (Hochst.) Pax (family *Euphorbiaceae)* is commonly referred to as jumping seed tree. It is a small to medium-sized, semi-deciduous tree up to 12 m in height, occasionally reaching 20-25 m (max. 35 m). The specific name '*ellipticum*' refers to the shape of the leaves, which are often elliptic, dark green, glossy and alternate.The plant is common on the outskirts of evergreen forest and in wooded ravines. It is widely distributed in Eastern Africa and tropical Africa. In southwest part of Nigeria, particularly among the Ilorin indigenes, the plant is popularly known as *aloko-ẹgbọ.* According to Burkill [1,2], a number of pharmacological effects have been traditionally associated with the plant: A preparation of dried leaves of *S. ellipticum* is applied to wounds in Tanzania, the leaf preparation is also used for sore-eyes and abdominal swelling. In Central Africa, the decoction of the stem bark is used for scurvy and stomatitis, as purgative in Congo and for treatment of eczema. Interestingly, it is believed to be a cure for stammering in Zaire. In Tanganyika, a leaf-preparation is used to relieve pains in the head, chest, shoulders and back. A root-concoction is prepared as a fomentation in East Africa for enlarged spleen in babies and is taken by adults for malaria.

Adesegun et al. [3] credited substantial antioxidant properties to the stem bark extract of the plant. Cytotoxicity screening of selected Nigerian plants used in traditional cancer treatment on HT29 (colon cancer) and MCF-7 (breast cancer) cell lines indicated that *Sapium ellipticum* leaf extract expressed the highest cytotoxic activity among other plants with anticancer potential [4]. The bioactive molecules present in different parts of plants are responsible for the definite medicinal or pharmacological response they elicit in humans [5,6,7]. Up till the time of this report, and from available scientific findings, there are no published data on the phytochemical constituents and antimicrobial potency of *Sapium ellipticum* leaf extract. Hence, part of the focus of this study was to investigate the phytochemical profile of different extracts of the plant leaf. Over the years, antibiotics have been the main therapeutic options in the treatment of microbial infections. However, multidrug resistance by pathogenic microbes is increasingly becoming a major clinical and health care challenge worldwide. Thus, it is imperative to explore possible alternative sources of clinically effective antimicrobial agents. This is what necessitates the second objective of this work, which was to evaluate the antimicrobial sensitivity of different leaf extracts of the plant, using pathogenic microbes which have been in implicated in the aetiology and progression of different microbial infections or diseases.

2. MATERIALS AND METHODS

2.1 Collection of *Sapium ellipticum* and Preparation of Leaf Extracts

Fresh *Sapium ellipcitum* leaves were harvested in the month December, 2012 from a forest in a

suburb of Ibadan, southwest of Nigeria. The harvested leaves were taxonomically authenticated by a botanist (Mr. T.K. Odewo) at the Lagos University Herbarium (LUH), Nigeria, were a specimen was deposited to obtain a voucher specimen number, LUH 5423. The plant material was freed of extraneous materials; air dried at room temperature and was milled into a fine powder with a milling machine. Different extract fractions were prepared by macerating 50 gram of the dried powdery sample in 300 mL of each extracting solvent (distilled water, methanol, ethanol, hexane, chloroform and diethyl ether) at room temperature. The mixture was allowed to stand for 72h and stirred intermittently to facilitate extraction. The mixture was sieved using a muslin cloth of mesh size, 42. The resulting volume on sieving was reduced with a rotary evaporator. Final solvent elimination and drying was done using a water bath at 40°C. The percentage yield of extracts of the different extracting solvents was calculated and the crude extracts were used, without further purification.

2.2 Qualitative and Quantitative Phytochemical Study

Standard procedures as described by Kapoor et al. [8], Harbone [9,10], Smolenski et al. [11], Boham and Kocipal- Abyazan [12], Van-Burden and Robison [13], Trease and Evans [14], Sofowara [15], Singleton et al. [16], Edeoga, [6] were used with some modifications to detect and estimate the phytochemicals present in the different extract fractions of the plant.

