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Research Article

Prevalence and Evaluation of Antimicrobial Activity of *Dodonaea viscosa* Extract and Antibacterial Agents against *salmonella* Spp. Isolated from Poultry

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Abstract: A total of 200 samples (180 fecal materials and 20 organ samples) were collected from (5 different poultry farms, 10 local poultry shops, 5 houses poultry, 5 Eggs stores shops and 5hand slaughters centers) in Ibb city, Yemen, 2014. According to morphological, cultural, as well as biochemical characterization and serological tests, 59(29.5%) isolates were identified as *Salmonella* spp. and all *Salmonella* isolates were categorized by serotype, which comprised of, 37(62.71%) *Salmonella* Typhimurium serovar, 21(35.59%). *Salmonella* Enteritidis serovar and 1(1.69%) *Salmonella* Heidlberg serovar. Antibiotic sensitivity test was done for bacterial isolates and the results showed there were clear differences in antibiotic resistant. Antimicrobial susceptibility of the isolates varies as follows: Ofloxacin (79.66%), Ciprofloxacin (67.80%), Colistin (59.32%) and Gentamycin (52.54%). All of isolates were resistant to Erythromycin, Penicillin and Lincomycin. Antibacterial activity was done for both aqueous and ethanol extracts of *Dodonaea viscosa* plant by using well and disc diffusion assay. The results indicated that well diffusion assay had best results than disc diffusion assay, the highest inhibition zone was (22)mm for well diffusion and (15)mm for disc diffusion assay, the results observed that ethanol extract had best antibacterial effect than aqueous extract which the percentage of bacterial isolates affected with ethanol extract was(71.19%) comparing with aqueous extract (28.81%)by using disc diffusion assay, while the percentage of bacterial isolates affected with ethanol extract was(88.13%) comparing with aqueous extract (52.54%)by using will diffusion assay.
Keywords: *Salmonella* spp, *Dodonaea viscosa*, Antimicrobial, Salmonellosis

INTRODUCTION

Salmonella spp. is important zoonotic pathogens and is considered one of the most common causes of food-borne illness in humans [1]. Salmonella is a gram negative bacillus and divided over 2,500 different serotypes. Some Salmonella serovars can affect multiple host species and it makes a serious problem according to the food chain [2]. There is evidence that eggs and poultry meat are two of the most important sources of Salmonella associated with human infection [3]. Salmonella possesses a number of structural and physiological virulence factors enabling it to cause acute and chronic disease in humans. Salmonella has the ability to overcome the low pH of the stomach, adhere to the small intestine epithelial cells and overcome host defense mechanisms to enable infection [4]. Contaminated poultry meat and eggs are among the most important sources for food-borne outbreaks in humans and salmonella are isolated more often from poultry and poultry products than from any other food animals [5]. Chickens can be infected with many different serovars of paratyphoid Salmonella [6]. Among these paratyphoid salmonella, infections due to *S. Typhimurium*, *S. Enteritidis* and *S. Heidelberg*, are of worldwide in distribution with wide host range [7].

Poultry meat is contaminated with Salmonella not only by infected poultry, but also by cross contamination with faeces, water, instruments and worker's hands during the slaughter process and handling [8]. Poultry and poultry products are often implicated in sporadic cases and in outbreaks of human salmonellosis [9]. Salmonellosis is an important cause of enteric illness. However, as the disease is primarily zoonotic, foods of animal origin have been consistently implicated as the main sources of human salmonellosis [10]. Salmonellosis have been reported depending on season, and often referred to as gastroenteritis or diarrheoa. It is estimated that approximately 600 persons die each year with acute salmonellosis as reported by Centre for disease control [11].

Antimicrobial- resistant strains of Salmonella spp. are now widespread all over the world and are causing

great concern due to the spread of multi-drug-resistant strains. Majority of resistant strains is of zoonotic origin and have acquired their resistance in an animal host before being transmitted to humans through the food chain [12]. The prevalence of resistant isolates in countries where intensive animal production is practiced is between 10% and 30%. When herds are held under strong antibiotic selective pressures, due to the intensive use of antibiotics, the prevalence of resistant strains rises to between 60% and 90%. As these bacterial strains are of considerable potential clinical importance to human health [13].

