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A comparative Evaluation of Antibacterial Potential of Aqueous and Ethanolic Extracts of Yemeni and Indian Allium cepa against Some Human Pathogenic Bacteria

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Abstract: In Yemen, many medicinal plants have been used for treatment of various diseases for thousands of years. The onion plant (Allium cepa) was one of these medicinal plants. The concept of the current study was based on the antimicrobial activity of different concentrations (12.5, 25, 50, 100, 200 µg mL^{-1}) of Aqueous and Ethanolic extracts of Yemeni (local) and Indian (Imported) A. cepa against five pathogenic Gram negative and Gram positive bacteria, Escherichia coli, Klebsiella pneumonia, Pseudomonas aeruginosa, Bacillus cereus and Staphylococcus aureus using agar well diffusion method. Agar dilution method was used for determination of Minimum Inhibitory Concentration (MIC). The current study detected that the Yemeni A. cepa achieved antibacterial activity higher than the activity of Indian A. cepa, and the ethanolic extracts were stronger than the aqueous extracts for both onions. Therefore, the highest inhibition activity achieved by the aqueous and ethanolic extracts of Yemeni A. cepa was detected for K. pneumonia (20.5±0.5 mm) and B. cereus (22.5±0.5 mm), respectively, while for the aqueous and ethanolic extracts of Indian A. cepa, the highest inhibitory activity was detected for S. aureus (14.0±2.0 mm) and K. pneumonia (20.0±0.0 mm), respectively. The difference in the antibacterial activities was significant ($p<0.05$) except in application of aqueous Yemeni extracts against P. aeruginosa. Moreover, S. aureus was not inhibited by all concentrations of aqueous Yemeni and ethanolic Indian A. cepa, and it was inhibited weakly by other extracts. MIC values were different, the lowest value (12.5 µg mL^{-1}) was recorded by Yemeni aqueous extract against E. coli and B. cereus, while the lowest value (25 µg mL^{-1}) was recorded by Yemeni ethanolic extract against K. pneumonia, B. cereus and S. aureus. Finally, the researchers recommend to conduct extensive and comprehensive studies about the effects of Yemeni A. cepa on fungi and other harmful organisms.

Key words: Allium cepa; medicinal; antibacterial; ethanolic extracts; escherichia coli.

1. Introduction:

Yemeni medicinal plants have been used for many years in the treatment of a number of human diseases by the community, specifically in traditional medicine. They are considered the main source of new, natural, and safe drugs to be utilized in managing diseases as an effective and harmless alternative medicine [1]. Onion (Allium cepa) is one of the most important condiment edible plants that are placed under the family Amaryllidaceae which contain the powerful sulfur and other numerous phenolic compounds [2]. Alliums have had an important nutritional and therapeutic role for thousands of years, and can be provided in the form of a capsule, powder, oil and cooked A. cepa extract [3], [4].

A. cepa is one of the most popular food ingredients widely used all over the world. They contain high concentrations of folic acid, vitamin B6, magnesium, calcium, potassium, and phosphorus as well as vitamins and minerals [2], [4]. The pungence of alliums is caused by the large number of sulfur compounds. One of their most potent and active, powerful antibiotic component is the organosulfur-containing compound called allicin [5]. The enzyme allinase is released when the tissues of mature, intact cysteine sulfoxides containing alliums are chopped, converting the cysteine sulfoxides into the thiosulfinates. Flavonoids such as kaempferol and quercetin, alk(en)yl cysteine sulfoxides including S-propyl cysteine sulfoxide, S-methyl cysteine sulfoxide, cycloalliin, thiosulfinates, and sulfides are the

main compounds of the plant and most are reactive, volatile, lachrymatory and odor producing [6] [7], [8], [9].

Alliums are widely used as an antimicrobial agent, and showed anticancer, antidiabetic, antioxidant, antiplatelet, antihypertensive, and antidepressant effects and neuroprotective, anti-inflammatory, and antiparasitic effects. Alliums have beneficial effects on the digestive, circulatory, and respiratory systems, as well as on the immune system [10], [11], [12], [13]. A. cepa extracts have been shown to prevent and reduce hyperlipidemia, hypertension, thrombosis, atherosclerosis and hepatitis [14], [15], [16], [17]. Consumption of the onion and its products is associated with the cold and flu prevention [18], and they have been traditionally used as diuretic, carminative, expectorant, stomachic, antibacterial, antifungal, antiviral and insecticidal agents [19].