2.2.1 Qualitative phytochemical analysis

2.2.1.1 Test for flavonoids

0.5 g of extract was heated with 10 ml of ethyl acetate over a steam bath for 3 min. The mixture was filtered and 4 ml of the filtrate was shaken with 1 ml of dilute ammonia solution and few drops of concentrated H_2SO_4. Yellow coloration shows the presence of flavonoids.

2.2.1.2 Test for alkaloids

0.5 g of extract was treated with 5 mL of aqueous 1% Hydrochloric acid on a boiling water bath for 20 minutes. The resulting mixture was centrifuged for 10 minutes at 3000 rpm. 1 mL of the filtrate was treated with few drops of Wagner's reagent. A reddish brown color was taken as a positive result.

2.2.1.3 Test for saponins

0.5 g of extract was boiled in 5mL of distilled water and filtered. 2.5mL of the filtrate was mixed with 1.5 mL of distilled water and shaken vigorously. Appearance of a stable or persistent froth indicates the presence of saponins. Any observed frothing is mixed with three drops of olive oil and shaken vigorously with water in a test tube and warmed in a water bath for formation of emulsion. This further confirms the presence of saponins.

2.2.1.4 Test for tannins

0.5 g of extract was boiled with 10 mL of distilled water in a test tube. The mixture was filtered and ferric chloride reagent was added to the filtrate, a blue-black precipitate was taken as evidence for the presence of tannin.

2.2.1.5 Test for terpenoids

1.0 g of extract dissolved in 2 mL of the extracting solvent. 2 mL of the solution was treated with 1 mL of 2, 4-dinitrophenyl hydrazine dissolved in 100 mL of 2M HCl. A yellow-orange coloration was observed as an indication of terpenoids.

2.2.1.6 Test for phlobatannins

1.0g extract was boiled in 1% aqueous hydrochloric acid (HCl) in a test tube on a water bath. A deposition of red precipitate was taken as evidence for phlobatannins.

2.2.1.7 Test for steroids

0.5 g of extract was dissolved in 2 mL of the extracting solvent. 1 ml of the solution was treated with 2 mL of acetic acid anhydride and cooled on ice. The mixture was mixed with 0.5 mL of chloroform, and 1 mL of concentrated H_2SO_4 was then added carefully by means of a pipette. At the separations level of the two liquids, a reddish-brown ring is an indication of the presence of steroids.

2.2.1.8 Test for glycosides/reducing sugar

1.0 g of extract was dissolved in 2mL of the extracting solvent in a test tube. 2.5 mL of 5% HCl and 2.5 mL 5% NaOH were successively added. The mixture was vigorously stirred and 5 mL of Fehling's solution B was added and the entire mixture was boiled on a water bath for 5 minutes to observe a brick red precipitate as an indication for the presence of glycosides.

2.2.1.9 Test for anthraquinones

0.5 g of extract was shaken with 10 mL of benzene and was filtered. 5 ml of 10% ammonia solution was added to the filtrate and the mixture was shaken well. The presence of violet color or pink red in the layer phase indicated the presence of the anthraquinones.

2.2.1.10 Test for phenols

0.5 g of extract was boiled with 2mL of distilled water in a test tube on a water bath. This was filtered and 10% ferric chloride reagent was added to the filtrate, a blue-black coloration was taken as a positive result for phenols.

2.2.1.11 Test for cardiac glycosides

0.5 g of extract was treated with 2 mL glacial acetic acid containing one drop of ferric chloride solution. This was under laid with 1 mL of concentrated H_2SO_4. A brown ring at the interface indicates a de-oxy sugar characteristic of cardenolides. A violet ring may appear below the brown ring, while in the acetic acid layer, a greenish ring may form just gradually throughout the thin layer.

2.2.2 Quantitative estimation of phytochemicals

The quantitative estimations of phytochemicals were carried out on the leaf powdered specimen of the plant.

