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Phytochemical and Microbiological Study on the Effect of Bark Extract of Mango Tree on Dental Caries Pathogens

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ABSTRACT

This research evaluated the antimicrobial properties of the phytochemical extracted from the bark of *Mangifera indica* plant against some bacterial strains, *Streptococcus mutans*, *Escherichia coli*, *Staphylococcus aureus*, *Lactobacillus acidophilus*) and the fungus (*Ccandia albican*) which causes dental caries. Phytochemical screening of the crude stem bark extracts of *Mangifera* indica revealed the presence of alkaloids, phenols, tannins, saponins and glycosides. The antimicrobial activity of both the dialysed and the undialysed extracts were assayed using the agar well diffusion methods on clinical microbial isolates which were obtained from Enugu State University Teaching Hospital (Park lane). Among the four extracts from *Mangifera indica* bark, dialysed methanol extract showed strong antimicrobial activity against *Streptococcus mutans* with inhibition zone of 31 mm at 100% concentrations. It can as well be seen that in the undialysed extracts, most of the extract did not produce any zone of inhibition on the test organisms at 6.25% concentration. Water extract showed strong activity against *Lactobacillus acidophilus* with inhibition zone diameter of 20 mm. The third strain *Escherichia coli* was highly sensitive to both ethanol and water extract with inhibition zone of 16 mm. The results demonstrate that the methanol extracts of has a strong antimicrobial activity and suggest that it can be useful in the treatment of dental caries.

Keywords: Antimicrobial, phytochemical, *Mangifera indica,* dialysed and undialysed extract.

INTRODUCTION

Medicinal plants are of great importance to the health of individuals and communities. *Mangifera indica* (also known as mango) being a medicinal plants possess some active chemical substances that produce definite physiological actions on the human body and animal health. The most important bioactive substances are alkaloid, tannin, flavonoid and phenolic compounds [1], [2]. The World Health Organization (WHO) has listed 21,000 plants, which are used for medicinal purposes around the world [3], [4]. At present nearly 30% or more of the modern pharmacological drugs are derived directly or indirectly from plants [5]. Mango (*Mangifera indica L.*) is a juicy stone fruit that belongs to the family of *Anacardiaceae* in the order of *Sapindales* and is grown in many parts of the world, particularly in tropical countries. It has been well documented that mango fruits are an important source of micronutrients, vitamins and other phytochemicals. Mango contains various classes of polyphenols, carotenoids, and ascorbic acid, which demonstrate different health promoting properties, mainly from their antioxidant activities [6]. Moreover, mango fruits provide energy, dietary fibre, carbohydrates, proteins, fats and phenolic compounds [7], which are vital to normal human growth, development and health [8].

Mango stem bark aqueous extract has been reported to possess anti-inflammatory, antimicrobial, analgesic and immune protective effects. A number of biological activities of mangiferin have been suggested, including antidiabetic

and anti-inflammatory abilities. Mango was also claimed to have antimalaria effects and was found to display *in vitro* activity against *Plasmodium falciparum* [9]. In Nigeria, mango leaves and stem bark are principally taken as a herbal remedy for fever and malaria. Although, a lot of information abound on the antimicrobial properties of mango stem bark extracts, there is dearth of information on the antimicrobial properties of *Mangifera indica* stem bark, thus research is still on going. Dental health is an inseparable part of general health [10]. Dental health has an effect on general health as it causes considerable pain and suffering. It has an impact on a person's speech, selection of food, quality of life, and well-being. In view of the prevalence of oral diseases, their impact on individuals and society, and the expense of their treatment, oral diseases may be considered a major public health problem and they are listed among the most common of the chronic diseases that affect mankind. Dental plaque is a general term for the diverse microbial community (predominantly bacteria) found on the tooth surface, embedded in a matrix of polymers of bacterial and salivary origin [11]. Plaque is an example of a biofilm; current researches are showing that the properties of bacteria associated with a surface in a biofilm can be markedly different than those of the same cells growing in liquid broth (planktonic cells). Plaque is found preferentially at protected and stagnant surfaces, and these are at the greatest threat of disease [12], [13], [14].