In addition to concern about the presence of resistant strains of *Salmonella* spp. as a potential food-borne pathogen, concern has also been raised about the human health impact of presence of genetic determinants for antimicrobial resistance that can be transferred among these organisms. The resistant organism may act as a donor of the resistance determinant to another pathogen in the human intestinal tract, or act as a donor of the resistance determinant to human commensal flora of the intestinal tract which may later be associated with disease or in turn supply the resistance gene to another pathogen [14]. This situation forced scientists to search for new antimicrobial substances. Therefore, there is a need to develop alternative antimicrobial drugs for the treatment of infectious diseases from medicinal plants [15]. *Dodonaea viscosa* possesses many medicinal properties and has been used by native peoples from all regions where it is found. It is a traditional medicine worldwide, administered orally or as poultice to treat a great variety of ailments. Stem or leaf infusions are used to treat sore throats; root infusions to treat colds. The stems and leaves are used to treat fever. The leaves are used to relieve itching, fevers swellings, aches and can be used as a antispasmodic agent and a lotion made from unspecified plant parts to treat sprains, bruises, burns and wounds. Digestive system disorders, including indigestion, ulcers, diarrhea and constipation are commonly treated in traditional medicine with an orally-administered decoction of either the leaves or roots [16].

Therefore the present study was aimed to determine the prevalence, antimicrobial susceptibility and evaluate the potentiality of ethanol and aqueous extracts of *Dodonaea viscosa* against *Salmonella* spp. isolated from poultry to limit the spread of the resistance.

MATERIALS AND METHOD

Sample collection

A total of 200 samples (180 fecal materials and 20 organ samples) were collected from (5 different poultry farms, 10 local poultry shops, 5 houses poultry, 5 Eggs stores shops and 5hand slaughters centers) in Ibb city, Yemen, 2014. At the selected farms, from one farm, four fecal samples were collected from each sectional of the compartment which were divided into five groups according to the age of poultry; 2, 3, 4, 5 and 6 weeks (± 3 days). Approximately 10 g of fresh feces which were selected randomly were collected into the sterilized tube. Organ samples including cecum, gall bladder and liver were obtained during autopsies of chicken showing clinical signs in the slaughter houses. Then, all samples were transported to the laboratory for the isolation of *Salmonella* spp. according to morphological, cultural, as well as biochemical characterization and serological tests.

Isolation and identification of Salmonella

Fecal samples were inoculated and cultured in 1% buffered peptone water (1:10 w /v) and incubated at 37°C for 18-20 hr. Afterwards, 1mL of culture fluid were transferred into 10 ml Tetrathionate broth and incubated at 37°C for 24 hr., then 10 µL loop full were streaked on Salmonella-Shigella agar (SS), Brilliant Green agar (BG), xylose lysine deoxycholate agar (XLD) and MacConkey agar plates. The plates were incubated at 37 °C for 24 hr.

Suspicious colonies morphologically similar to Salmonella were sub-cultured for biochemical examination. Identification of the biochemical characteristics was performed using triple sugar iron (TSI) medium, urea medium, indole, vogesproskauer tests, Simmon's citrate medium and motility medium [17].

Serotyping

Salmonella colonies were used for serotyping in the central Laboratories. The isolates were first cultured onto TSI slant medium and grown overnight at 37 °C, and then were tested using antisera O and H based on slide and tube agglutination tests to determine O and H antigens, respectively [17].

Antimicrobial susceptibility test

The antibiotic susceptibility pattern of the Salmonella isolates was tested by 12 antibiotics, determined by the modified Kirby-Bauer disk diffusion technique. Mueller Hinton agar plates were inoculated with 100 µL of Salmonella isolates after growing them in Nutrient broth and diluting appropriately to a 0.5 McFarland standard (1.5×10^8 CFU/ml), then left to dry at room temperature for a period (10-15 minutes). Then, the antibiotic disk was transferred aseptically on to the surface of the inoculated Muller Hinton plates, and the plates were incubated at 37°C for 18 hr. [18].

The diameter of the zone of inhibition produced by each antibiotic disk was measured and recorded, and the isolates were classified as "resistant" or "sensitive" based on the standard interpretative according to [19](formerly NCCLS) guidelines.

Antibacterial activity of *Dodonaea viscosa* plant

D. viscose belongs to the family Sapindaceae was collected from a mount of Badan in Ibb city. Leaves were separated and washed under running tap water, air dried, homogenized to fine powder, and stored in airtight container.