2.2.2.1 Alkaloid estimation

The method of Harbone [10] was used. 200 mL of 10% acetic acid was added to 5 g of the plant sample contained in a beaker, covered with foil and allowed to stand for 4h. The mixture was filtered and the resulting volume (filtrate) was reduced on a water bath to one-quarter of its original volume. Concentrated ammonium hydroxide was added drop wise to the filtrate until precipitation was complete. The mixture was allowed to settle and the precipitate was collected and washed with dilute ammonium hydroxide and then filtered. The weight of the dry precipitate was determined and is equivalent to amount of alkaloids present in the sample.

2.2.2.2 Flavonoids estimation

10 g of crude powder was extracted repeatedly with 100 mL of 80% aqueous methanol at room temperature. The whole solution was filtered through Whatman filter paper No. 42 (125 m). The filtrate was later transferred into a weighed crucible, evaporated to dryness and weighed to a constant weight. The weight of the dry residue by difference was taken as the weight of flavonoids.

2.2.2.3 Tannin estimation

The amount of tannin in the powdered sample was determined by the method of Van-Burden and Robison [13]. 0.5 g of the plant material was weighed into a 50 mL plastic bottle. 50mL of distilled water was added and shaken for 1h in a mechanical shaker. The mixture was filtered into a 50 mL volumetric flask and made up to the mark. The 5 mL of the filtrate was pipette out into a test tube and mixed with 2 mL of 0.1M $FeCl_3$ in 0.1M HCl and 0.008M potassium ferrocyanide. After 10 minutes the absorbance was measured at 615 nm in a spectrophotometer. Tannic acid was used as a standard. Serial dilution of 20 mg/mL of the standard was made to obtain a calibration curve. Tannin value was determined from the calibration concentration curve.

2.2.2.4 Total phenol estimation

Total phenol content was estimated according to the method of Singleton et al. [16] using Folin-Ciocalteu reagent. The extract (100 mg mL-1, 1.0 mL) was mixed thoroughly with 5 mL Folin-Ciocalteu reagent (diluted ten-fold) and after 5 min, 4.0 mL of sodium carbonate (0.7 M) was added and the mixture was allowed to stand for 1h with intermittent shaking. The absorbance was measured at 765 nm in a spectrophotometer. Gallic acid was used as a standard. Serial dilution of 10 mg/mL of the standard was made to obtain a calibration curve. Total phenol was determined from the calibration concentration curve as gallic acid equivalent (GAE).

2.2.2.5 Glycosides estimation

2 g of the powdered sample was boiled with 95% ethanol for 2 minutes. The resulting mixture was filtered and cooled. The filtrate was diluted with 5mL of water and 3 drops of strong solution of lead acetate was added. This was filtered after mixing thoroughly into a pre-weighed crucible. The filtrate was concentrated to dryness and the residue is taken as glycosides.

2.3 Antimicrobial Sensitivity Test

2.3.1 Test microorganisms

The clinical microbial isolates used in this study were obtained from the Laboratory unit,

Department of Medical Microbiology, University College Hospital (UCH), Ibadan, Nigeria. They include *Staphylococcus epidermidis*, *Proteus mirabilis, Pseudomonas aeruginosa*, *Escherichia coli Aspergillus niger, Aspergillus flavus, Penicillicin camemberti and Saccharomyce cerevisae.*