According to the World Health Organization (WHO) report, dental caries, though exhibiting a declining trend in many parts of the industrialized world, is still an important public health concern in many developing countries. The established practices to prevent dental caries and periodontal diseases are the use of fluorides in different forms and mechanical plaque control in combination with professional care, respectively. However, in reality, a major bulk of the population will not have adequate dexterity and motivation that are necessary to maintain optimum oral hygiene especially true in rural areas. Antimicrobial mouth rinses have also been suggested as adjuncts for mechanical plaque control methods and this is not readily available in rural areas [15], [16], [17], [18]. The most commonly used antiplaque agent is chlorhexidine gluconate. The use of chlorhexidine has some potential drawbacks like altered taste sensation, staining of teeth, and development of resistant bacteria that incapacitate its application on long-term basis. These chemicals can alter oral microbiota and have undesirable side effect, such as vomiting, diarrhea, and tooth staining. There exists a need to develop some innovative strategies that act against both dental caries and periodontal diseases simultaneously. One such strategy would be to explore the abundantly available medicinal plants in nature. The “naturally occurring” active ingredients in plant medicines restore health, with minimal harmful effects and maximum efficiency. Hence the search for unconventional product continues and natural phytochemicals isolated from plants used as traditional medicines are considered as good alternatives. However 80% of the world’s population use plant as their primary source of medication [19] in view of the fact that antibiotics are sometimes associated with adverse side effects to the host including hypersensitivity, immunosuppressive and allergic reactions, it is of interest to develop alternative antimicrobial drugs such as medicinal plants for treatment of infectious diseases. The plant extract or phytochemicals that hinder the growth of oral pathogens, diminish the progress of dental plaque, manipulate the adhesions of bacteria to surface and reduce the symptoms of the oral diseases. The use of natural products is a comprehensive remedy that includes promotive and preventive strategies in the maintenance of health. Natural herbs used either exclusively or in combination are proven to be safe and effective in the management of various oral health problems such as halitosis, bleeding gums, mouth ulcers, and dental caries.

Herbal products have the dual advantage of minimal side effects and being alcohol and/or sugar-free, which are the two most common ingredients found in other over-the-counter products [20], [21].

Objective of the study

The aim of this study is to determine the phytochemical and microbiological study on the effect of bark extract of *Mangifera indica* which would have activity against dental caries pathogens

MATERIALS AND METHODS

Collection, Identification and preparation of bark of *mangifera indica* plant.

Collection and Identification

The bark of the *mangifera indica* plant were collected on August, 2016 from Agbani, Nkanu West Local Government Area of Enugu State. *Mangifera indica* plant is a juicy stone fruit that belongs to the family of *Anacardiaceae* in the order of Sapindales and is grown in many parts of the world, particularly in tropical countries. It has been well documented that mango fruits are an important source of micronutrients, vitamins and other phytochemicals. Mango contains various classes of polyphenols, carotenoids, and ascorbic acid, which demonstrate different health promoting properties, mainly from their antioxidant activities [22].

Preparation

The bark of *Mangifera indica* plants were cut-off from a mature mango tree. The samples were cut into smaller fragment (for easy drying) and air-dried for 5 days at room temperature, after which it was pulverized to powder form using mortar and pestle and immediately proceeded for extraction.

Extraction

Four 1000ml clean white glass bottles containing 300ml each of water, n-hexane, ethanol and methanol were set out and 100g of the pulverized sample were weighed and added into the bottles respectively. The bottles were properly covered and the mixture left for 24 hours. After 24 hours, the mixtures were filtered using a whatman's filter paper and each of the extracts divided into two portions. The first portion that will serve as undialysed extract was stored in a refrigerator while the second portion proceeds to dialysis process.

Dialysis

5 molar sucrose solution were prepared in a 1000ml beaker and the extract taken out for dialysis were poured and tied into a dialysis bag provided by Very Rev. Dr J. I Nwankwo. These bags alongside with it constituents were inserted into the 5 molar sugar solution that was prepared and was left for 48 hours for dialysis to complete. The dialysed extract were removed from the dialysis bag and stored in small white bottles, after which a buffer solution was prepared as follows.

Preparation of 1000ml buffer solution

Measure out 1000ml of distilled H_2O. Measure 0.2g of Sodium Di-hydogen Phosphate.

Measure 1.15g of Di-hydogen Phosphate. Measure 9g of NaCl and mix thoroughly. Using pH meter, measure the pH. If the pH is above 6.8, add a mixture of diluted acetic acid in drops to reduce pH. The above buffer solution is used to preserve the dialysed extract prior to used.

Phytochemicals

Test for alkaloid: 1ml of each solvent was added into a test tube and evaporated to dryness. 5ml of 2% HCl was added, shaked and filtered. Reagents such as Dragendoff's, Wagner's and Meyer's reagent were used to check for turbidity and precipitation.

Test for saponin: 1ml of the crude extract was added to 5ml of distilled water and vigorously shaken. Then we observe for foam at the upper layer of the mixture.

Test for tannin: Few drops of 5% ferric chloride was added to the mixture of crude extracts and 2mls of distilled water was added to the mixture, a blue or greenish black colour was observed.

Test for phenol: one drop of 5% Ferric chloride was added to 2ml of the crude extract and blue colour was observed.

Steroid and terpenoids: 2ml of chloroform was added to 2ml of the crude extract then, 3 to 4 drops of acetic anhydride was added followed by addition of excess drops of sulfuric acid

to the mixture. We observe for violet colour for terpenoid and greenish-blue colour for steriod.

Test for flavonoids: 1.5ml of 5% ethanol was added to 1ml of the crude extract and heated for 5 minutes, little quantity of metal magnesium was added and shaken, 1ml of concentrated HCl was added and observed for colour change. If the colour change to red, it flavonoid but if orange, it is flavon.

Test for glycoside: 2ml of the crude extract was added to 2ml of acetic acid, then few drops of ferric chloride was added followed by addition of 0.5 to 1ml of H_2SO_4 to the mixture. Then observe for reddish brown colour at a point on the center of the test-tube and bluish green at the top of the tube.