Plant extraction

For aqueous extraction, 10g of air-dried powder was taken in distilled water and boiled on slow heat for 2 hr. It was then filtered through 8 layers of muslin cloth and centrifuged at 5000rpmfor 10 min. The supernatant was collected. This procedure was repeated twice. After 6 h, the supernatant was collected at an interval of 2 hr., pooled together, and concentrated to make the final volume one-fourth of the original volume. It was then autoclaved at 121°C under 15 lb/in^2 pressure and stored at 4°C.

For ethanol extraction, 10g of air-dried powder was taken in 100 ml of ethanol in a conical flask, plugged with cotton, and then kept on a rotary shaker at 190-220 rpm for 24 hr. After 24 hr., it was filtered through 8 layers of muslin cloth and centrifuged at 5000 rpm for 10 min. The supernatant was collected and the ethanol was evaporated to make the final volume one-fourth of the original volume and stored at 4°C in airtight bottles [20].

Antibacterial activity

The antibacterial assay was performed by 2 methods: Agar disc diffusion and Agar well diffusion method.

Mueller Hinton agar plates were inoculated with 100 µL of Salmonella isolates after growing them in Nutrient broth and diluting appropriately to a 0.5 McFarland standard (1.5×10^8 CFU/ml), then left to dry at room temperature for a period (10-15 minutes). For agar disc diffusion method, the disc (0.7cm) was saturated with 100 µl of the test compound, allowed to dry, and introduced on the upper layer of the agar plate. For agar well diffusion method, a well was prepared in the plates with the help of a cup-borer (0.85cm). Into the well, 100 µl of the test compound was introduced.

Plates were incubated at 37 °C for 24 hr. The antimicrobial activity was determined by measuring the diameter of the inhibition zone around the disc and wells. For each bacterial strain, controls were maintained where pure ethanol were used instead of the extract. The control zones were subtracted from the test zones[20].

RESULTS AND DISCUSSION

Isolation and Identification

A total of 180 fecal materials and 20 organ samples were collected for determining prevalence of Salmonella in poultry, only 59(29.5%) isolates were found to be *Salmonella* spp. from 200 samples. Data analysis based on the sites of sources (Table1), showed that 33 (55.93%) isolates were recovered from each sectional of the farms, 12(20.34%) isolates from local poultry shops, 7(11.86%) isolates from houses poultry, 4(6.78%) isolates from eggs stores shops and 3(5.08%) from hand slaughters centers. Isolation of Salmonella from poultry and poultry products is higher compared to the isolation from other animal species [21].Therefore, poultry and their products are widely acknowledged as the major sources of food borne salmonellosis to human beings. Environmental sampling has been shown to be an accurate indicator of the presence of Salmonella in poultry farms and there is a good agreement between the level of environmental contamination and the prevalence of salmonella and associated human disease[7].In the present study, an overall percentage of Salmonella isolated from poultry and poultry products was 59(29.5%) which has economic and public health significance for the country, whereas our study which was related with the contamination of poultry and poultry products with Salmonella was differ than those observed by other authors, as 11.4% [22]and 38.3 % [23]. This variation may be associated with different factors such as, season of the study, geographic location, number of samples and hygienic conditions in the farm [7].

Table 1: Represents the prevalence of *Salmonella* spp. isolated from different sites of sampling

Site of sampling	No. samples	No. isolates	(%)
Poultry farms	100	33	55.93%
Local poultry shops	50	12	20.34%
Houses poultry	15	7	11.86%
Eggs stores shops	15	4	6.78%
Hand slaughters centers	20	3	5.08%
Total	200	59	29.5%

Isolation of Salmonella contaminate the egg surface which observed (6.78%) in this study is somewhat higher than (2.5%) that belongs to [23].This variation may also be due to the same reasons as mentioned above for egg samples. While the results contaminated poultry tissue samples was (5.08%) and this was closely related to [24]who had 8.57% Salmonella positive at slaughter chickens.

Poultry become infected with Salmonella in three main ways: by direct contact with clinically ill or symptomless birds, by the consumption of contaminated feed or water and through the environment. The hatchery may be the most important source of Salmonella in broilers and this is an important point in the prevention of colonization or significant reduction of Salmonella from chickens during production. At hatching, most chicks have very few microflora in the gut and are far more susceptible than older chicks to Salmonella colonization. Canadian research suggests that a bird on day 7 will require a challenge 10,000 times greater than a day-old chick to become infected with a pathogen such as Salmonella [25]. Unless there is disease or temperature stress, the highest level of intestinal colonization of Salmonella in broilers generally occurs during the second or third week of grow-out (the period during which day-old chicks are raised to six- to seven-week-old broiler chickens), after which there is a gradual decline in frequency which continues until the time of processing [26].

