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Assessment of the Antimicrobial Properties of *Aloe Vera* Extract on some Clinical Isolates

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ABSTRACT

The crude of *Aloe Vera* gel was investigated with the aim of determining the microbial activity (MIC), the best solvent to be used for extraction and the organism that is most susceptible to the crude *Aloe vera* gel extract. The present study investigates the minimum inhibitory concentration (MIC) of *Aloe vera* extracts against tested bacteria isolates (*Staphylococcus aureus, Klebsiella pneumonia, Streptococcus spp., Proteus spp., Pseudomonas aeruginosa, Escherichia coli, Morganella morganii, Citrobacter spp.* and *Enterobacter spp*.) from various samples (urine, wound swab, stool and blood). Hydrochloric acid, Acetic acid, Propylene glycol and Isopropyl alcohol extracts were used as solvent for extraction. Although HCl extract had the highest MIC after extraction as compared to Acetic acid, Propylene glycol and Isopropyl alcohol extracts. The HCl extract gave a better minimum inhibitory concentration (MIC) (21.15 to 42.30 mg/ml) than Acetic acid (MIC 0.0 mg/ml), Propylene glycol (MIC 0.0 mg/ml) and Isopropyl alcohol (MIC 0.0 mg/ml) extracts. The study revealed that HCl extracts of *aloe vera* gel was susceptible to the all pathogens and also lend more weight to general acceptability of these crude extracts for therapeutic purposes. It was observed that only HCL extract (µg/ml) of *aloe vera* had antibacterial effect on tested organisms with MIC of 21.15 mg/ml to 42.30 mg/ml. The present study has revealed the importance of natural products to control antibiotic resistant bacteria, which have been a threat to human health. This study confirms the better understanding of the in vitro antibacterial activity of HCL Aloe vera gel against skin pathogens. From our results it can be concluded that Aloe vera gel HCl extract possesses several bioactive compounds with antimicrobial properties which can be used as antimicrobial agents in new drugs formulations of infectious diseases in humans.

Keywords: *Aloe Vera, Microbial, Staphylococcus, Streptococcus*, MIC, Clinical.

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INTRODUCTION

Plants have been an important source of medicine for thousands of years. Even today, the World Health Organization estimates that up to 80 percent of people still rely mainly on traditional remedies such as herbs for their medicines. Its civilization is very ancient and the country as a whole has long been known for its rich resources of medical plants. Today, Ayurvedic, Hoemoeo and Unani physicians utilize numerous species of medicinal plants that found their way a long time ago into the Hindu Material Media. *Aloe vera* (*Aloe barbadensis miller*) is a cactus like xerophytes plant and about 360 species of this plant have been identified so far. It has been named due to its therapeutic effectiveness among all tested species. It is cultivated in warm climatic areas of the world. *Aloe vera* (AV) has been known as "secret plant" because it contains photochemical, vitamins and nutrients [1]. This plant has elongated, pointed and fleshy leaves which consists of two parts, an outer skin (green rind or latex) and an inner pulp which is colorless mucilaginous gel [2,3].

Aloe barbadensis Miller, commonly known as *Aloe vera*, belongs to the family *Liliaceae* [4]. *Aloe vera* is a typical xerophyte with thick fleshy, strangely cuticularized spiny leaves. It has been endorsed for large variety of conditions and has come to play a prominent role as a contemporary folk medicine [5]. The peeled, spineless leaves of the plant contain mucilaginous jelly from the parenchyma cells which is referred as *Aloe vera* gel. The gel is a watery-thin, viscous, colorless liquid that contains anthraquinone glycosides, glycoprotein, gamma-linolenic acid, prostaglandins and mucopolysaccharides that are essentially responsible for the medicinal properties including antibacterial, antifungal and its antiviral activity [6]. It is a natural coolant which is bittersweet in taste. Therefore, in Ayurveda, it is believed to subside the vitiated (destructive) pitta and kapha doshas. It has purgative, growth enhancer or promoter, aphrodisiac, and anti-inflammatory properties. It is also a good blood purifier, uterine tonic. *Aloe vera* is widely used in liver- spleen inflammatory conditions, skin diseases and ophthalmic disorders. Due to its anti-inflammatory and wound healing properties it is especially used in abscess, boils, blisters, ulcers and infected burn wounds [7].