Test for reducing sugars: About 5ml of the extracts were diluted with distilled water. Fehling solutions A and B were added and the mixture warmed. The brick red precipitate at the bottom of the tube indicates reducing sugars.

Composition of some media and their preparation procedure

MRS agar (accumix): For cultivation and isolation of lactobacillus species.

How to prepare MRS agar

Suspend 67.15g of the powder in 1000ml distilled water and mix thoroughly. Boil with frequent agitation to dissolve the powder completely. Sterilize by autoclaving at 121°C (15lbs pressure) for 15 minutes.

Composition of MRS agar

Ingredients	G/litre
Dextrose	20.0
Beef extract	10.0
Proteose peptone	10.0
Yeast extract	5.0
Sodium acetate	5.0
Ammonium citrate	2.0
Dipotassium phosphate	2.0
Polysorbate	1.0
Magnesium sulphate	0.1
Manganese sulphate	0.05
Agar	12.0

Macconkey agar: For isolation and identification of lactose fermenting and non-lactose fermenting enteric bacteria.

How to prepare Macconkey agar

Dissolve 38g in 1000ml distilled water. Gently heat to dissolve the medium completely. Sterilize by autoclaving at 15psi (121°C) for 15 minutes. Cool to room temperature prior to dispense.

Composition of Macconkey Agar

Ingredients	gm/ltr
Beef, infusion from	300.00
Casein acid hydrolysate	17.50
Agar	17.00
Starch	1.50
Distilled water	1ltr

Mueller-Hinton agar: for cultivation of Neisseria and determination of susceptibility of microorganism to antibiotics.

How to prepare Mueller-Hinton agar

Dissolve 47 gm in 1000ml distilled water. Gently Heat to dissolve the medium completely. Sterilize by autoclaving at 15psi (121°C) for 15 minutes.

Composition of Mueller-Hinton agar

Ingredients.	gm/ltr
Peptic digest animal tissue.	20.00
gar	12.00
Lactose	10.00
Bile salt	5.00
Neutral red	0.075
Distilled water	1 ltr

Sabouraud dextrose agar: for cultivation of yeast, mold and aciduric bacteria.

How to prepare Sabouraud dextrose agar

Suspend 65.0g of the powder into 1000ml of distilled water and mix thoroughly. Boil with frequent agitation to dissolve the powder completely. Avoid over heating the agar as it could cause a softer medium. Sterilize by autoclaving at 121°C (15lbs pressure) for 15 minutes.

Composition of Sabouraud dextrose agar

Ingredients	gm/ltr
Peptone	5.0
Tryptone	5.0
Dextrose	40.0
Agar	15.0

Nutrient agar: general purpose medium used for cultivation of wide variety of microorganisms.

How to prepare nutrient agar

Dissolve 28.00 gram in 1000ml distilled water. Gently heat to dissolve the medium

completely. Sterilize by autoclaving at 121°C (15 psi) for 15 minutes. Dispense the medium as desired.

Composition of nutrient agar

Ingredient	**gm/ltr**
➢ Agar	15.00
➢ Peptone	5.00
➢ Sodium chloride	5.00
➢ Beef extract	1.50
➢ Yeast extract	1.50
➢ Distilled water	1 ltr.

Source of test microorganisms: The test organisms were gotten from Enugu state university teaching hospital (parklane). These organisms are pure clinical isolates of *Streptococcus mutans, Staphylococcus aureus, Escherichia coli, Lactobacillus acidophilus* and *Candida albican.*

Determination of Sensitivity Test and Inhibitory Zone Diameter (1ZD): The antimicrobial activity of the test organisms to the four (4) extracts (ethanol, methanol, n-hexane and water) was screened by using the agar-well diffusion method (Perez et al., 1990). Our test organisms were streaked uniformly on the plates containing 20ml each of solidified mueller-Hinton Agar (MHA). The inocula were allowed to dry for 5minutes. Holes of 8mm in diameter were made in the seeded agar media using sterile cork borer. Exactly 0.1ml of the extract prepared as described earlier were accordingly put into the wells and then allowed to stand for 30minutes for proper diffusion. The plates were then incubated at 37°C for 24hours except for candida which was incubated at 30°C for 72 hours. The resulting zone of inhibition was measured in millimeters (mm).

Determination of Minimum Inhibitory concentration (MIC): The Minimum inhibitory concentration was considered the lowest concentration of the sample that prevented visible growth. It was determined using the agar well diffusion technique. 101 plates of Mueller Hinton agar were prepared; the activities of the four extracts were tested against the five test organisms. 0.1ml of the extracts at varying concentration was incorporated into the wells bored on the solidified Mueller Hinton agar containing the test organisms respectively. The control experiment containing the growth medium and each of the test organisms, excluding the extract and the fractions were also set. The experiments were incubated at 37°C for 24hours. The lowest concentration of extract and fraction that did not allow microbial growth within the incubation period was taken to be the MIC.

