WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 5.045
Volume 4, Issue 01, 258-271. Research Article ISSN 2277– 710541

THE ANTIMICROBIAL ACTIVITY AND PHYTOCHEMICAL CHARACTERISTIC OF MORINGA OLEIFERA SEEDS, LEAVES, AND FLOWERS

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Article Received on
03 Nov 2014,

Revised on 24 Nov 2014,
Accepted on 17 Dec 2014

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ABSTRACT

Background: Moringa oleifera was traditionally used in west Sudan for purification of water. In this study, ether, alcohol and water extracts of Moringa oleifera (seeds, leaves and flowers) were tested for their antimicrobial effect against control strains and 155 clinical bacterial isolates. The isolates included gram-negative bacteria (E. coli, P. mirabilis, P. aeruginosa, K. Pneumoniae, Salmonella tyhimurium, Enterobacter species, Salmonella typhi, Salmonella paratyphi B, Shigella flexneri, Shigella sonnei and Serratia marcescens). While gram-positive bacteria included (S. aureus, MRSA, S. epidermidis, Diphtheroid, S. faecalis, S. pyogenes, L. monocytogenes and Streptomyces somaliensis). **Methods:** The phytochemical screening of Moringa oleifera (seeds, leaves and flowers) extracts was performed using qualitative determination whilst the antimicrobial activity of ether, alcohol and water extracts of seeds, leaves and flowers was performed using agar diffusion and macrobroth dilution method. **Results:** The results of the phytochemical analysis demonstrated the presence of alkaloids, steroids, flavonoids, tannins and saponin. The studied extracts displayed no activity on gram-negative bacteria whilst displayed various degrees of antibacterial activities against gram-positive bacteria. The extract of seed alcohol, seed water and leaf alcohol was active against all gram-positive. The extract of seed alcohol was very active against S. aureus, Diphtheriod, with the lowest recorded minimal inhibitory concentration (MIC) of 31.25mg/ml, while the seed water extract was very active against S. aureus, Diphtheriod with lowest recorded MIC of 62. 5mg/ml. **Conclusion:** The results of the present study support that Moringa oleifera has antibacterial activity against gram-positive bacteria tested herein.

KEYWORDS: antimicrobial, Moringa oleifera (leaves, seeds, flower), phytocomponents, Minimum inhibitory concentration (MIC).

INTRODUCTION

Since ancient times and in early history, plants were and still important in treatment of disease. The uses of plants continue to be witnessed throughout the world. The World Health Organization (WHO) estimated that 80 % of the population of some developing countries relies on herbal medicine for some aspect of primary health care.[1] Indigenous remedies are the only form of therapy available to the majority of poor people. It has been estimated that only 11% of the population has access to formal health care. [2]

Moringa oleifera is one of the 14 species of the family Moringaceae. [3] According to Muluvi the Moringa tree was introduced to Africa from India at the turn of the twentieth century where it was to be used as a health supplement. [4] M. oleifera is referred to as the 'drumstick tree' or the 'horse radish tree', whereas in others it is known as the kelor tree. [5] While in the Nile valley (Sudan), the name of the tree is 'Shagara al Rauwaq',which means 'tree for purifying. [6] M .oleifera has been widely used for the treatment of different types of diseases due to its antibacterial activity. It is rich in compounds containing the simple sugar, rhamnose and a unique group of compounds called glucosinolates and isothiocyanates. [7, 8] Other medical proprieties include antipyretic, antiepileptic, antiinflamatory, antiulcerative, antihypertensive, cholesterol lowering, antioxidant, antibacterial and antifungal activities, anti diabetic, hepatoprotective. [9, 10, 11, 12, 13] M. oleifera had been tested before but the active components of the plant may vary according to the geographical location. This study is conducted to evaluate the antimicrobial effect, minimum inhibitory concentration and phytochemical characteristic of seeds, leaves and flowers of M. oleifera.