Allium cepa has been identified in the treatment of infectious diseases. Due to the contained bioactive components, they exhibited a broad antibacterial activity against a panel of both gram negative and gram positive bacteria including species of bacteria such as: Staphylococcus aureus, Micrococcus luteus, Escherichia coli, Streptococcus, Shigella, Bacillus cereus, B. cenerea, Clostridium, Salmonella enteritidis, S. typhimurium, Klebsiella, Proteus, Helicobacter pylori, Listeria monocytogenes and Pseudomonas aeruginosa [20], [21], species of yeasts such as: Saccharomyces cerevisiae, Candida albicans, C. tropicalis [22], and species of fungi such as: Fusarium oxysporum, Penicillium cyclopium, and Aspergillus Niger [23].

In Yemen, the herbal medicine is employed widely for treatment of various diseases. Recent investigations were published during the last decade about the antimicrobial, pharmacological and chemical properties of a minority of traditionally used medicinal herbal plants in Yemen [1], [24], [25], [26], [27]. Considering to the importance of these untapped research area, the aim of this study was to evaluate the in vitro potential of one traditionally used medicinal plant (A. cepa) grown in Yemen, and their aqueous and ethanolic extracts as antibacterial agents. This research was growing on these plants as cheap, safe, and more acceptable for people than synthetic antibiotics.

2. Materials and methods:

2.1. Plant materials:

A. cepa bulbs were collected from Hadhramout farms (Local, Bafteem), and Indian A. cepa tubers (Imported) were purchased from the local markets of Hadhramout, Yemen in April 2020. The bulbs were free from any chemical pre-harvest treatment, and free from any deformities. The selected bulbs of A. cepa were peeled, washed, dried in room temperature, milled by an electric grind and stored at 4℃. The extraction was carried out using 80% ethanol (BDH chemical) and de-ionized water prepared by Milli-Q Plus system (Millipore, Bedford, USA) [1].

2.2. Bacterial strains:

In vitro antimicrobial studies were mediated against five human pathogenic Gram positive and Gram negative bacteria, Bacillus cereus, Staphylococcus aureus, Escherichia coli, Klebsiella pneumonia and Pseudomonas aeruginosa. The strains were provided from National Center for Public Health Laboratories, Mukalla branch, and stored at 4℃ in the refrigerator. The researchers confirmed the type of bacteria in the Microbiology Laboratory of the Faculty of Environmental Sciences and Marine Biology, Hadhramout University.

2.3. Media used:

Nutrient Agar and broth, peptone water, MacConkey-Agar, Eosin methylene blue Agar, Pseudomonas Isolation Agar, Brain–Heart Infusion Agar and broth and Muller Hinton Agar were purchased from HiMedia – Mumbai – India, and used for preparation of inocula, confirmatory identification and preservation of test bacteria and evaluation of antibacterial potential.

2.4. Preparation of inoculum:

The bacterial inoculum was prepared using Brain Heart Infusion broth (BHI) and it was growing at 37℃ for 24 h in an incubator (J.P. Selecta, Spain). Using peptone water, the actively growing inocula were prepared to a density of 108 cfu/ml [28], [29] as initial cell counts.

2.5. Preparation of aqueous extracts:

Ninety grams of fresh tuber powder of local and Indian L. cepa were mixed separately with deionized water (200 ml), blended for 15 min, then the mixtures were filtered using sterile gauze to remove the solids, this was followed by centrifugation at 4500 rpm for 30 min at 20 °C. The resulting supernatant was filtrated using vacuum pump (Heidolph Instruments GMbH, Germany) through Whatman filter paper no. 1. Finally, the separately collected extract was stored in a refrigerator at 4°C [1], [30].

2.6. Preparation of ethanolic extracts:

Amount of fifty grams of each powder was extracted using 200 ml of 80% ethanol and left for 24 h in a closing conical flask. Whatman filter paper no. 1 was used to filter the resulting liquid four times. The filtrates were concentrated in a rotary evaporator (IKA-WERKE, Germany) at 45°C to eliminate ethanol. The water was removed from the aqueous residue by drying the samples in an oven 45°C (Daihan Lab-Tech Co.) for about 48 h [1].