Table 1: Results of the phytochemistry

Extract Phytochemical constituent		E	M	n-H	H_2O
Tanins		++	+	-	+++
Steroids		-	-	-	-
Terpenoids		+++	+++	+	+
Saponin		-	+	++	++
Phenol		++	++	-	++
Glycoside		++	++	++	++
Alkaloid	Dragendorff reagent	++	+	+	-
	Meyers reagent	-	+	_	+
	wagners reagent	+	-	+	-

Key: +++ = Abundantly present
++ = moderately present
+ = present in trace amount
- = not present

Diagram of plates showing the zones of inhibition on test organisms

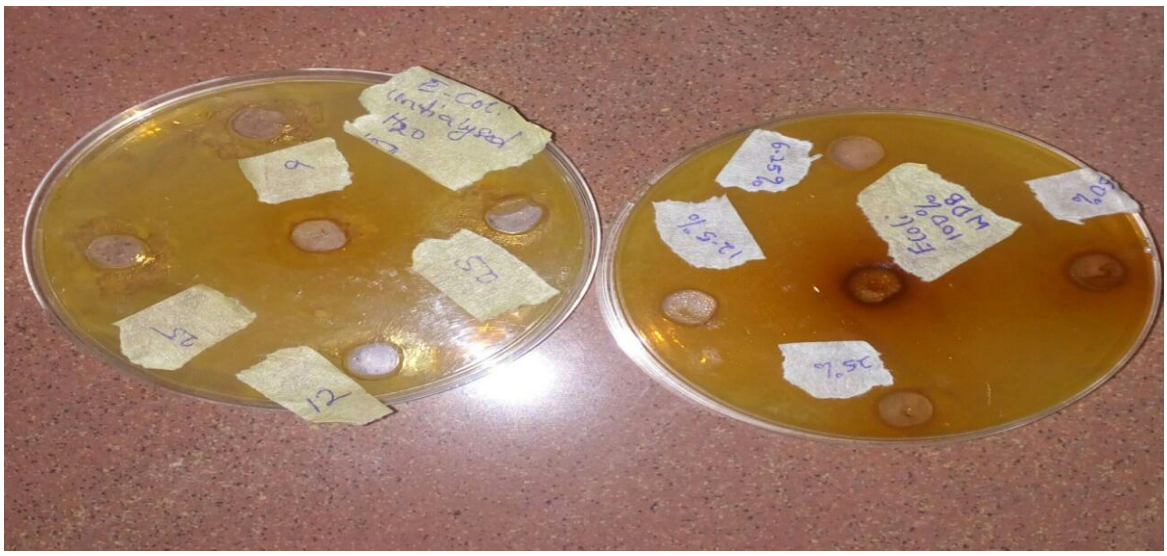

Fig 1: Agar well diffusion plate of dialysed and undialysed water extract on *Escherichia coli.*

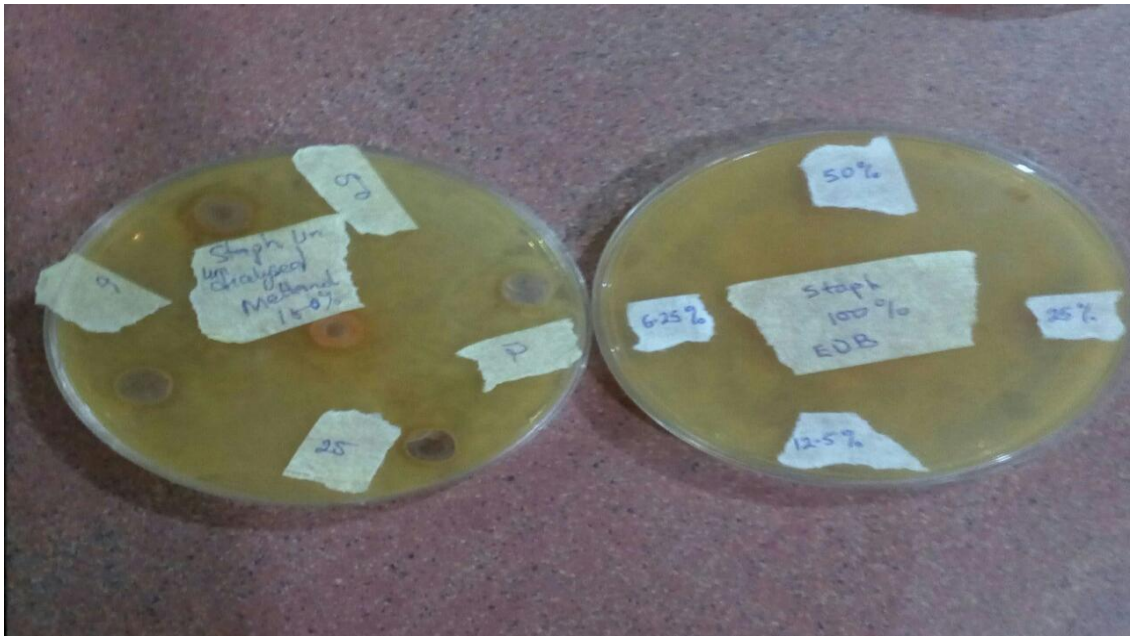

Fig 2: Agar well diffusion plate of dialysed methanol and dialysed ethanol extract on *Staphylococcus aureus.*