Traditional medicine is in practice for many centuries by a substantial proportion of the population of many centuries. It is recognized that in some developing countries, plants are the main medicinal source to treat various infectious diseases. Plant extracts represent a continuous effort to find new compound against pathogens. Approximately 20% of the plants are found in the world have been submitted to pharmacological or biological test, and a substantial number of new antibiotics introduced on the market are obtained from natural or semisynthetic resources [8]. *Aloe vera* (*Aloe barbadensis* miller) is a plant, which belongs to the family of Liliaceae and is mostly succulent with a whorl of elongated, pointed leaves [9,10]. The name is derived from the Arabic word 'alloeh' which means 'bitter', referring to the taste of the liquid contained in the leaves. Aloe that is believed to have originated in the Sudan. *Aloe vera* grows in arid climates and is widely distributed in Africa, India and other arid areas. The species is frequently cited as being used in herbal medicine. *Aloe vera* is a perennial, drought resisting, succulent plant. It has stiff green, lance-shaped leaves containing clear gel in a central mucilaginous pulp. Its thick leaves contain the water supply for the plant to survive long periods of drought [11]. The leaves have a high capacity of retaining water also in very warm dry climates and it can survive very harsh circumstances. When a leaf in cut, an orange-yellow sap drips from the open end. When the green skin of a leaf is removed a clear mucilaginous substance appears that contains fibres, water and the ingredient to retain the water in the leaf. The gel contains 99.3% of water, the remaining 0.7% is made up of solids with carbohydrates constituting for a large component [11]. Concentrated extracts of Aloe leaves are used as laxative and as a haemorrhoid treatment. Aloe gel can help to stimulate the body's immune system [12]. The use of plant product for pharmaceutical purpose has been gradually increased. According to World Health Organisation, medicinal plants would be the best source for obtaining a variety of drugs [13]. The use of plant extracts, with known antimicrobial properties, can be of great significance in the treatment of various microbial infections. In the last decade, numerous studies have been conducted in different countries to prove such efficiency in number of medicinal plants. Most of the studies are restricted with crude extracts [14,15].

Diseases due to pathogenic bacteria and fungi represent a critical problem to human health and they are one of the main causes of morbidity and mortality worldwide [16]. The evolution of multiple drug resistant human pathogenic microorganisms has driven the search for new sources of antimicrobial substances, including plant metabolites [17]. Thus, the investigation of the efficacy of plant-based drugs in traditional medicine has been paid great attention because these drugs elicit few side effects, cheap and easily available, according to World Health Organization, 80% of the world population still relies mainly on plant drug [18]. Many studies have demonstrated so far the presence of many biologically active phytochemicals in the various solvent extracts of *Aloe vera* gel [19], which may be responsible for its hypoglycemic and antioxidant properties [20]. The aim of this study is to evaluate the minimum inhibitory concentration *Aloe vera* extracts on some selected organisms.

MATERIALS AND METHODS

The plant of *Aloe vera* (leaves) was collected from Herbal Garden in Ekpoma. The plant part (leaves) was identified by a taxonomist in the Department of Botany, Ambrose Alli University, Ekpoma, Edo Sate, Nigeria.

Extraction

The leaves of *Aloe vera* plant were washed several times using distilled water, air dried and crushed to small piece using Mortar and Pestle and powdered in an electric grinder. Ten grams of powdered plant materials mixed with 100ml of various solvents (1%Hydrochloric acid, 5%Acetic acid, Propylene glycol and Isopropyl alcohol). The extracts preparations were done as previously described by Alade and Irobi [21]. The plant extracts were prepared by using soxhlet apparatus collected and stored in a vial for further studies.

- 500g of plant parts (*aloe vera* plant, aloe barbardensis) was weighed and dried for 5days in a drying cabinet at 50°C
- The dried plant was grinded to powered using electric grinding machine
- 10grams of the powered plant, was weighed into four 250ml conical flasks. 100mls of each extraction solvent (1%Hcl, 5% acetic acid, propylene glycol (PPG) and Isopropyl alcohol (IPA) was added to the conical flasks respectively.
- The conical flasks were placed on mechanical shaker and allowed to extract overnight.
- The extracts were filtered into sterile conical flasks using Whatman filter paper number
- The filtrate was used for the experiment while the deposit was discarded [22].