MATERIALS AND METHODS

Preparation of the extract and phytochemical analysis of the plant

The plant used in this study (M. oleifera) was collected from a farm in Sennar State, Sudan during the period from April to October 2013. This plant was taxonomically identified and authenticated from the Medicinal and Aromatic Plants Research Institute (MAPPRI), in Khartoum, Sudan. The flowers, leaves were dried in shade at room temperature and were ground in a mortar to form powder. The brown shells of seeds were removed and the white Kernels were ground in a mortar to form powder. Thereafter, 170g of each of the leaves, seeds, and flower of Moringa were extracted by petroleum ether, ethanol and water

successively by using soxhelet apparatous. The extract was filtered using Whatman filter paper No (1) and evaporated under reduced pressure using Rota-vap. The extracted plant material was then dried inside oven at 45°C to prevent contamination and to ensure that it is completely evaporated. Each residue was weighed. The different extracts were poured in to screw capped glass universal bottles and kept in refrigerator until used. The phytochemical analysis was performed using qualitative determination according to. [14, 15, 16, 17]

Bacterial strains and Identification

The strains of E. coli ATCC25922, P. mirabilis ATCC35659, P. aeruginosa ATCC27853, K. pneumoniae ATCC43816, Salmonella tyhimurium ATCC14028 and S. aureus ATCC25923 were provided by the bacteriology department of the national health laboratory. The bacterial strains were isolated from 155 patients presenting with different clinical condition (wound infection, urinary tract infection, peritonitis, tonsillitis, cough, enteric fever and exit site infection) during 2013 -2014 in Khartoum state, Sudan. Specimens were aseptically collected and inoculated on to chocolate agar, blood agar and MacConkey agar (Hi-Media, Mumbai India). Once pure colonies identified, conventional tests were performed for identification following standard procedures. [18, 19]

Antibiotic profile

Susceptibilities of control and clinical strain to, cefazolin, vancomycin, gentamicin, ciprofloxcin, amikacin, ceftazidime, meropenem, ceftriaxone, penicillin and erythromycin (Hi-Media, Mumbai India) were determined according to the Clinical and Laboratory Standards Institute. [20]

Bacterial susceptibility to plant extract

The minimal inhibitory concentrations (MICs) of the three plant extracts were determined using agar diffusion methods. Briefly, Bacterial culture adjusted to 0.5 McFarland standards were inoculated into Muller & Hinton media (Hi-Media, Mumbai India) Four wells with 7mm in diameter were then cut in the inoculated culture media plate using sterile cork borer. One gram of each extract was dissolved in 1ml of D.W for water extract and 1% dimethyl sulfoxides (DMSO) for ether and alcohol extracts in separate tubes, then serially diluted two fold to obtain final concentration (500mg/ml, 250 mg/ml, 125mg/ml, 62.5mg/ml, 31.25 mg/ml and 15.6 mg/ml). One hundred microliters of each prepared concentrations were then added into the corresponding wells. The plates were then left at room temperature for 1 hour.

Then incubated at 37°C for 24 h. Inhibition zone around each well were then measured using a ruler in millimeters.

As for the oil extract, Four concentrations (100%, 75%, 50%, 25%) v/v of Moringa seed oil type 1 (oil extracted by ether), type 2 (ready to use oil) was prepared as follows: one colony of bacteria was emulsified in 1ml of undiluted seed oil (100%), for the remaining concentrations the 75 µl, 50 µl and 25µl of oil was mixed with 25 µl, 50 µl, 75 µl of bacterial broth culture adjusted to 0.5 McFarland standards respectively. Five drops of ether was added to each tube to help in emulsification. The mixture was incubated at 35ºC for 24h. Each of the tests mentioned above was performed in duplicates. The MIC of the oil was determined by sub-culturing samples from the concentrations above on new plates of Mueller Hinton agar at 35ºC for 48h. [20, 21]