2.3.2 Antimicrobial assay

The antibacterial and antifungal activities (antimicrobial sensitivity) of the extract fractions were determined using the agar well diffusion technique [17]. This method depends on the diffusion of antimicrobial agent from cavity through the solid medium in the plates such that growth of the cultured organism is restricted for a zone, thereby forming a circular area around the antimicrobial agent. The observed cleared zone and the diameter of such clearance is directly proportional to the efficacy of the antimicrobial agent [18].100 mg/mL of each extract fraction was used as the highest extract concentration. This was obtained by dissolving 1 g of the extract in 10 mL of the extracting solvent. 50 mg/mL, 25 mg/mL, 12.5 mg/mL, 6.25 mg/mL, and 3.01 mg/mL test solutions were subsequently prepared by serial dilution, using the extracting solvent as diluents in each case. The culture media used were carefully handled and prepared according to the manufacturer's instruction. They were all commercial products of Oxoid Ltd Company, England. Each of the test organisms (0.1 mL of standardized test organism of microbial cells) was streaked on the solid nutrient agar plates until it covered the plates using sterile inoculating loop. A sterile cork borer of 8mm in diameter was used to cut deep uniform wells into the agar gel. Each well was then filled with 0.1 mL of different concentrations of each extract fraction. The plates were allowed to stand for 45 minutes at room temperature to allow proper diffusion after which they were incubated for 24 and 48 h at 37°C. In the same manner, control experiments were set up using each of the extracting solvents (without extracts). The diameter of the zones of clearance around each well was measured in millimeter (mm). The effective inhibition by each extract fraction was determined by subtracting any inhibition observed in the corresponding control experiment. The least extract concentration with inhibitory clear zone of above 6mm diameter is considered as minimum inhibitory concentration (MIC) [19,20]. Sensitivity Test Disc (STD) was also used side by side to compare the degree of clearance by the test fractions.

3. RESULTS AND DISCUSSION

3.1 Percentage Yield and Phytochemicals in Leaf Extracts of *Sapium ellipticum*

Different parts of various plants are best extracted with certain solvents (organic/inorganic, polar/non-polar or mixed solvents in a particular ratio. This knowledge is pertinent to the full utilization of their medicinal and nutritional potentials. Akinpelu and Obutor [21] suggested that different solvent extracts of the same plant may exhibit different medicinal values.

The percentage yield of the various extract fractions of *S. ellipticum* leaves are shown in Fig. 1. Among the solvents used for extraction, methanol produced the highest yield of extract (22.8%). This was followed by ethanol and water, with 20.62 and 15.6% yields respectively. Hexane (5.02%), diethyl ether (3.80%) and chloroform (3.64%) were obviously poor extracting solvents for the plant material.

Documented information on the presence of some bioactive substances in various plants, which basically serve as food and medicinal herbs abound, and are daily on the increase following continuous scientific investigations. In this study, flavonoids, tannins, phenols, glycosides, alkaloids and cardiac glycosides were all detected in the aqueous, methanol and ethanol fractions of *Sapium ellipticum*. Steroids were observed in the hexane, diethyl ether, chloroform and ethanol fractions. Only the ethanol and aqueous fractions of the plant were found to contain anthraquinones (Table 1). More phytochemicals were observed in ethanol fraction than other fractions (Table 1). This observation indicates that most of the bioactive compounds in *S. ellipticum* leaves are more soluble in polar organic solvents such as ethanol and methanol and agrees with the report of Girija et al. [22] which holds that alcohol is a good organic solvent for the extraction of most plant bioactive constituents of medicinal relevance. Though saponins and phlobatannins were evidently absent in all the fractions, several other phytochemicals present in the plant material have been reported to exert multiple biological and pharmacological effects (antibacterial, anti-hypertensive, antidiabetic antioxidant, and anti-inflammatory activities [23].

Quantitative estimation of the powdered leaf sample showed 10.8±0.54% flavonoids,

9.24±0.12% alkaloids, 7.26±1.01% tannins, 1.63±0.14% glycosides and 74.0±3.12 mgGEA/g total phenols (Table 1). These values are comparable to amounts associated with other plants such as *Zingiber cassumunar Roxb* [24], *Euphorbia spp., Rumex dentatus, phalaris minor* [25], The presence of these substances and amounts in which they are present in *S. ellipticum* suggests that the plant leaves possess valuable medicinal potential yet to be explored.