Serotyping of salmonella

From these isolates (Table 2), 3 serovars were identified, which included 37(62.71%) *Salmonella* Typhimurium serovars, 21(35.59%) *Salmonella* Enteritidis serovars and 1(1.69%) *Salmonella* Heidlberg serovar. The study also showed that all isolates of Salmonella isolated from all sources belonging to serogroup only B and D, mostly in sero group B (64.4%) compared with sero group D (35.59%).

Different Salmonella serotypes in different sero groups were isolated from all the sample sources examined in this study. Many of the salmonella serotypes isolated are known to be pathogenic to man. [23].From these isolates, the serovars of 59 isolates were confirmed as *S. Typhimurium*, *S. Enteritidis* and *S. Heidelberg* by standard typing method. *S. Typhimurium* was the most prevalent serovar identified (62.71%) followed by *S. Enteritidis* (35.59%), while the low ratio (1.69%) was belonged to S. Heidelberg. According to the Centers for Disease Control and Prevention (CDC), *S. Typhimurium* and *Enteritidis* are the 2 most common serovars associated with human disease, and are therefore of importance to public health, because it is a zoonotic bacterium and frequently isolated from chicken litter or fecal samples [17]. *Salmonella* Heidelberg was also listed among the serovars identified in the CDC report, where *Salmonella* Heidelberg is the fourth most common source of human salmonellosis in the United States and in the top 3 most detected serotypes for swine and poultry [6]. *Salmonella* Heidelberg was also the most common serovar detected by the retail meat wing of NARMS. The isolates of the serovar were typically associated with chicken breasts and ground turkey [27]. Among the isolates, the serogroup B was the most frequent (64.4%). There are two similar papers about the sero-prevalence of Salmonella in Korea [2] and [28] have reported that the most frequently isolated salmonella was serogroup B which showed 69.8% and 69.5%, respectively. Some Salmonella serovars are cause a serious disease depending to host animal.

Table 2: Distribution of *Salmonella* serotype and rates by serum agglutination test

Serotype	O group	No. isolates	(%)
Typhimurium	B	37	62.71%
Enteritidis	D	21	35.59%
Heidlberg	B	1	1.69%
Total		59	100%

Antimicrobial susceptibility test

The results of antibiotic sensitivity test were shown in Table (3). The isolates were highly susceptible to ofloxacin and ciprofloxacin with a ratio (79.66%) and (67.80%) respectively. On the other hand the isolates showed resistance (100%) to erythromycin, penicillin and Lincomycin. Susceptibility ratio of the other antibiotics varies as follows; colistin (59.32%), gentamycin (52.54%), chloramphenicol (45.76%), trimethoprim (42.37%), cefotaxime (40.68%), amoxyclave (33.90%) and ampicillin (32.20%).The development of antimicrobial resistance in zoonotic bacteria (e.g. Salmonella) constitutes a public health risk, as it may potentially affect the efficacy of drug treatment in humans [29]. The emergence of antimicrobial resistant salmonella is associated with the use of antibiotics in animals raised for food; resistant bacteria can be transmitted to humans through foods, particularly those of animal origin [30].

Table 3: Antimicrobial susceptibility of *Salmonella* spp. isolated from poultry

Antibiotics	Prevalence			Susceptibility (100%)
	Resistance	Intermediate	Susceptibility	
Amoxyclave	35	4	20	33.90
Ampicillin	35	5	19	32.20
Cefotaxime	23	12	24	40.68
Chloramphenicol	27	5	27	45.76
Ciprofloxacin	9	10	40	67.80
Colistin	5	19	35	59.32
Erythromycin	59	0	0	00.00
Gentamycin	24	4	31	52.54
Lincomycin	59	0	0	00.00
Ofloxacin	0	12	47	79.66
Penicillin	59	0	0	00.00
Trimethoprim	28	6	25	42.37