Susceptibility testing of the aerobic actinomycetes (Streptomyces species.) was done using broth macrodilution method. The colonies were dissolved in Brain heart infusion broth and vortexed for 15 seconds. Then adjusted to 0.5 Macfarland standards to obtain approximately 5×10^5 CFU/ml. This dilution was achieved when 500µl from the adjusted inoculums was added to 500µl of the prepared extracts. Serial dilution was then done to achieve the following concentration (250 mg/ml, 125mg/ml, 62.5mg/ml, 31.25 mg/ml 15.6 mg/ml, and 7.8 mg/ml) in a sterile test tube. The seed oil was done as method mentioned above. Then was incubated at 37 ± 2 ºC for three days, The MIC was taken as the lowest concentration that prevented bacterial growth. To exclude contamination of plant extract, the essay was performed as above without inoculation of organism. To exclude the solvent effect the essay was performed as above with the solvent and bacterial strain without adding the plant extract.[22]

RESULTS

Three parts of Moringa oleifera were phytochemically analysed and they showed variation in their chemical component as shown in table 1

Table 1: Phytochemical component of the different parts of M. oleifera extracts

Seeds	Saponin	Flavonoids	Alkaloids	Steroid	Tanin	Glycosides	Reduced sugars
Ether extract	N	N	P	P	N	N	N

Alcoholic extract	**P**	**P**	**P**	**N**	**P**	**P**	**N**
Aqueous extract	**P**	**P**	**N**	**N**	**T**	**N**	**N**
Leaves							
Ether extract	**N**	**N**	**P**	**P**	**N**	**N**	**N**
Alcoholic extract	**P**	**P**	**N**	**T**	**P**	**N**	**N**
Aqueous extract	**P**	**T**	**N**	**N**	**T**	**N**	**N**
Flowers							
Ether extract	**N**	**N**	**T**	**P**	**N**	**N**	**N**
Alcoholic extract	**N**	**T**	**T**	**P**	**T**	**N**	**N**
Aqueous extract	**N**	**T**	**N**	**N**	**T**	**N**	**N**

***P: Positive, N: Negative, T: Trace.**

All extracts from the different parts of Moringa showed no anti-microbial activity against the tested gram negative bacteria. The seed alcohol extracts exerted antimicrobial activity against all the tested gram positive bacteria with variation of its action according to concentrations. It showed inhibition zones for all gram positive at concentration of 62.5 mg/ml except 3 organisms Diphtheroid, S. aureus against which it was effective up to concentration of 31.23mg/ml and S. pyogenes, L. monocytogenes up to 125mg/ml. The best action of the extract was against the standard S. aureus inhibition zone of (28mm at concentration of 500mg/ml) table 2A and 3. Seed water was the second effective extract against gram positive organisms table 2B. In this study M. oleifera seed oil type1, type 2 extracted were used at concentrations 100%, 75%, 50%, 25% revealed no antibacterial activity against gram positive bacteria control strains and clinical isolates and so leaves and flowers ether at (500mg/ml).

Table 2A: The inhibition zones of the different concentrations of alcohol extract of M. oleifera seed on bacterial isolates. Diameter of the inhibition zone in mm

Bacteria species	No	500 mg/ml	250 mg/ml	125 mg/ml	62.5 mg/ml	31.25 mg/ml	15.6 mg/ml
Staphylococcus aureus ATCC	**1**	**28**	**22**	**10**	**8**	**6**	**resistant**
Staphylococcus aureus	**36**	**27-24**	**22-18**	**16-12**	**10-7**	**6-3**	**resistant**
Methicillin-resistant Staphylococcus aureus (MRSA)	**3**	**24-22**	**20-17**	**15-13**	**9-7**	**resistant**	**resistant**
Staph. epidermidis	**12**	**25-22**	**18-16**	**15-12**	**11-3**	**resistant**	**resistant**
Diphtheroid speices	**12**	**27-24**	**22-19**	**17-13**	**11-8**	**6-3**	**resistant**
Streptococcus faecalis	**5**	**22-20**	**20-17**	**15-12**	**11-9**	**resistant**	**resistant**
Streptococcus pyogenes	**2**	**24-22**	**20- 16**	**12-10**	**resistant**	**resistant**	**resistant**
Listeria monocytogenes	**1**	**13**	**11**	**8**	**resistant**	**resistant**	**resistant**