2.7. Determination of antibacterial activity:

Agar well diffusion method was used to determine the antibacterial activities of the previously prepared extracts of local and imported L. cepa depending on the measurement of the Inhibition Zone Diameter (IZD). A BaSO4 turbidity (0.5) McFarland standard was used for standardization of the inoculum density of the five bacterial species. Each prepared bacterial suspension was uniformly spread using a sterile cotton swab on Muller Hinton agar (MHA) (HiMedia, Mumbai, India), separately. Six wells were bored in the inoculated plates using a 6 mm diameter sterile borer. Dimethyl sulfoxide, DMSO (1%) (BDH chemical) was used for preparation of five serial dilutions for the final product of each extract yielding concentrations of, 12.5, 25, 50, 100, 200 µg mL-1. Using a micropipette, 90µl from each extract dilution were poured into each well in the inoculated plates. Sterile aqueous DMSO (1%) was used as a negative control, and the Ofloxacin antibiotic disk, 5µg (HiMedia, India) was used as a positive control using Kirby-Bauer disk diffusion technique depending on the guidelines of the Clinical and Laboratory Standard Institute (CLSI) [31]. The inoculated plates were incubated for 24 h at 36ºC ± 1ºC under aerobic

conditions. The previous procedure was performed in duplicate. After 24 h incubation, the bacteria had grown. Using a ruler, the inhibition of bacterial growth representing by IZD was measured in millimeters [1], [32], [33]. The Minimum Inhibitory Concentration, MIC (The lowest concentration of the antibacterial plant extract which completely inhibited the microbial growth) was determined using the Agar Dilution Method under the above conditions. The results were expressed in micrograms per milliliter [34], [35].

Statistical analysis:

The measured growth inhibition zone diameters achieved by the crude extracts were expressed as mean value ± standard deviation. Statistical differences between the antibacterial activities of aqueous and ethanolic extracts were detected using the Statistical Package for Social Sciences (SPSS) software version 26.0 (SPSS, Chicago, IL, USA).

The analysis of variance (One way-ANOVA) followed by Tukey Test were conducted to test the differences between the antibacterial activities of each type of bacteria, and to test the dimensional comparisons between the aqueous and ethanolic extract concentrations. P value lower than 0.05 ($p < 0.05$) was considered significant.

Results:

3.1. Determination of the average inhibition zone diameters induced by the aqueous and ethanolic extracts of local and imported A. cepa:

The current study achieved distinct differences in the inhibition activities for the different concentrations of A. cepa extracts against E. coli. Extracts of A. cepa inhibited the growth of E. coli, whereas the aqueous extracts of the local and imported A. cepa had a better inhibitory effect more than that of an ethanolic extract. However, the aqueous extract of local A. cepa induced higher inhibition effect than the aqueous extract of imported A. cepa (Figure 1 and Table 1).

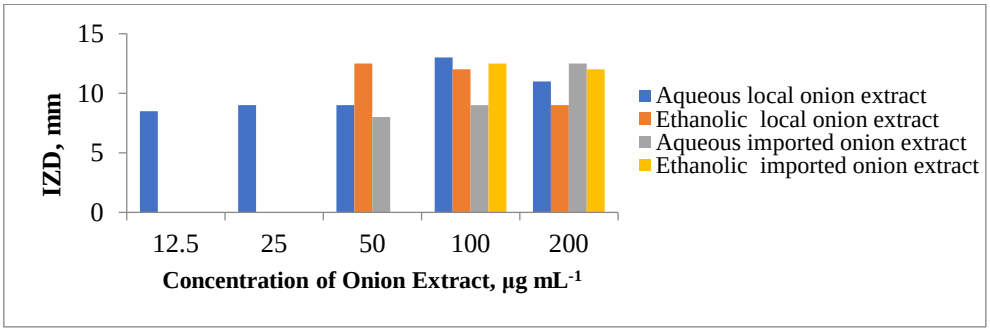

Figure 1. The effect of the concentration of the aqueous and ethanolic extract of the local and imported A. cepa on the average inhibition zone diameters of E. coli. IZD : Inhibition Zone Diameter.