Determination of Purity of Extract

With the aid of 4mm wireloop, one loop extract solution was streaked inoculated onto nutrient agar and incubated at 370c for 24hours. The absence of growth after overnight incubation indicates purity of extract solution. A 1 in 2 dilution of the extract solution is made, followed by a 1 in 20 dilution serial dilution of the extract solution is made as follows

Protocol

- 1in 2 dilution of the extract solution is made in 5 test tubes.
- With the aid of a 50ml dropper pipette, 1 in 100 dilution of an overnight both culture of the test organism is added a each test tube
- Controls are set up as follows
- I test tube with 1ml of plain broth C1
- 1 tube with 1ml of extract solution (C2) is incubated along with the text.

Determination of Extract Concentration

The specific gravity, S.G of each diluent/solvent (1%HCL, 5% acetic acid, propylene glycol (PPG) and Isopropylacohol (IPA)) was determined as follows: The weight, W1 of the clean dried empty specific gravity, S. G bottle was taken The specific gravity bottle was filled with the diluents and the stopper was place. The overflowed fluid was cleared off from the body of the bottle with a filter paper. The weight W2 of the diluents with the S.G bottle was taken. The weight W3, of the diluent was gotten by subtracting the weight W1 of the empty S.G bottle from the weight W2 of the diluent with S.G bottle i.e W3=W2-W1

The S.G of the diluents was determined by the expression below.

Specific gravity = (Weight of solvent+ S.G bottle – weight of empty S.G bottle)/(volume of S.G botlle (V))

S.G of solvent /diluents *(W2-W1)/V=W3/V*

Where V= Vol. of S.G bottle = 25ml

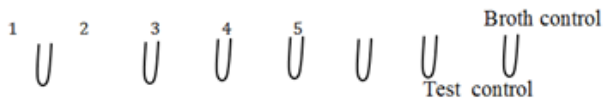
In the same manner above, the S.G of each extract solution was also determined

The concentration of each extract solution was determined by the expression below

Concentration of extract solution = specific gravity of extract solution – specific gravity of plain solvent = SG2–SG1.

Determination of minimum inhibitory concentration (MIC) of extract solution

- A row of 5 test tubes was set up on a test tube rack
- 1 ml of extract solution was dispensed into each test tube
- With the aid of 1ml pipette, 1ml of normal saline was added to test tube 1 and mixed properly
- From test tube 1, 1ml was transferred into text tube 2 and the serial dilution was completed till the end of the row.
- 1 drop of a 1 in 100 dilution of overnight text organism (broth culture) was added to each tube
- 1ml of plain solvent each was placed in test tube(C1) and 1ml of extract solution each was placed in the test tubes respectively as controls and incubated along with the test tubes

- The last test tube from the beginning without growth is
- 

Source of Bacterial Isolates

The different test organisms were gotten from urine, stool, blood and wound swab of clinical samples of patient visiting Irrua Specialist Teaching Hospital (ISTH) Irrua, Edo state and were analyzed using Medical Diagnostic Laboratory, College of Medical Sciences, Ambrose Alli University, Ekpoma, Edo State. The test organisms isolated for the study includes; *Staphylococcus aureus, Klebsiella pneumonia, Streptococcus species, Proteus spp, Pseudomonas aeruginosa, Escherichia coli, Morganella morganii, Citrobacter species* and *Enterobacter species*.

Preparation of Test Organisms: The different organism isolated; *Staphylococcus aureus, Klebsiella pneumonia, Streptococcus species, Proteus species, Pseudomonas species, Escherichia coli, Morganella morganii, Citrobacter species* and *Enterobacter species* were sub-cultured into peptone water for 8 hours before antibiogram extract testing.

Identification of Test Organisms: All isolates for this study were identified by their colonial morphology, Gram stain reaction, biochemical test characterization. Also using their colonial appearances on the media which include Size, Shape, Elevation, Opacity, Edge, Colour, haemolysis and fermentation.

Gram staining was carried out on culture that yielded growth using standard procedures.

Catalase test was done on Gram positive cocci. Catalase negative Gram-positive Cocci in chains were identified as *Streptococcus species* while the catalase positive cocci in clusters were identified as *Staphylococcus species*. Coagulase test was carried out on all the catalase positive cocci. The coagulase positive organism was identified as *Staphylococcus aureus*.