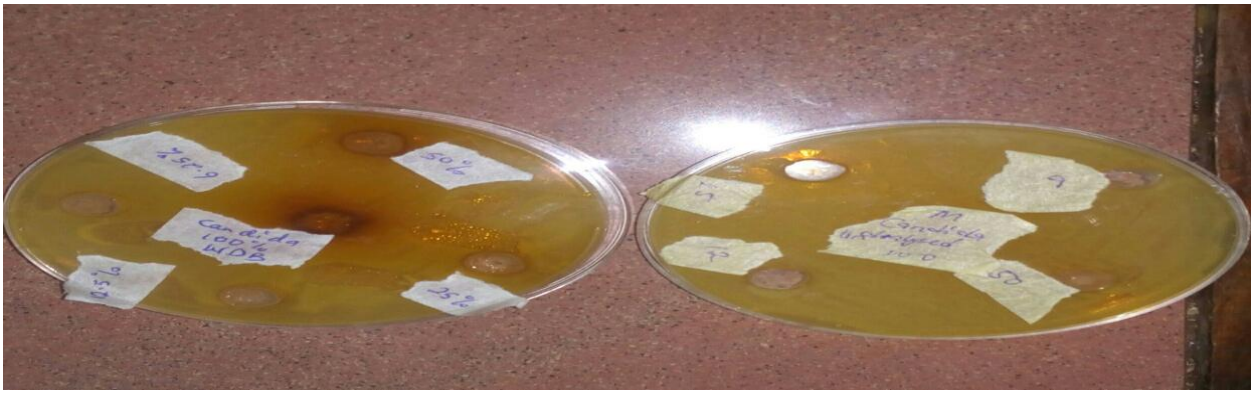

Fig 3: Agar well diffusion plate of dialysed water and undialysed methanol extract on *Candida albican.*

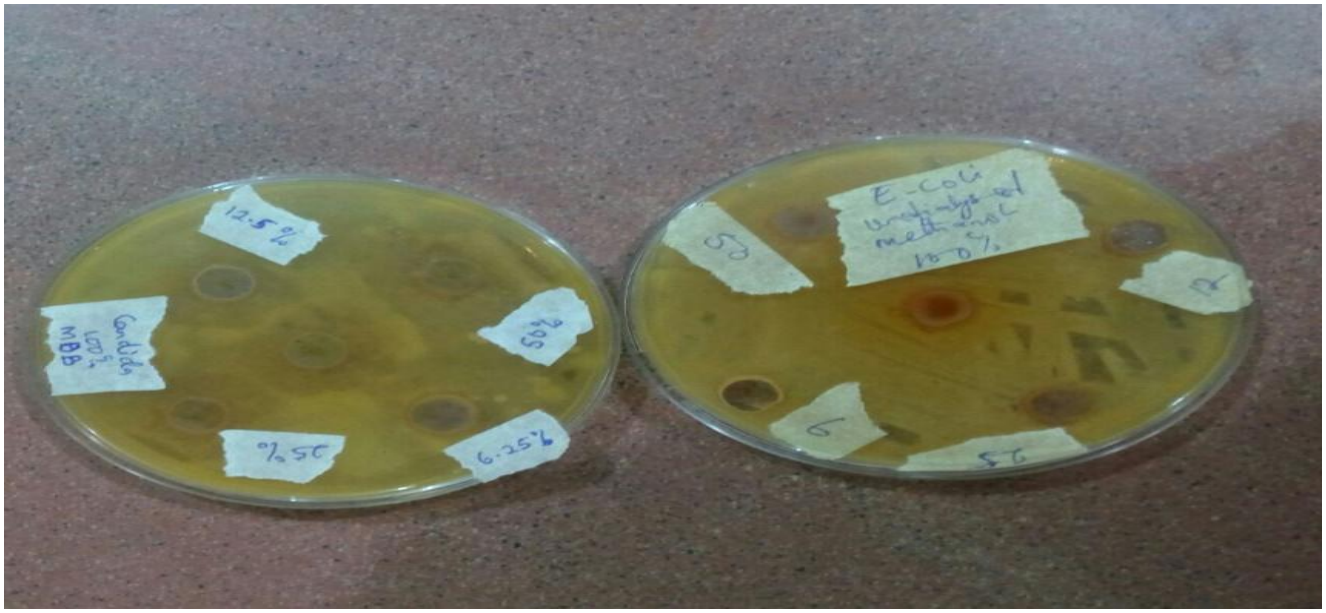

Fig 4: Agar well diffusion plate of dialysed methanol and undialysed ethanol extract on *Candida albican and Escherichia coli* respectively.

Methanol Dialysed

Methanol showed the highest activity at the log of concentration of 2.00 on the isolate *S. mutans* with IZD value of 31mm.