For the local A. cepa extracts, the aqueous extract showed apparent inhibitory activity against E. coli at all concentrations, especially the concentration of 100 µg mL^{-1}, which inhibited the growth more (13.0 mm) than all other concentrations. The lowest inhibition activity (8.5 mm) was achieved by the concentration of 12.5 µg mL^{-1}. For the imported A. cepa extracts, there was no inhibition activity at concentrations of 12.5 and 25 µg mL^{-1} for the aqueous and ethanolic extracts. While the rest concentrations of aqueous and ethanolic extracts were active giving the highest inhibition activity (12.5 mm) at 200 and 100 µg mL^{-1}, respectively. The concentration 50 µg mL^{-1} showed the lowest inhibition activity (8.0 mm) for aqueous extract and no inhibition activity for ethanolic extract (Figure 1 and Table 1). A. cepa extracts inhibited the growth of P. aeruginosa, whereas the statistical averages indicated that the aqueous extracts of the local A. cepa recorded a better inhibitory effect than ethanolic extracts, as well as the ethanolic extracts of the imported A. cepa were better and more inhibiting than the aqueous extracts. However, the aqueous extracts of local A. cepa recorded inhibition effect better than the aqueous extract of Imported A. cepa against P. aeruginosa (Figure 2 and Table 1).

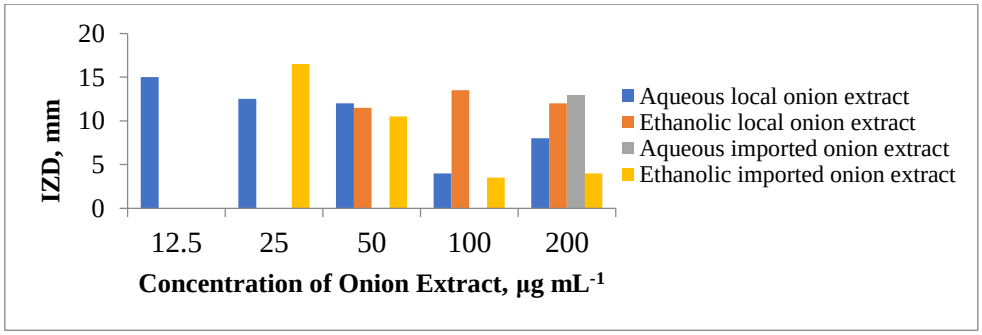

Figure 2. The effect of the concentration of the aqueous and ethanolic extract of the local and imported A. cepa on the average inhibition zone diameters of P. aeruginosa. IZD : Inhibition Zone Diameter.

The previous figure indicated that all extracts of A. cepa did not inhibit the growth of P. aeruginosa at a concentration of 12.5 µg mL^{-1} except for the aqueous extract of local A. cepa, which gave an inhibition activity of 15.0 mm. At the concentration of 25 µg mL^{-1}, the ethanolic extract of the imported A. cepa induced the highest inhibition value of 16.5 mm, and the aqueous extract of the local A. cepa gave 12.5 mm, while the ethanolic extracts of the local A. cepa and the aqueous extracts of the imported A. cepa did not affect. The extracts of the ethanolic imported A. cepa (100 µg mL^{-1}), aqueous local A. cepa (100 µg mL^{-1}), and the ethanolic imported A. cepa (200 µg mL^{-1}) exhibited the lowest inhibition activities of 3.5, 4.0 and 4.0 mm, respectively (Figure 2 and Table 1).

Regarding K. pneumonia, the researchers observed that the inhibition activity of all A. cepa extracts increased with the increasing of their concentrations. Table (1) recorded that the aqueous extract of the local A. cepa achieved antibacterial activity against K. pneumonia higher than that of its ethanolic extract, as well as the ethanolic extract of the imported A. cepa was more inhibiting than its aqueous extract, thus we found that the ethanolic extract of the imported A. cepa exhibited an antibacterial activity higher than that of the aqueous extract of the local A. cepa against K. pneumonia. It was indicated that in the case of the ethanolic extracts of local A. cepa and the aqueous extracts of imported A. cepa there was no inhibition activity at the concentration of 12.5 µg mL^{-1}. Also, at the concentration of 25 µg mL^{-1}, there was no inhibition activity of the ethanolic extract of the local A. cepa (Figure 3 and Table 1).