3.2 Antimicrobial Sensitivity of Leaf Extracts of *Sapium ellipticum*

The results of the antimicrobial screening of the various extract fractions of *Sapium ellipticum* leaf are summarized in Fig. 2 and Table 2. Extracts obtained from *Sapium ellipticum* leaves using highly polar solvents such as water, ethanol and methanol were observed to be reactive at various concentrations on the bacterial isolates, partially on yeast, but non-reactive on fungi used in this study. The only exception was ethanol fraction that was sensitive to *Penicillinin camemberti* only at undiluted concentration (100 mg/mL) (Table 2). The less polar fractions (Hexane, chloroform and diethyl ether) were non-reactive to all the microbes (bacteria, fungi and mould), except in few cases where hexane extract weakly resisted the growth of *Saccharomyces cerevisae* and *Escherichia coli* Table 2.

At undiluted concentration of 100 mg/mL, aqueous, ethanol and methanol fractions of *Sapium ellipticum* leaf extracts respectively demonstrated 113, 160 and 227% antibacterial potency on *Staphylococcus epidermidis* as compared with gentamycin (10 µg) (Fig. 2a) which elicited the highest sensitivity to the isolate among other antibiotics (cotrimazole=10mm and chloramphenicol=14 mm) (Table 2). In a sensitive disc test, only ofloxacin (10 µg) was inhibitory to *Proteus mirabilis* (10 mm zone inhibition) (Table 2). Aqueous and ethanol extracts were 250 and 320% as potent as the antibacterial drug on the isolate (Fig. 2b).

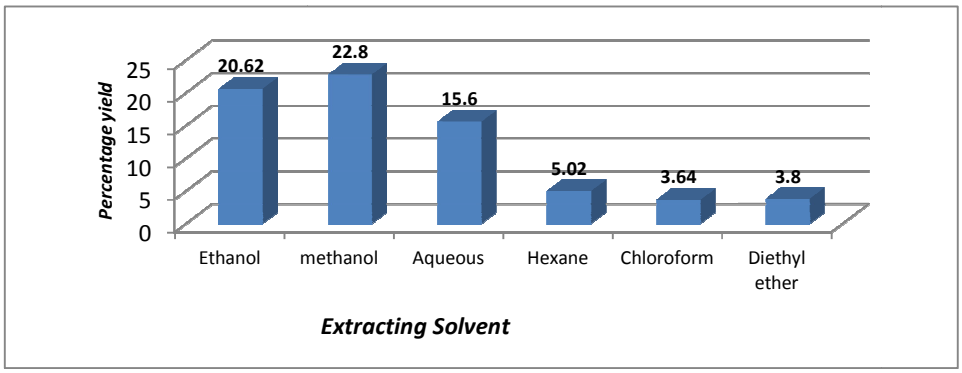


Fig. 1. Percentage yield of *Sapium ellipticum* leaf extracts

Table 1. Distribution of phytochemicals in *Sapium ellipticum* leaf extracts

Phytochemicals	Extracting solvent						Quantity
	Ethanol	Methanol	Aqueous	Hexane	Chloroform	Diethyl ether	Powdered sample
Flavonoids	+	+	+	-	-	-	10.8 ±0.54%
Alkaloids	+	+	+	+	-	-	9.24 ± 0.12%
Tannins	+	+	+	-	-	-	7.26 ± 1.01%
Saponins	-	-	-	-	-	-	ND
Antraquinones	+	-	+	-	-	-	ND
Glycosides	+	+	+		-	-	1.63 ± 0.14%
Steroids	+	-	-	+	+	+	ND
Phlobatannins	-	-	-	-	-	-	ND
Phenols	+	+	+	-	-	-	74±3.12 mg GAE/g
Cardiac glycosides	+	+	+	+	+	-	ND
Terpenoids	+	+	-	+	-	-	ND