Conc. (mg/ml)	**100**	**50**	**25**	**12.5**	**6.25**
Log. Conc.	2	1.6980	1.3979	1.0961	0.7958
Parameter (mm) Organisms	IZD	IZD	IZD	IZD	IZD
E. coli	16	12	9	7	3
S. aureus	23	20	18	14	11
C. albican	16	12	9	7	3
L. acidophilus	19	17	12	7	3
S. mutans	31	28	22	17	13

Table 2: Effects of concentration of dialysed methanol on isolates

Methanol Undialysed

Effect of concentration of undialysed methanol on the test organism. The extract shows highest activity on S. mutans at log concentration of 2.00 with inhibition zone diameter of 30mm.

Conc. (mg/ml)	**100**	**50**	**25**	**12.5**	**6.25**
Log. Conc.	2	1.6980	1.3979	1.0961	0.7958
Parameter (mm)	IZD	IZD	IZD	IZD	IZD
Organisms					
E. coli	13	10	9	3	2
S. aureus	19	14	8	6	3
C. albican	10	7	5	-	-
L. acidophilus	18	15	11	6	5
S. mutans	30	20	14	10	7

Table 3: The effect of concentration of undialyzed methanol extract on different test organisms

Ethanol Dialysed

Effect of concentration of dialysed ethanol on test organisms. The extract shows highest activity on *Streptococcus mutans* at log. conc. of 2.00 with inhibition zone diameter (IZD) of 30mm.

Conc. (mg/ml)	**100**	**50**	**25**	**12.5**	**6.25**
Log. Conc.	2	1.6980	1.3979	1.0961	0.7958
Parameter (mm)	IZD	IZD	IZD	IZD	IZD
Organisms					
E. coli	19	15	13	10	7
S. aureus	20	18	17	14	13
C. albican	19	12	8	7	5
L. acidophilus	25	19	14	11	10
S. mutans	30	24	18	15	13

Table 4: The effect of concentration of dialyzed ethanol extract on different test organisms.

Ethanol Undialysed

Effect of concentration of undialysed ethanol on test organisms. The extract shows highest activity on *Streptococcus mutans* at log.conc. of 2.00 with inhibition zone diameter (IZD) of 21mm.

Conc. (mg/ml)	**100**	**50**	**25**	**12.5**	**6.25**
Log. Conc.	2	1.6980	1.3979	1.0961	0.7958
Parameter (mm)	IZD	IZD	IZD	IZD	IZD
Organisms					
E. coli	13	11	9	3	-
S. aureus	18	13	8	5	3
C. albican	11	7	4	-	-
L. acidophilus	13	10	9	6	2
S. mutans	21	16	10	7	5

Table 5: The effect of concentration of undialyzed ethanol extract on different test organisms.

N-Hexane Dialysed

Effect of concentration of dialysed n-Hexane on test organisms. The extract shows highest activity on *Streptococcus mutans* at log. conc. of 2.00 with inhibition zone diameter (IZD) of 21mm.

Conc. (mg/ml)	**100**	**50**	**25**	**12.5**	**6.25**
Log. Conc.	2	1.6980	1.3979	1.0961	0.7958
Parameter (mm)	IZD	IZD	IZD	IZD	IZD
Organism					
E. coli	11	7	5	4	3
S. aureus	14	10	9	3	2
C. albican	12	8	5	3	-
L. acidophilus	19	15	8	2	-
S. mutans	21	17	7	5	3

Table 6: Effect of concentration of dialysed n-Hexane on test organisms.

Conc. (mg/ml)	100	50	25	12.5	6.25
Log. Conc.	2	1.6980	1.3979	1.0961	0.7958
Parameter (mm)	IZD	IZD	IZD	IZD	IZD
Organisms					
E. coli	12	10	7	3	2
S. aureus	17	14	9	4	3
C. albican	11	7	5	-	-
L. acidophilus	25	18	10	3	-
S. mutans	20	15	11	8	-

Table 7: Effect of concentration of undialysed n-Hexane on test organisms

Water Dialysed

Effect of concentration of dialysed water on test organisms. The extract shows highest activity on *L. acidophilus* at log. conc. of 2.00 with inhibition zone diameter (IZD) of 25mm.

Table 8: Effect of concentration of dialysed water on test organisms.

Conc. (mg/ml)	**100**	**50**	**25**	**12.5**	**6.25**
Log. Conc.	2	1.6980	1.3979	1.0961	0.7958
Parameter (mm)	IZD	IZD	IZD	IZD	IZD
Organisms					
E. coli	10	7	5	-	-
S. aureus	15	13	10	5	4
C. albican	10	8	3	-	-
L. acidophilus	25	11	7	5	2
S. mutans	12	10	7	4	2

Water Undialysed

Effect of concentration of undialysed water on test organisms. The extract shows highest activity on *S. aureus* at log. conc. of 2.00 with inhibition zone diameter (IZD) of 15mm.

Conc. (mg/ml)	**100**	**50**	**25**	**12.5**	**6.25**
Log. Conc.	2	1.6980	1.3979	1.0961	0.7958
Parameter (mm)	IZD	IZD	IZD	IZD	IZD
Organisms					
E. coli	10	7	5	-	-
S. aureus	15	13	10	5	4
C. albican	10	8	3	-	-
L. acidophilus	25	11	7	5	2
S. mutans	12	10	7	4	2

Table 9: Effect of concentration of undialysed water on test organisms.