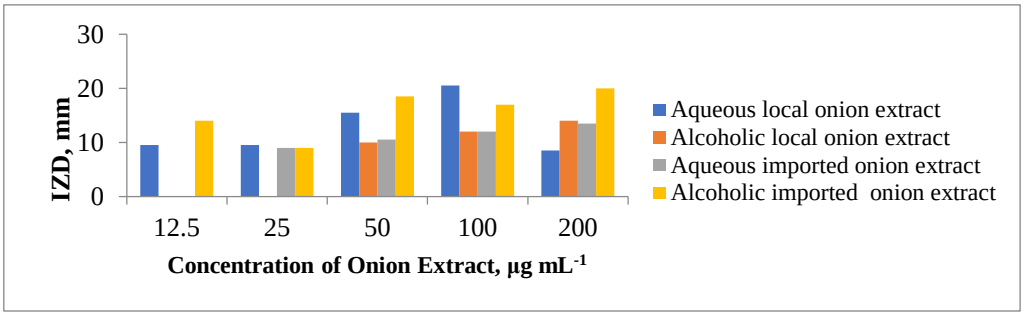

Figure 3. The effect of the concentration of the aqueous and ethanolic extract of the local and imported A. cepa on the average inhibition zone diameters of K. pneumonia. IZD : Inhibition Zone Diameter.

Figure 3 showed that the inhibitory effect of the aqueous extract of local A. cepa reached a value (25.0 mm) at a concentration of 100 µg mL^{-1} greater than the inhibitory effect of its ethanolic extract (20.0 mm) at a concentration of 200 µg mL^{-1}. Also, the ethanolic extract of imported A. cepa achieved an inhibition activity (20.0 mm) at a concentration of 200 µg mL^{-1} and inhibited the growth of K. pneumonia more than that of its aqueous extract (13.5 mm) at the same concentration. The study also showed that the aqueous extract of the local A. cepa inhibited the growth of K. pneumonia with an inhibition activity higher than the ethanolic extract of the imported A. cepa.

The growth of B. cereus bacteria was not inhibited by the local and imported A. cepa extracts at all concentrations, especially 12.5, 25 and 50 µg mL^{-1}, except the aqueous extract of local A. cepa which inhibited the growth (13.5 mm) at concentration 12.5 µg mL^{-1} and the ethanolic extract of local A. cepa (10.5 mm) and the aqueous extract of imported A. cepa (9.5 mm) at 50 µg mL^{-1} and the ethanolic extract of local A. cepa (22.5 and 19.0 mm) at 100 and 200 µg mL^{-1}, and the ethanolic extract of imported A. cepa (18.0 and 8.0 mm) at 100 and 200 µg mL-1, respectively (Figure 4 and Table 1).

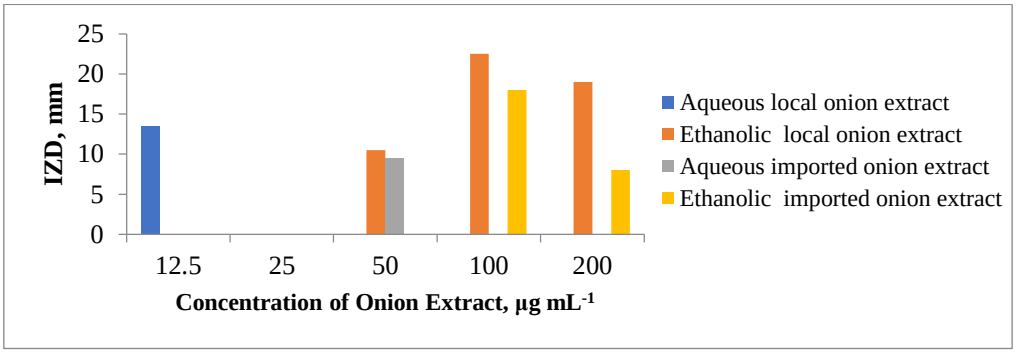

Figure 4. The effect of the concentration of the aqueous and ethanolic extract of the local and imported A. cepa on the average inhibition zone diameters of B. cereus. IZD : Inhibition Zone Diameter.

The most effective inhibition activity was achieved by the ethanolic extract of the local A. cepa (22.5, 19.0 and 10.5 mm at concentrations of 100, 200 and 50 µg mL^{-1}, respectively against B. cereus.

The ethanolic extract of the local A. cepa induced an inhibitory effect against S. aureus higher than that of its aqueous extract, as well as the aqueous extract of the imported A. cepa was more inhibiting than its ethanolic extract and more inhibiting than the aqueous extract of the local A. cepa against S. aureus (Figure 5 and Table 1).