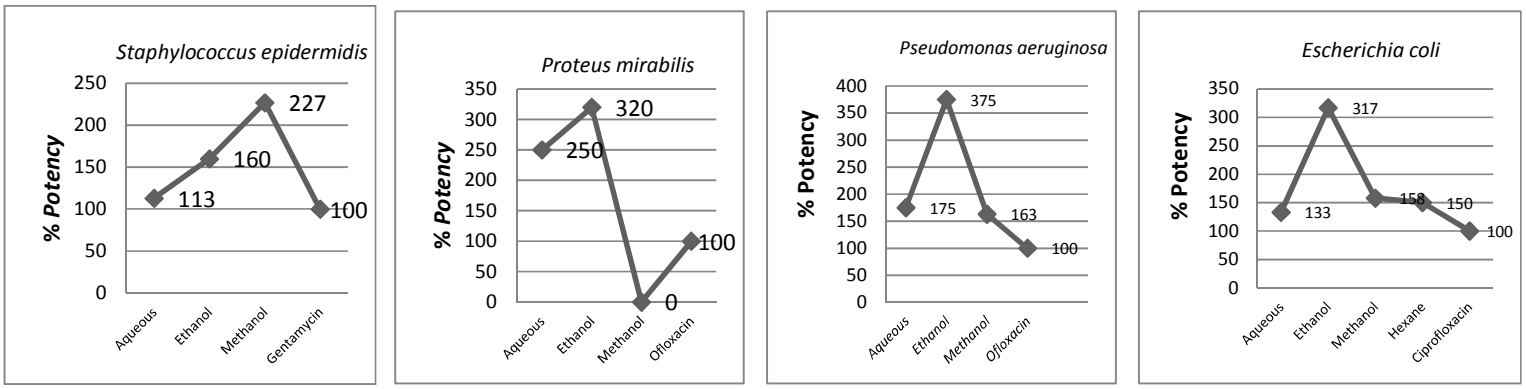
Results are means of triplicate determinations - = No inhibition ND = Not determined

Table 2. Effective Zones of Inhibition by *Sapium ellipticum* leaf extracts and selected antibiotics (Diameter in millimeter)

Test		Concentration (mg/mL)						Antibiotics
Isolate	**Extract fraction**	**100.0**	**50.0**	**25.0**	**12.5**	**6.25**	**3.01**	**GEN (10µg)**
Staphylococcus epidermidis	Aqueous	17.0	14.0	10.0	-	-	-	15.0 mm
	Ethanol	24.0	18.0	16.0	12.0	6.0	-	
	Methanol	34.0	26.0	14.0	10.0	4.0	-	
	Hexane	-	-	-	-	-	-	
	Chloroform	-	-	-	-	-	-	
	Diethyl ether	-	-	-	-	-	-	
								OFL (10µg)
Proteus mirabilis	Aqueous	25.0	20.0	12.0	-	-	-	10.0 mm
	Ethanol	32.0	26.0	18.0	14.0	12.0	-	
	Methanol	4.0	4.0	-	-	10.0	-	
	Hexane	-	-	-	-	-	-	
	Chloroform	-	-	-	-	-	-	
	Diethyl ether	-	-		-	-	-	
								OFL (10µg)
Pseudomonas aeruginosa	Aqueous	14.0	11.0	-	-	-	-	8.0 mm
	Ethanol	30.0	29.0	23.0	-	-	-	
	Methanol	13.0	8.0	-	-	-	-	
	Hexane	-	-	-	-	-	-	
	Chloroform	-	-	-	-	-	-	
	Diethyl ether	-	-	-	-	-	-	
								CIP (10µg)
Escherichia coli	Aqueous	16.0	-	-	-	-	-	12.0 mm
	Ethanol	38.0	27.0	16.0	8.0	-	-	
	Methanol	19.0	18.0	12.0	-	-	-	
	Hexane	-	8.0	-	-	-	-	
	Chloroform	-	-	-	-	-	-	
	Diethyl ether	-	-	-	-	-	-	

***Saccharomyces cerevisae* (yeast)**	Aqueous	-	-	-	-	-	-
	Ethanol	14.0	8.0	6.0	-	-	-
	Methanol	29.0	21.0	20.0	14.0	5.0	-
	Hexane	10.0	-	-	-	-	-
	Chloroform	-	-	-	-	-	-
	Diethyl ether	-	-	-	-	-	-
Penicillinin Camemberti	Aqueous	-	-	-	-	-	-
	Ethanol	14.0	6.0	-	-	-	-
	Methanol	-	-	-	-	-	-
	Hexane	-	-	-	-	-	-
	Chloroform	-	-	-	-	-	-
	Diethyl ether	-	-	-	-	-	-