DISCUSSION

The dental pathogens for this study were isolated from the dental plaque samples and were identified as *Streptococcus mutans*, *Staphylococcus aureus, Escherichia coli, Lactabacillus acidophilus* and *Candida albican*. The antimicrobial activity of mangifera indica bark extracts against these test organism shows that *Streptococcus mutans* are more susceptible to the phytochemicals of the *Mangifera indica* bark because they produce a wider inhibition zone diameter (IZD) of 31mm as shown in table 4. Undialysed n-hexane did not show any zone of inhibition on *Lactobacillus acidophilus,* hence no Minimum inhibitory concentration was recorded.

Phytochemical screening showed the presence of active pharmacological components such as tannins, saponins, steroids, glycoside, flavonoid and alkaloids. These components are known to be biologically active because they protect the plant against infections and predations by animals. Flavonoids are phenolic compounds known to be produced by plants in response to microbial infections to which this aspect has been extensively studied and found to have antimicrobial activity against an array of microorganisms *in vitro* [23], [24], [25]. Phytochemicals generally exert their antimicrobial activities through different mechanisms to that of synthetic drugs [26], [27]. There was clear indication that the solvents that were used in the phytochemical extraction played a significant role in the solubility of the bioactive components and influences the antimicrobial activity [28]. From the extraction analysis using different extraction solvents, methanol was more efficient solvent of extraction than water for dialysed extract and in table for undialysed extract. Medicinally, this is important for the treatment of pneumonia, asthma and inflammed tissues. It also plays important roles in

herbs for treating dysentery [28]. This justified the use of M. indica in traditional medicine. The antimicrobial assay was performed using the agar-well diffusion method which best showed the clear zones of inhibition in diameters. The varied susceptibility on the test organisms on the basis of zones of growth of inhibitions and Minimum Inhibitory Concentration (MIC). These differences are dependent on the microorganisms and extracting solvents. Lengths of zones of growth of inhibition from different studies vary from one organism to another, plants and concentration difference [23]. The organisms which are sensitive tend to move away from the region around the extract while those that are resistant show no zones of growth of inhibition.

From the result of the zones of growth of inhibition, it was seen that the dialysed methanolic extract demonstrated the higher activity with respect to the different concentrations. For *S. mutans* at 100 mg/ml, 50 mg/ml and 25 mg/ml; zones in diameter were 31mm, 28mm and 22mm. *S.aureus* also at 100 mg/ml, 50 mg/ml and 25 mg/ml; zones in diameters were 23mm, 20mm and 18mm, while in *E. coli* at 100 mg/ml, 50 mg/ml and 25 mg/ml the zones in diameters were 16mm, 12mm and 9mm respectively. Activities for dialysed water extract are as follows *S. mutans* at 100 mg/ml, 50 mg/ml and 25 mg/ml, zones in diameters were 20mm, 15mm and 11mm, while for *S. aureus* at 100mg/ml, 50mg/ml and 25mg/ml zones in diameters were 17mm, 14mm and 9mm. Then for *E. coli* at 100mg/ml, 50mg/ml and 25mg/ml zones in diameters were 12mm, 10mm and 7mm respectively. Both the extracts demonstrated antimicrobial activity but higher in methanolic extract at the varied concentrations. Related reports have been conducted [24]. Since activities were seen in both the methanolic and water extract, it means that the dialysed extract can further be refined into pure form and used against pathogens that cause infections in local communities. Therefore the phytochemical analysis revealed that the crude water, hexane, ethanol and methanol extracts have chemical compounds that have been found to possess antibacterial activities which could contribute to the result obtained from antimicrobial analysis.

CONCLUSION

Plants are one of the most important sources of medicines. The role of medicinal plants in promoting the ability of human health to cope with the unpleasant and difficult situations is well documented from ancient times till date all over the world. This study showed that *Mangifera indica* stem bark possess antimicrobial activity against some organisms associated with dental caries.

REFERENCES

1. Abubakar A A, Salka M N, Hassan F B (2011). Asian J. Plant Sci. Res. 1:1-95.
2. Amrita B, Liakot A, Masfida A and Begum R (2009). Studies on the antidiabetic effects of Mangifera indica stem-barks and leaves on nondiabetic, type 1 and type 2 diabetic model rats. Bangladesh J Pharmacol. 4:110–4.
3. Bidla G, Titanji V P, Jako B, Bolad A and Berzins K (2004). Antiplamodial activity of seven plants used in African folk medicine. Indian J Pharmacol.36:245–6.
4. Carvalho A C, Guedes M M, De Souza A L, Trevisan M T, Lima A F and Santos F A (2007). Gastroprotective effect of mangiferin: A xanthonoid from Mangifera indica against gastric injury induced by ethanol and indomethacin in rodents. Planta Med. 73:1372–6.
5. Garrido G, Gonzalez D and Delporte C (2001). Analgesic and anti-inflammatory effects of Mangifera indica extract (Vimang) Phytother Res. 15:18–21.
6. Garrido G, Gonzalez D, Lemus Y, Garcia D, Lodeiro L and Quintero G (2004). In vivo and in vitro anti-