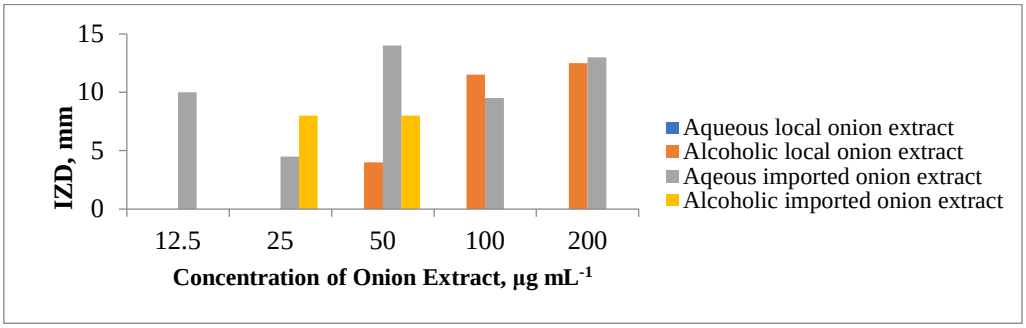

Figure 5. The effect of the concentration of the aqueous and ethanolic extract of the local and imported A. cepa on the average inhibition zone diameters of S. aureus. IZD : Inhibition Zone Diameter.

The previous figure showed that all the concentrations of the aqueous extract of local A. cepa did not inhibit the growth of S. aureus, as well as its ethanolic extract at the tow concentrations of 12.5 and 25 µg mL^{-1}, as well as the ethanolic extract of imported A. cepa at concentrations of 12.5, 100 and 200 µg mL^{-1}. It was noticed that the highest inhibition activity (14.0 mm) among all extracts was for the aqueous extract of the imported A. cepa at a concentration of 50 µg mL^{-1}, followed by (13.0 mm) at a concentration of 200 µg mL^{-1}, followed by the inhibition activity of the ethanolic extract of the local A. cepa (12.5 mm) at a concentration of 200 µg mL^{-1}, finally followed by (11.5 mm) at a concentration of 100 µg mL^{-1}.

Table 1. Average* inhibition zone diameters (antibacterial activity), mm, induced by the aqueous and ethanolic extracts of local and imported A. cepa. Different superscripts denote significant differences among the antibacterial activities achieved by all concentrations of aqueous local, aqueous imported, ethanolic local and ethanolic imported A. cepa extracts, separately at $p < 0.05$

Bacteria	*A. cepa* extract	Inhibition zone Diameter IZD, mm									
		Concentration of *A. cepa* extract, µg mL^{-1}									
		12.5		25		50		100		200	
		Aqueous extract	Ethanolic extract	Aqueous extract	Ethanolic extract	Aqueous extract	Ethanolic extract	Aqueous extract	Ethanolic extract	Aqueous extract	Ethanolic extract
E. coli	Local onion	$8.5^{a}\pm0.5$	0^{a}	$9.0^{a}\pm0.0$	0^{a}	$9.0^{a}\pm0.0$	$12.5^{bc}\pm0.5$	$13.0^{b}\pm0.0$	$12.0^{c}\pm0.0$	$11.0^{ab}\pm1.0$	$9.0^{d}\pm1.0$
	Imported onion	0^{a}	0^{a}	0^{a}	0^{a}	$8.0^{bc}\pm0.0$	0^{a}	$9.0^{c}\pm0.0$	$12.5^{b}\pm1.5$	$12.5^{d}\pm0.5$	$12.0^{cb}\pm1.0$
P. aeruginosa	Local onion	$15.0^{a}\pm0.0$	$12.0^{a}\pm1.0$	$12.5^{a}\pm2.5$	$13.5^{a}\pm1.5$	$12.0^{a}\pm1.0$	$11.5^{bcd}\pm1.5$	$4.0^{a}\pm4.0$	0^{cd}	$8.0^{a}\pm0.0$	0^{d}
	Imported onion	0^{a}	0^{a}	0^{a}	$16.5^{b}\pm1.5$	0^{a}	$10.5^{ab}\pm0.5$	0^{a}	$3.5^{ab}\pm3.5$	$13.0^{b}\pm5.0$	$4.0^{ab}\pm4.0$
K. pneumonia	Local onion	$9.5^{a}\pm0.5$	0^{a}	$9.5^{a}\pm0.5$	0^{a}	$15.5^{ab}\pm3.5$	$10.0^{bc}\pm0.0$	$20.5^{b}\pm0.5$	$12.0^{cd}\pm1.0$	$8.5^{a}\pm0.5$	$14.0^{d}\pm1.0$
	Imported onion	0^{a}	$20.0^{a}\pm0.0$	$9.0^{bcde}\pm1.0$	$17.0^{a}\pm1.0$	$10.5^{cde}\pm0.5$	$18.5^{ac}\pm1.5$	$12.0^{de}\pm1.0$	$9.0^{ad}\pm0.0$	$13.5^{e}\pm1.5$	$14.0^{b}\pm1.0$
B. cereus	Local onion	$13.5^{a}\pm2.5$	0^{a}	0^{bcde}	0^{a}	0^{cde}	$10.5^{b}\pm0.5$	0^{de}	$22.5^{c}\pm0.5$	0^{e}	$19.0^{d}\pm1.0$
	Imported onion	0^{a}	0^{a}	0^{a}	0^{a}	$9.5^{b}\pm0.5$	0^{a}	0^{a}	$18.0^{b}\pm2.0$	0^{a}	$8.0^{c}\pm0.0$
S. aureus	Local onion	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	$4.0^{abc}\pm4.0$	0^{a}	$11.5^{bc}\pm0.5$	0^{a}	$12.5^{c}\pm0.5$
	Imported onion	$10.0^{a}\pm1.0$	0^{a}	$4.5^{b}\pm4.5$	$8.0^{b}\pm0.0$	$14.0^{c}\pm2.0$	$8.0^{b}\pm0.0$	$9.5^{a}\pm0.5$	0^{a}	$13.0^{c}\pm1.0$	0^{a}