Table 2B: The inhibition zones of the different concentrations of water extract of M. oleifera seed on bacterial isolates. Diameter of the inhibition zone in mm

Bacteria species	500 mg/ml	250 mg/ml	125 mg/ml	62.5 mg/ml	31.25mg/ml	15.6 mg/ml
Staphylococcus aureus ATCC	24	19	12	8	resistant	resistant
Staphylococcus aureus	24-21	19-17	14-11	10-4	resistant	resistant
Methicillin-resistant Staphylococcus aureus (MRSA)	20-17	16-14	7-0	resistant	resistant	resistant
Staph. epidermidis	22-18	14-10	9-6	resistant	resistant	resistant
Diphtheroid speices	22-17	15-12	10-7	6-2	resistant	resistant
Streptococcus faecalis	25-22	20-17	14-4	resistant	resistant	resistant
Streptococcus pyogenes	23-20	17-14	13-8	resistant	resistant	resistant
Listeria monocytogenes	15	14	10	resistant	resistant	resistant

Table 2D showed that the leaves water, showed no activity against S. pyogenes, L. momocytogenes, and Diphtheriod species.

Two isolates of S. aureus (isolated from urine) were resistant to all Moringa parts. While 3 isolates of S. epidermidis isolated from peritoneal fluid and exit site infection of peritoneal catheter, and 5 isolates of Diphtheroid species isolated from exit site were resistant to leaves alcohol at 500mg/ml. Leaves ether showed inhibitory action only against Diphtheroid, S. pyogenes, L. momocytogenes. The Diphtheroid was sensitive to leaf ether extract at 500mg/ml with zones of inhibition (17-16mm), 250mg/ml (14-10mm), 125mg/ml (10-7mm) and 62.5mg/ml (6-2mm). The MIC of leaf ether to Diphtheroid was 62.5mg/ml. S. pyogenes was inhibited at the same concentrations above with inhibition zones of 16-14mm, 12-9 mm, 8-7 mm and 6-3mm respectively and MIC of 62.5mg/ml. For L. momocytogenes the inhibition zone were 20mm, 14mm and 8mm for the concentration 500mg/ml, 250mg/ml and 125mg/ml respectively. The MIC was 125mg/ml.

Table 2C: The inhibition zones of the different concentrations of alcohol extract of M. oleifera leaf on bacterial isolates. Diameter of the inhibition zone in mm

Bacteria species	500 mg/ml	250 mg/ml	125 mg/ml	62.5 mg/ml	31.25 mg/ml	15.6 mg/ml
Staphylococcus aureus ATCC	25	16	7	resistant	resistant	resistant
Staphylococcus aureus	25-20	18-15	12-3	resistant	resistant	resistant
Methicillin-resistant Staphylococcus aureus(MRSA)	20-19	16-10	8-5	resistant	resistant	resistant
Staph. epidermidis	22-18	15-10	8-4	resistant	resistant	resistant
Diphtheroid speices	27-23	20-18	15-10	8-3	resistant	resistant
Streptococcus faecalis	18-15	13-10	9-3	resistant	resistant	resistant

Streptococcus pyogenes	**24-22**	**21-13**	**12-7**	**resistant**	**resistant**	**resistant**
Listeria monocytogenes	**12**	**10**	**resistant**	**resistant**	**resistant**	**resistant**

Table 2D: The inhibition zones of the different concentrations of water extract of M. oleifera leaf on bacterial isolates. Diameter of the inhibition zone in mm

Bacteria species	500 mg/ml	250 mg/ml	125 mg/ml	62.5 mg/ml	31.25 mg/ml	15.6 mg/ml
Staphylococcus aureus ATCC	**20**	**15**	**10**	**resistant**	**resistant**	**resistant**
Staphylococcus aureus	**20-17**	**14-11**	**10-3**	**resistant**	**resistant**	**resistant**
Methicillin-resistant Staphylococcus aureus(MRSA)	**19-17**	**13-10**	**resistant**	**resistant**	**resistant**	**resistant**
Staph. epidermidis	**20-18**	**14-7**	**6-4**	**resistant**	**resistant**	**resistant**
Diphtheroid speices	**resistant**	**resistant**	**resistant**	**resistant**	**resistant**	**resistant**
Streptococcus faecalis	**17-12**	**10-7**	**6-4**	**resistant**	**resistant**	**resistant**
Streptococcus pyogenes	**resistant**	**resistant**	**resistant**	**resistant**	**resistant**	**resistant**
Listeria monocytogenes	**resistant**	**resistant**	**resistant**	**resistant**	**resistant**	**resistant**