The present study demonstrated that the antimicrobial resistance and emergence of multidrug resistance were seriously higher than in the past years or in other countries [31; 32; 33]. [31]reported that All of 30 Salmonella isolated in 2005 in Shiraz province of Iran from poultry farms were susceptible to the antimicrobial effect of Colistin, Ciprofloxacin, Gentamicin, Chloramphenicol, and Cefotaxime In contrast, [33]reported that 42 Salmonella isolates during 2005, 2006 and 2007 in Croatia from pig breeding farms were not or low resistant to cl(0%), Gm(5%), Cf(5%), Amc(14%), C(33%), and Am(33%). [2] reported that 63 Salmonella spp. isolated in 2011 in Korean from the swine farms and slaughter houses were resistant to P (100%), E (100%), K (67.5%), Am (65%), Amc (62.5%) and Tmp (60%). In comparison to the finding of the previous studies showed that Salmonella's resistance tends to increase and become more complex.

Table 4 summarizes the resistance according to serotype. Among the 3 serotype identified, resistance was found varying between them. Out of the 59 isolates which showed resistance against Colistin belonged to the *Sal.* Typhimuriumserovars (5/37 isolates). Similarly, all isolates which showed resistance against Amoxyclave, Cefotaxime, Ciprofloxacin, Gentamycin and Trimethoprim belonged to the *Sal.* Typhimuriumserovars and *Sal.* Enteritidisserovars, while resistance against Ampicillin, Chloramphenicol, Erythromycin, Lincomycin and Penicillin were Distributed on all serotype.

Association of Salmonella serotype and antimicrobial resistance phenotype: There did not appear to be an association between antimicrobial resistance phenotype and a particular serotype; however, several notable exceptions were observed. For example, the majority of *Salmonella* Typhimurium isolates displayed resistance to Gentamycin, Trimethoprim and Chloramphenicol but much lower rates of resistance were found among other serotypes (Table 4). Similar study of differences in antimicrobial resistance among Salmonella serotypes have been reported by other investigators [32, 34].

Table 4: Distribution of antimicrobial resistance according to *Salmonella* serotypes

Antibiotics	No. of serovar			
	Typhimurium 37	Enteritidis 21	Heidlberg 1	Total 59
Amoxyclave	24	11	0	35
Ampicillin	25	9	1	35
Cefotaxime	16	7	0	23
Chloramphenicol	21	5	1	27
Ciprofloxacin	8	1	0	9
Colistin	5	0	0	5
Erythromycin	37	21	1	59
Gentamycin	21	3	0	24
Lincomycin	37	21	1	59
Ofloxacin	0	0	0	0
Penicillin	37	21	1	59
Trimethoprim	25	3	0	28

Antibacterial activity of *Dodonaea viscosa* plant

The antibacterial activity of the *Dodonaea viscosa* plant was studied against the *Salmonella* spp. using agar well and disc diffusion methods. Results of inhibition zones in the agar well and disc diffusion methods using of ethanol and aqueous extracts of *Dodonaea viscosa* showed significant zone of inhibition against *Sal. Typhimurium* serovars, *Sal. Enteritidis* serovars and *Sal.* Heidlbergserovar. Deferent concentrations (100%, 50%, 25% and 12.5%) were determined for ethanol and aqueous extracts. The results confirmed the efficiency of crude concentration (100%) to inhibit growth of all *Salmonella* serotype and the antibacterial activity was decreased while the dilution was increased method (Table 5, 6).

The results indicated that well diffusion assay had best results than disc diffusion assay, where at crude concentration (100%), the highest zone of inhibition was observed by well diffusion assay against *Sal. Typhimurium* serovars (22mm), *Sal. Enteritidis* serovars (18mm) and *Sal.* Heidlbergserovar (19mm), while by disc diffusion assay against *Sal. Typhimurium* serovars (15mm), *Sal. Enteritidis* serovars (12mm) and *Sal.* Heidlberg serovar (9mm).

The results observed that ethanol extract had best antibacterial effect than aqueous extract which the number and percentage of bacterial isolates affected with ethanol extract at different concentration (100%, 50%, 25% and 12.5%) were[52(88.13%), 29(49.15%), 12(20.34%) and 1(1.69%)] respectively, comparing with aqueous extract [31(52.54%), 19(32.20%), 4(6.78%) and 0(0%)] by agar well method, as well as with ethanol extracts were [42(71.19%), 19(32.20), 6(10.17%) and 0(0%)]comparing with aqueous extract[17(28.81%), 8(1356%), 0(0%) and 0(0%)] by disc diffusion assay method (Table 5,6).