inflammatory activities of Mangifera indica L. extract (VIMANG) Pharmacol Res. 50:143–9.
7. Jahurul M H A, Zaidul I S M, Ghafoor K, Al-Juhaimi F A, Nyam K L, Norulaini N A N, Sahena F and Omar A K M (2015). Mango (Mangifera indica L.) by-products and their valuable components: A review. Food Chemistry.183:173-180.
8. Khan M N, Nizami S S, Khan M A and Ahmed Z (1993). New saponins from Mangifera Indica. J Nat Prod. 56:767–70.
9. Martinez G, Delgado R, Perez G, Garrido G, Nunez Selles A J and Leon O S (2000). Evaluation of the in-vitro antioxidant activity of Mangifera indica L: Extract (Vimang) Phytother Res.14:424–7.
10. Muruganandan S, Scrinivasan K, Gupta S, Gupta P K and Lal J (2005).Effect of mangiferin on hyperglycemia and atherogenicity in streptozotocin diabetic rats. J Ethnopharmacol.97:497–501.
11. Odebiyi A and Sofowora A (1999). Phytochemical Screening of Nigeria Msedicinal plant. Part 1, 11 Lyodia 41:234-46.
12. Pardo-Andreu G L, Sanchez-Baldoquín C, Avila-González R, Yamamoto E T, Revilla A and Uyemura S A (2006). Interaction of Vimang (Mangifera indica L.extract) with Fe(III) improves its antioxidant and cytoprotecting activity. Pharmacol Res.54:389–95.
13. Pardo Andreu G, Delgado R, Velho J, Inada N M, Curti C and Vercesi A E (2005). Mangifera Indica L. extract (Vimang) inhibits Fe citrate-induced lipoperoxidation in isolated rat liver mitochondria. Pharmacol Res. 51:427–35.
14. Perpétuo G F and Salgado J M (2003). Effect of mango (Mangifera indica L.) ingestion on blood glucose levels of normal and diabetic rats. J Plant Foods Hum Nutr. 58:1–12.
15. Ross I A (1999). Medicinal plants of the world; Vol. 1. New Jersey Totowa: Human Press; pp. 199–200.
16. Rocha Ribeiro S M, Queiroz J H, Lopes Ribeiro M E, Campos F M and Pinheiro Santana H M (2007). Antioxidant in mango (Mangifera indica L.) pulp. Plant Foods Hum Nutr. 62:13–7.
17. Rolo A P and Palmeira C M (2006). Diabetes and mitochondrial function: Role of hyperglycemia and oxidative stress. Toxicol Appl Pharmacol.212:167–78.
18. Rivera D G, Balmaseda I H, Leon A A, Hernandez B C, Montiel L M and Garrido G G (2006). Anti-allergic properties of Mangifera indica L. extract (Vimang) and contribution of its glucosylxanthone mangiferin. J Pharm Pharmacol. 58:385–92.
19. Scalbert A (1991). Antimicrobial properties of tannins. Phytochem. 30:3875-83.
20. Sairam K, Hemalatha S, Kumar A, Srinivasan T, Ganesh J and Sarkar M (2003). Evaluation of anti-diarrhoeal activity in seed extracts of Mangifera indica . J Ethnopharmacol. 84:11–5.
21. Stoilova I, Gargova S, Stoyanova A and Ho L (2005). Antimicrobial and antioxidant activity of the polyphenol mangiferin. Herb Polonica. 51:37–44.
22. Sharma S R, Dwivedi S K and Swarup D (1997). Hypoglycemic potential of Mangifera indica leaves in rats. Int J Pharmaco. 35:130.
23. Shankarnarayanan D, Gopalakrishman C, Kameswaran L and Arumugum S (1979). The effect of mangostin, mangostin-3,6-di-O-glucoside and Mangiferin in carbon tetrachloride liver injury. Mediscope. 22:65.
24. Shibahara A, Yamamoto K, Shinkai K, Nakayama T and Kajimoto G (1993). Cis-9, cis-15-octadecadienoic acid:a novel fatty acid found in higher plants.

Biochimi Biophy Acta. 1170:245–52.
25. Seifried H E, Anderson D E, Fisher E I and Milner J A (2007). A review of the interaction among dietary antioxidants and reactive oxygen species. J Nutr Biochem. 18:567–79.
26. Seth S D and Sharma B (2004). Medicinal plants of India. Indian Journal of Medical Research. 120:9-115.
27. Yoshimi N, Matsunaga K, Katayama M, Yamada Y, Kuno T and Qiao Z (2001). The inhibitory effects of mangiferin: A naturally occuring glucosylxanthone, in bowel carcinogenesis of male F344 rats. Cancer Lett. 163:163–70.
28. Zhu X M, Song J X, Huang Z Z, Whu Y M and Yu M J (1993). Antiviral activity of mangiferin against herpes simplex virus type 2 in vitro. Zhongguo Yao Li Xue Bao. 14:452–4.