Table 2E, 2F showed that the flower alcohol and flower water extracts showed no activity against S. pyogenes and L. momocytogenes.

Table 2E: The inhibition zones of the different concentrations of alcohol extract of M. oleifera flower on bacterial isolates. Diameter of the inhibition zone in mm

Bacteria species	500 mg/ml	250 mg/ml	125 mg/ml	62.5 mg/ml	31.25 mg/ml	15.6 mg/ml
Staphylococcus aureus ATCC	**23**	**16**	**10**	**resistant**	**resistant**	**resistant**
Staphylococcus aureus	**23-21**	**18-16**	**12-6**	**resistant**	**resistant**	**resistant**
Methicillin-resistant Staphylococcus aureus(MRSA)	**22-20**	**18-15**	**11-4**	**resistant**	**resistant**	**resistant**
Staph. epidermidis	**20-15**	**12-10**	**6-4**	**resistant**	**resistant**	**resistant**
Diphtheroid speices	**20-18**	**16-13**	**9-5**	**resistant**	**resistant**	**resistant**
Streptococcus faecalis	**22-16**	**15-12**	**10-5**	**resistant**	**resistant**	**resistant**
Streptococcus pyogenes	**resistant**	**resistant**	**resistant**	**resistant**	**resistant**	**resistant**
Listeria monocytogenes	**resistant**	**resistant**	**resistant**	**resistant**	**resistant**	**resistant**

Table 2F: The inhibition zones of the different concentrations of water extract of M. oleifera flower on bacterial isolates. Diameter of the inhibition zone in mm

Bacteria species	500	250 mg/ml	125 mg/ml	62.5 mg/ml	31.25	15.6 mg/ml

	mg/ml				mg/ml	
Staphylococcus aureus ATCC	**20**	**15**	**10**	**resistant**	**resistant**	**resistant**
Staphylococcus aureus	**20-15**	**12-9**	**8-3**	**resistant**	**resistant**	**resistant**
Methicillin-resistant Staphylococcus aureus (MRSA)	**17-15**	**12-9**	**7-4**	**resistant**	**resistant**	**resistant**
Staph. epidermidis	**21-14**	**11-6**	**9-3**	**resistant**	**resistant**	**resistant**
Diphtheroid speices	**18-14**	**10-8**	**7-3**	**resistant**	**resistant**	**resistant**
Streptococcus faecalis	**15-13**	**11-6**	**5-3**	**resistant**	**resistant**	**resistant**
Streptococcus pyogenes	**resistant**	**resistant**	**resistant**	**resistant**	**resistant**	**resistant**
Listeria monocytogenes	**resistant**	**resistant**	**resistant**	**resistant**	**resistant**	**resistant**

The Minimum inhibitory concentration of each organism against the different extracts range from 250mg/ml – 31.25 mg/ml table 3.

Table 3: Minimum inhibitory concentration of Petroleum ether, Ethanol and Water extract of M. oleifera seeds, leaves and flowers activity against human pathogens expressed in mg/ml.