Table 5: Antimicrobial activity of different concentrations of *Dodonaea viscosa* by well diffusion method

Serotype	No. of serotype	Extracts acts	Concentration of extract (100%)			
			100%	50%	25%	12.5%
Typhimurium	37	Aqueous	21	12	3	0
		Ethanol	32	20	9	1
Enteritidis	21	Aqueous	9	7	1	0
		Ethanol	19	8	2	0
Heidlberg	1	Aqueous	1	0	0	0
		Ethanol	1	1	1	0
Total	59	Aqueous	31(52.54%)	19(32.20%)	4(6.78%)	0(0%)
		Ethanol	52(88.13%)	29(49.15%)	12(20.34%)	1(1.69%)
Control (DMSO)			0	0	0	0

Table 6: Antimicrobial activity of different concentrations of *Dodonaea viscosa* by disc diffusion assay method

Serotype	No. of serotype	Extracts acts	Concentration of extract (100%)			
			100%	50%	25%	12.5%
Typhimurium	37	Aqueous	10	8	0	0
		Ethanol	26	13	5	0
Enteritidis	21	Aqueous	6	0	0	0
		Ethanol	15	6	1	0
Heidlberg	1	Aqueous	1	0	0	0
		Ethanol	1	0	0	0
Total	59	Aqueous	17(28.81%)	8(13.56%)	0(0%)	0(0%)
		Ethanol	42(71.19%)	19(32.20)	6(10.17%)	0(0%)
Control (DMSO)			0	0	0	0

Recently, multiple drug resistance has developed due to indiscriminate use of commercial antimicrobial drugs that are commonly used in the treatment of infectious diseases, making it a global growing problem. There is an urgent need to develop new antimicrobial drugs for the treatment of infectious diseases from medicinal plants, which may be less toxic to humans and possibly with a novel mechanism of action. There are numerous examples of antimicrobials of plant origin that have an enormous therapeutic potential [35].

Dodonaea viscosa is used as a traditional medicine in different countries and was chosen due to the widespread use against diseases in my country, in addition to the presence of the compounds that have some interesting biological properties. Stem or leaf infusions were used to treat sore throat, root infusion to treat colds. The leaves are used to treat itching, digestive system disorders, including indigestion, ulcers and diarrhea; and the powdered leaves were given to expel round worms. The plant is also used as antibacterial and has insecticidal activity [36, 37].

Al-Asmari AK *et al*. [16] reported that the phytochemical analysis of the *D. viscosa* extracts is the vital source of innumerable number of antimicrobial compounds. Recent phytochemical studies have confirmed that *D. viscosa* contains all the major secondary plant metabolites like tannins, alkaloids, flavonoids, carbohydrate, steroids and essential oils etc., which effective antimicrobial substances against a wide range of microorganisms. Herbs that have tannins as their main component are astringent in nature and used for treating intestinal disorders such as diarrhoea and dysentery, thus exhibiting antimicrobial activity. One of the largest groups of chemical produced by plant is the alkaloids and their amazing effect on humans has led to the development of powerful pain killer medications [38]. In another study, antibacterial activity of *D. viscose* extraction was determined using a serial dilution microplate technique. The minimum inhibitory concentration (MIC) of isolated compounds against Gram positive bacteria such as *Staphylococcus aureus* and and Gram negative bacteria such as *Salmonella typhi* were found to be varied from 16 µg/ml to more than 250 µg/ml [39]. The antibacterial activity of newly isolated compounds from dichloromethane and acetone fractions of leaf powder of *D.viscosa* was evaluated and found positive for different organism. The minimum inhibitory concentration (MIC) of isolated compounds against *Staphylococcus aureus*, *Enterococcus faecalis*, *Escherichia coli* and *Pseudomonas aeruginosa* varied from 16 µg/ml to 250 µg/ ml [16].

CONCLUSION

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. Studies are in progress to further evaluate the mechanisms of action *D. viscosa* extracts on some organisms associated with human diseases. Hence, the present study suggests that pathogenic microorganisms may become resistant to existing drugs. Moreover, this study shows that some plants show much promise in the development of phytomedicines having antimicrobial properties. In this endeavour, traditional herbal medicines must perforce be granted the benefits of modern science and technology to serve further global needs. The drugs derived from herbs may have the possibility of use in medicine because of their antibacterial activity.

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