Results are means of triplicate determination



(a) **(b)** **(c)** **(d)**

Fig. 2. Antimicrobial potency of *Sapium ellipticum* leaf extracts in comparison with selected antibiotics

In the same manner, aqueous, ethanol and methanol fractions were effective against *Pseudomonas aeruginosa* by 175, 375 and 162.5% in respect to ofloxacin (Fig. 2c). The growth of *Escherichia coli* was resisted by four of the extract fractions as follows: Hexane (150%), Aqueous (133%), Methanol (158%) and Ethanol (317%) in comparison with Ciprofloxacin to which the organism was only reactive in the sensitive disk test (Fig. 2d).

The inhibitory effect of the extract fractions (Ethanol, Methanol and Aqueous) of *S. ellipticum* leaves on the bacteria isolates was broad spectrum, and observed to increase with increased concentration of the extracts, indicating a dose dependent effect (Table 2).This observation could be adduced to the phytochemical constituents of these fractions and corroborates a previous report by Aspen [26] 'that an increase in the concentration of an antimicrobial agent tend to increase its effectiveness'. Table 1 shows that the three fractions are rich in flavonoids and phenols amidst other phyto-compounds which are strongly associated with antimicrobial activities [27,28,29] Conversely, complete absence or low amounts of these phytochemicals in hexane, chloroform and diethyl ether extracts probably accounts for the poor or non antibacterial effects associated with these fractions as observed in this study (Table 1, Fig. 1). According to Adegoke [30], 'antimicrobial properties exhibited by many plant extracts are due to the presence of bioactive components (chemical compounds) present in them'. These components have both bacteriostatic and bactericidal activities on different and diverse types of organisms [31].

Results obtained from this investigation also show that all the extract fractions examined were completely resisted by *Aspergillus flavus* and *Aspergillus niger* (fungi) at all concentrations used. This observation suggests lack of antifungal activities by *Sapium ellipticum* leaf extracts. The reasons for this are not clear. However, it could be adduced to the fact that the genetic properties, cell structure morphology and permeability as well as chemical composition of fungi generally enhance their resistance to the effects of most antimicrobial agents to which bacteria are easily susceptible [32,33]. Overall, leaf extracts of *Sapium ellipticum* obtained using aqueous; ethanol and methanol were reactive at various concentrations, with ethanol fraction exhibiting the best potency, with minimum inhibitory concentration (MIC) range of 6.25-50 mg/mL. This was followed by methanol and aqueous fractions with MIC ranges of 12.5-50 mg/mL and 25.0-100 mg/mL respectively. These findings support the claim of Okigbo and Omodamiro [34] that 'the strong extracting capacity of organic solvents produces greater number of bioactive constituents responsible for antimicrobial activity. It also agrees with the findings of Nair et al. [35], which holds that preparing an extract with an organic solvent seem to provide a better antimicrobial activity.

The mechanism by which the investigated plant material elicited the broad spectrum antibacterial activity noted in this study was not ascertained. However, as it is common with most antibacterial agents, *Sapium ellipticum* leaf extracts may have probably inhibited the biosynthesis of proteins, nucleic acids and membrane phospholipids in the bacteria isolates on which they were tested [36,37].

4. CONCLUSION

Leaf extracts of *Sapium ellipticum* obtained using polar solvents, especially ethanol fraction contain diverse bioactive compounds in substantial amounts; and are capable of eliciting significant antibacterial activities, as much as 113-375% potency in comparison to well known antimicrobial drugs such as Ofloxacine (OFL), Gentamycin (GEN), Chloramphenicol (CHL) and Ciprofloxacin (CIP). The microbes against which the extracts were effective are pathogens already implicated in the etiology and severity of human diseases. Thus, the plant extract may be of immense application in the treatments of bacterial infections or diseases. Hence, further purification and the possibility of formulation of *S. ellipticum* leaf extracts into antibiotics is been considered in our laboratory.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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