For the Gram-negative bacilli, overnight broth cultures was made for each by adding the colonies to sterilized peptone water and incubated for 24 hours at 370C and motility test was done to ascertain their motility.

Data Analysis

The data generated was analyzed statistically using the mean±SD to ascertain the significance of the study.

RESULTS

The present study investigates the minimum inhibitory concentration (MIC) of *Aloe vera* extracts against tested bacteria isolates (*Staphylococcus aureus, Klebsiella pneumonia, Streptococcus spp., Proteus spp., Pseudomonas aeruginosa, Escherichia coli, Morganella morganii, Citrobacter spp.* and *Enterobacter spp.*) from various samples (urine, wound swab, stool and blood).

Table 1 shows the samples analyzed and organisms isolated from urine, wound swab, stool and blood. From the urine samples the following organisms were isolated; *Staphylococcus aureus, Escherichia coli, Klebsiella pneumonia, Pseudomonas aeruginosa, Morganella morganii, Streptococcus spp., Proteus spp.* and *Citrobacter spp*. The organisms isolated from wound swab samples in the study are; *Proteus spp., Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus, Morganella morganii, Klebsiella pneumonia, Enterobacter spp.* and *Streptococcus spp*. The organisms isolated from stool samples in the study are; *Escherichia coli, Pseudomonas aeruginosa* and *Enterobacter spp*. Only one organism was isolated from the blood samples examined in the study which is Staphylococcus aureus.

Table 2 shows the Minimum Inhibitory Concentration (MIC) of HCL extract (µg/ml) of *aloe vera* against test organisms. It was observed that HCL extract (µg/ml) of *aloe vera* had MIC of 21.16µg/ml when tested against *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Morganella morganii, Streptococcus spp*. and MIC of 42.30 µg/ml when tested against *Proteus spp., Citrobacter spp., Enterobacter spp.,* and *Klebsiella pneumonia*.

Table 3 shows the Minimum Inhibitory Concentration (MIC) of Acetic acid extract (µg/ml) of *aloe vera* against test organisms. It was observed that Acetic acid extract (µg/ml) of *aloe vera* had MIC of 0.0 µg/ml when tested against all the test organisms; *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Morganella morganii, Streptococcus spp., Proteus spp., Citrobacter spp., Enterobacter spp.,* and *Klebsiella pneumonia*.

Table 4 shows the Minimum Inhibitory Concentration (MIC) of Propylene glycol (PPG) (µg/ml) of *aloe vera* against test organisms. It was observed that Propylene glycol extract (µg/ml) of *aloe vera* had MIC of 0.0 µg/ml when tested against all the test organisms; *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Morganella morganii, Streptococcus spp., Proteus spp., Citrobacter spp., Enterobacter spp.,* and *Klebsiella pneumonia*.

Table 5 shows the Minimum Inhibitory Concentration (MIC) of Isopropyl Alcohol (IPA) (µg/ml) of *aloe vera* against test organisms. It was observed that Isopropyl Alcohol extract (µg/ml) of *aloe vera* had MIC of 0.0µg/ml when tested against all the test organisms; *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Morganella morganii, Streptococcus spp., Proteus spp., Citrobacter spp.,*

Enterobacter spp., and *Klebsiella pneumonia*.

Table 6 shows the summary of the Minimum Inhibitory Concentration (MIC) of all the *aloe vera* extracts studied against test organisms. It was observed that only HCL extract (µg/ml) of *aloe vera* had antibacterial effect on tested organisms with MIC of 21.15µg/ml to 42.30 µg/ml.

Table 1. Showing Samples Analyzed and Organisms Isolated

Samples Analyzed	Organisms isolated
Urine	*Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Morganella morganii, Streptococcus spp, Proteus spp, Citrobacter spp, Klebsiella pneumonia*
Wound swab	*Proteus spp, Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus, Morganella morganii, Klebsiella pneumonia, Enterobacter spp, Streptococcus spp*
Stool	*Escherichia coli, Pseudomonas aeruginosa, Enterobacter spp,*
Blood	*Staphylococcus aureus*

Table 2. Minimum Inhibitory Concentration (MIC) of HCL extract (µg/ml) of *aloe vera* against test organisms