Clinical isolates	SA	SW	LE	LA	L W	FA	F W
Staphylococcus aureus ATCC	**31.25**	**62.5**	**resistant**	**125**	**125**	**125**	**125**
Staphylococcus aureus	**31.25**	**62.5**	**resistant**	**125**	**125**	**125**	**125**
Methicillin-resistant Staphylococcus aureus (MRSA)	**62.5**	**125**	**resistant**	**125**	**250**	**125**	**125**
Staph. epidermidis	**62.5**	**125**	**resistant**	**125**	**125**	**125**	**125**
Diphtheroid speices	**31.25**	**62.5**	**62.5**	**62.5**	**resistant**	**125**	**125**
Streptococcus faecalis	**62.5**	**125**	**resistant**	**125**	**125**	**125**	**125**
Streptococcus pyogenes	**125**	**125**	**62.5**	**125**	**resistant**	**resistant**	**resistant**
Listeria monocytogenes	**125**	**125**	**125**	**250**	**resistant**	**resistant**	**resistant**

SA: seed alcohol, SW: seed water, LE: leaf ether, LA: leaf alcohol, LW: leaf water, FA: flower alcohol, FW: flower water.

Streptomyces was completely inhibited by seed water and resistant to seed oil type 1 and 2 leaves ether, leaves water, flower ether as shown in (table 4).

Table 4: Antimicrobial activity of Petroleum ether, Ethanol and Water extract of M. oleifera seeds, leaves and flowers activity against Streptomyces somaliensis.

Extract type	Concentration required in mg/ml					
	250	125	62.5	31.25	15.6	7.8
Seed alcohol	No growth	No growth	No growth	No growth	Hazy	Moderate
Seed water	No growth	No growth	No growth	No growth	No growth	No growth
Leaf ether	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant
Leaf alcohol	No growth	No growth	No growth	Hazy	Moderate	Heavy
Leaf water	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant
Flower ether	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant
Flower alcohol	No growth	No growth	No growth	Hazy	Moderate	Heavy
Flower water	No growth	No growth	No growth	No growth	Hazy	Clumpy

The appropriate standard antibiotic discs were tested against standard bacteria and clinical isolates. All the organisms tested were sensitive to antibiotics used except MRSA was resistant to all antibiotic tested except vancomycin and presented in Table 5A and 5B.

Table 5A: Antimicrobial activities of control strains and clinical isolates of gram positive bacteria against the corresponding standard antibiotics.

Bacteria species	VA	CZ	G	CIP	CAZ	P	E	CTR
S. aureus ATCC	26	30	25	28	ND	ND	ND	ND
S. aureus	18-25	20-24	22-30	22-26	ND	ND	ND	ND
Methicillin-resistant Staphylococcus aureus (MRSA)	18-20	R	R	R	R	ND	ND	R
S. epidermidis	20-30	20-25	22-29	22-24	ND	ND	ND	ND
Diphtheriod species	25-31	ND	26-30	22-28	ND	ND	ND	ND
S. faecalis	20-24	R	18-20	22-25	ND	ND	ND	ND
S. pyogenes	ND	ND	ND	ND	ND	29-32	22-23	28-30
L. monocytogenes	ND	ND	30	32	ND	30	ND	R

VA: vancomycin, CZ: cefazolin, G: gentamicin, CIP: ciprofloxacin, CAZ: ceftazidime, P: penicillin, E: erythromycin, CTR: ceftriaxone ND: not done, R: resistant, numbers indicate the measurement of inhibition zone in mm

Table 5B: Antimicrobial activities of control strains and clinical isolates of gram negative bacteria against the corresponding standard antibiotics.

Bacteria species	N	G	CIP	AK	CAZ	MRP
Escherichia coli ATCC	1	22	30	20	32	30
Klebsiella pneumoniae ATCC	1	22	38	25	32	30
Pseudomonas aeruginosa ATCC	1	24	29	23	26	29
Salmonella tyhimurium ATCC	1	ND	30	ND	ND	ND
Proteus mirabilis ATCC	1	23	25	30	33	30
P. aeruginosa	21	22-30	26-31	25-30	20-27	26-30
E. coli	27	20-30	28-30	20-26	26-30	25-35
Proteus mirabilis	13	25-30	22-30	18-20	22-25	25-32
K. Pneumoniae	8	15-22	21-28	18-22	30-35	22-32
Enterobacter species	2	32	23	25	22	25

Salmonella typhi	**1**	**ND**	**30**	**ND**	**ND**	**ND**
Salmonella paratyhi B	**1**	**ND**	**26**	**ND**	**ND**	**ND**
Shigella sonnei	**1**	**ND**	**22**	**ND**	**ND**	**ND**
Shigella flexneri	**1**	**ND**	**23**	**ND**	**ND**	**ND**
Serratia marcescens	**1**	**25**	**30**	**25**	**30**	**ND**

G: gentamicin, CIP: ciprofloxacin, AK: amikacin, CAZz: ceftazidime, MRP: meropenem, ND: not done, numbers indicate the measurement of inhibition zone in mm.