Test Organisms	Concentration of Extracts (42.30 – 2.64 µg/ml)					
	42.30	21.15	10.58	5.24	2.64	MIC (µg/mL)
Staphylococcus aureus	-	-	+	+	+	21.15
Escherichia coli	-	-	+	+	+	21.15
Pseudomonas aeruginosa	-	-	+	+	+	21.15
Morganella morganii	-	-	+	+	+	21.15
Streptococcus spp.	-	-	+	+	+	21.15
Proteus spp.	-	+	+	+	+	42.30
Citrobacter spp.	-	+	+	+	+	42.30
Enterobacter spp.	-	+	+	+	+	42.30
Klebsiella pneumonia	-	+	+	+	+	42.30

KEY

- = No turbidity

+ = Turbidity

Table 3. Minimum Inhibitory Concentration (MIC) of Acetic acid extract (µg/ml) of *aloe vera* against test organisms

Test Organisms	Concentration of Extracts (42.30 – 2.64 µg/ml)					
	9.6	4.8	2.4	1.2	0.6	MIC (µg/ml)
Staphylococcus aureus	+	+	+	+	+	0
Escherichia coli	+	+	+	+	+	0
Pseudomonas aeruginosa	+	+	+	+	+	0
Morganella morganii	+	+	+	+	+	0
Streptococcus spp.	+	+	+	+	+	0
Proteus spp.	+	+	+	+	+	0
Citrobacter spp.	+	+	+	+	+	0
Enterobacter spp.	+	+	+	+	+	0
Klebsiella pneumonia	+	+	+	+	+	0

Table 4. Minimum Inhibitory Concentration (MIC) of Propylene glycol (PPG) extract (µg/ml) of *aloe vera* against test organisms

Test Organisms	Concentration of Extracts (42.30 – 2.64 µg/ml)					
	39.2	19.6	9.8	4.9	2.45	(µg/ml)
Staphylococcus aureus	+	+	+	+	+	0
Escherichia coli	+	+	+	+	+	
Pseudomonas aeruginosa	+	+	+	+	+	0
Morganella morganii	+	+	+	+	+	0
Streptococcus spp.	+	+	+	+	+	0
Proteus spp.	+	+	+	+	+	0
Citrobacter spp.	+	+	+	+	+	0
Enterobacter spp.	+	+	+	+	+	0
Klebsiella pneumonia	+	+	+	+	+	0

Table 5. Minimum Inhibitory Concentration (MIC) of Isopropyl Alcohol (IPA) extract (µg/ml) of *aloe vera* against test organisms

Test Organisms	Concentration of Extracts (42.30 – 2.64 µg/ml)					
	147.85	73.93	36.96	18.48	9.24	MIC (µg/ml)
Staphylococcus aureus	+	+	+	+	+	0
Escherichia coli	+	+	+	+	+	0
Pseudomonas aeruginosa	+	+	+	+	+	0
Morganella morganii	+	+	+	+	+	0
Streptococcus spp.	+	+	+	+	+	0
Proteus spp.	+	+	+	+	+	0
Citrobacter spp.	+	+	+	+	+	0
Enterobacter spp.	+	+	+	+	+	0
Klebsiella pneumonia	+	+	+	+	+	0

Table 6. Summary of the Minimum Inhibitory Concentration (MIC) of *Aloe vera* extracts (µg/ml) against test organisms

Test Organisms	*Aloe vera* extracts			
	Hydrochloric acid (HCL)	Acetic Acid (AA)	Propylene glycol (PPG)	Isopropyl alcohol (IPA)
Staphylococcus aureus	21.15	0	0	0
Escherichia coli	21.15	0	0	0
Pseudomonas aeruginosa	21.15	0	0	0
Morganella morganii	21.15	0	0	0
Streptococcus spp.	21.15	0	0	0
Proteus spp.	42.30	0	0	0
Citrobacter spp.	42.30	0	0	0
Enterobacter spp.	42.30	0	0	0
Klebsiella pneumonia	42.30	0	0	0

DISCUSSION

In the last decade *Aloe vera* has been used extensively in healthcare product including topical body creams, cosmetics, and heath drinks. All products available in the market claim to have beneficial properties based on the extensive studies that have been carried out on different species of Aloe including its antimicrobial properties [23]. The minimum inhibitory concentration (MIC) of the *aloe vera* gel extract which is the concentration giving the least inhibitory activity and below which there is no further inhibition.