DISCUSSION

Each of the extract tested in the current study showed no antibacterial activity on gram-negative bacterial strains tested. However they showed antibacterial activities against gram-positive bacterial strains. In general the seed alcohol, water extract showed the best antibacterial activity followed by leaves alcohol extract against all grams positive bacteria tested. The results of this present research showed that Moringa seed ethanol extract had broadest spectrum of activity on the tested bacteria. The overall data of this study were in accordance with previous results.

The antibacterial activity of Moringa seeds had been reported by many researchers. Our results were in agreement with Saadabi who reported that Moringa seeds extract has the best antibacterial activity. The petroleum ether had no antibacterial activity against S. aureus, E. coli, P. aeruginosa while seed water had antibacterial activity against S. aureus. [23]

Some food pathogen like S. aureus, E. coli, were tested against seed ethanol extract and found to be sensitive at 50mg/ml while Enterobacter spp, Shigella spp, P. aeruginosa, and Salmonella typhi were not sensitive to seed ethanol extract. [24]

Also our findings are consistent with the findings of Gomashe who reported that the Petroleum extract of leaves was not effective against all the test pathogens (Salmonella typhi, Klebsiella pneumoniae, Escherichia coli, Staphylococcus aureus) at 30mg/ml except P. aeruginosa (12mm). [25] Doughari 2007 who reported in their study on the antibacterial activity from the aqueous, acetone and ethanol extracts of the leaves of M. oleifera that ethanol extract of the plant demonstrated the highest activity, while the aqueous extract showed the least activity at 100 mg/ml. [26] In this study leaf aqueous extract showed the least activity and did not inhibit L. monocytogenes, S. pyogenes and Diphtheriod species, while the ethanol extract showed significant and better activity at 125mg/ml.

To the best of our knowledge, the antimicrobial activity of seed water against streptomyces somaliensis described here was not recorded before. The overall antibiotic susceptibility results were similar to antimicrobial activity of the plant extracts.

Ellert and Guevera reported that the antimicrobial activity of Moringa seed is due to the presence of phyto-chemical compounds. Due to presence of 4(α-L-rhamnosyloxy)-benzyl isothiocyanate. [27, 28] The concentrations of these phytochemicals and the variations in the findings of this study compared to earlier studies reported may be due to the environment, geographical site, genetics, and soil. [29] Moringa leaves ethanol revealed presence of flavonoids and saponins and Moringa seed ethanol contains alkaloids in agreement with bukar. [24] Moringa seed ethanol contain tannins and saponins in agreement with Napolean. [30] The flowers contain pterogospermin, this component an active antibacterial activity. [31]

It has been reported that different solvents have different extraction capabilities. [25, 32, 33] Himal reported that to extract broad spectrum antimicrobial compound from plant is confirmed by the ethanol solvents. [34] The differences observed between antibacterial activities of the extracts could be explained by the differences in the chemical composition of these extracts.

CONCLUSION

M. oleifera extract proved to be highly potent against different strains of gram positive organisms. Leaves and flowers possess antibacterial to a lesser extent. The best activity reported by the seeds alcohol and water extract against S. aureus control strain and clinical isolates. The inhibition zones of the plant are closely resembled to the inhibitory zones of the antibiotics so can lead to the development of new chemical compounds which can be used to treat various types of infection.

ACKNOWLEDGEMENT

The author would like to thank the staff member if the National Ribat University Hospital and Peritoneal Dialysis Program Khartoum, Sudan for their great help.

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