The Minimum Inhibitory Concentrations (MIC) of *Aloe Vera* extract in 5% acetic acid, propylene glycol, and isopropyl alcohol against all the test organisms displayed a value of 0.0 µg/ml. This may be due to the antimicrobial effects which are brought to limelight the combination activity of the *aloe vera* and the substrates.

Our results showed that the HCL extract (µg/ml) of *aloe*

vera had stronger effect on the test organisms. Aloe plant has important role in antimicrobial activity in everyday life. Aloe gel is mostly use in humanity for cosmetic, burn and medicinal application. Aloe plant has major role in the promotion of recombinant-DNA based product, targeting compounds of value to be isolated and produced in stable and realistic quantities [2]. Such type aloe is a "wonder plant" because of its use in multiple problems like antiseptic, anti-inflammatory agent and help in relieve of diabetes. The aloe plant is need to a greater research emphasis for better utilization of this plant in humankind welfare, it remains for us to introduce to ourselves and thank the nature for its never-ending gift. Furthermore, study of all principles of *aloe vera* needs to be evaluated in future for scientific using, so that its other therapeutic uses can be widely explored. Isolation and maintenance procedures of aloe products require special care and these have been established after painstaking efforts [13].

The antibacterial activity of different solvent extracts of the *Aloe vera* gel preparations was investigated against some selected organisms isolated from clinical samples and the results are presented in table 1. It was found during the present study that; 1%HCL extract (µg/ml) of *aloe vera* had MIC of 21.16 µg/ml when tested against Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Morganella morganii, Streptococcus spp. and MIC of 42.30µg/ml when tested against Proteus spp., Citrobacter spp., Enterobacter spp., and Klebsiella pneumonia (Table 2).

HCl extracts had a higher minimum inhibitory concentration MIC) compared to others used in this investigation. The minimum inhibitory concentration (MIC) of each extract of the gel revealed the best solvent for extraction It was determined that *aloe vera* gel have inhibitory effects against pathogenic bacteria, causing different diseases in humans, especially Escherichia coli and Staphylococcus aureus. *Aloe vera* can be alternative to chemicals used in medication, food and cosmetics. It is hoped that this study would lead to the establishment of some compounds that could be used to formulate new and more potent antimicrobial drugs of natural origin.

The outcome of the result of this study may be as a result of the novel method been tested as stated in the methodology. Thus, the results of the present study successfully demonstrated the usefulness of this plant in folk medicine for the treatment of various skin diseases. Moreover, *Aloe vera* is also well known for its wound and burn healing properties. Results of the present research confirms its promising applications in wound and blood infections. In the face of ever increasing microbial antibiotic resistance, it is becoming more imperative for studies which seek to, identify natural antimicrobial compounds and the future development of this compound.

The present study has revealed the importance of natural products to control antibiotic resistant bacteria, which have been a threat to human health. It is, therefore highly essential that medicinal plants whose properties have not been fully characterized should form a top agenda of top management in developing nations whose citizens are sometimes unable to afford expensive orthodox medicine. This study has revealed the presence of many secondary metabolites in the HCl *Aloe vera* extract. It has further confirmed that the plant extracts could be used for the treatment of various infections including skin transmitted infections. The results lend credence to the folkloric use, of this plant in treating microbial infection and shows that *Aloe vera* could be exploited for new potent antimicrobial agents.

Aloe vera gel represents an alternative source of natural antimicrobial substances in prevention of such infections. However, further analysis of the promising extract could be done to isolate the bioactive components present in it and respective skin toxicity should be analyzed thoroughly so that they can be used as bioactive antimicrobial ingredients in various topical skin formulations.

The major limitation of this study was getting the extracts into discs.

CONCLUSION

The present study has revealed the importance of natural products to control antibiotic resistant bacteria, which have been a threat to human health. In summary this study confirms the better understanding of the in vitro antibacterial activity of HCL *Aloe vera* gel against skin pathogens. From our results it can be concluded that *Aloe vera* gel HCl extract possesses several bioactive compounds with antimicrobial properties which can be used as antimicrobial agents in new drugs formulations of infectious diseases in humans.

Following the findings in this study, it is hereby recommended that;

- It is expected that using natural products as therapeutic agents will probably elicit resistance in microorganisms.
- Orthodox medical practices can therefore be complemented with traditional practices. It is essential that research should continue to isolate and purify the active components of this natural herb and use in experimental animals.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest. The authors alone are responsible for the content and the writing of the paper.

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