*Average (n=2) ± standard deviation (SD). The mean difference is significant at the 0.05 level. DMSO solvent showed no growth inhibition for the tested organisms.

3.2.The susceptibility of test bacteria toward the negative and positive controls

All growing test bacteria were not inhibited when the sterile aqueous DMSO (1%) was applied, but clear inhibition zones were observed in the growth of all test bacteria induced by the effect of Ofloxacin antibiotic (5 µg) when added. The antibacterial activity of Ofloxacin against bacteria E. coli, P. aeruginosa, K. pneumonia, B. cereus and S. aureus was varied depending on the type of bacteria: 32.0, 41.0, 25.0, 34.0 and 21.0 mm, respectively. All bacterial strains were susceptible to Ofloxacin comparing to the standard IZDs.

3.3.Determination of the Minimum Inhibitory Concentration (MIC) of aqueous and ethanolic extracts of local and imported A. cepa

Table 2 indicated that the aqueous extract of local A. cepa was more inhibiting for E. coli and B. cereus by a value of MIC equals 12.5 µg mL^{-1}, and its ethanolic extract was more inhibiting K. pneumonia, B. cereus and S. aureus by a value of MIC equals 50 µg mL^{-1}. Thus, we conclude that the aqueous extract of the local A. cepa is more inhibitory than its ethanolic extract. The aqueous and ethanolic extracts of imported A. cepa were inhibiting for K. pneumonia and S. aureus by a value of MIC equals 25 µg mL^{-1}, while the aqueous extract inhibited the growth of E. coli, P. aeruginosa and B. cereus at low MIC values. The aqueous extract of the imported A. cepa is more inhibitory than its ethanolic extract.

Table 2. Average* Minimum Inhibitory Concentration (MIC) of aqueous and ethanolic extracts of local and imported A. cepa against some bacteria

Bacteria	Values of Minimum Inhibitory Concentration (MIC), µg mL^{-1}			
	Local *A. cepa*		Imported *A. cepa*	
	Aqueous Extract	Ethanolic Extract	Aqueous Extract	Ethanolic Extract
E. coli	12.5±0.5	200±14	50±4	200±10
P. aeruginosa	100±7	200±16	50±7	100±3
K. pneumonia	200±19	50±2	25±4	25±3
B. cereus	12.5±0.6	50±5	50±1	200±10
S. aureus	-	50±4	25±6	25±2

*Average (n=2) ± standard deviation (SD) at the 0.05 level. The sign (-) means absence of inhibition at all studied concentrations.

3.4.The statistical differences among the inhibition activities of the aqueous extracts and among the inhibition activities of the ethanolic extracts of local and imported A. cepa

Oneway-ANOVA was conducted to analyze the differences between the antibacterial activity of the aqueous extracts of local and imported A. cepa in addition to the differences between the antibacterial activity of the ethanolic extracts of local and imported A. cepa against the tested bacteria (Table 3).

Table 3. Explanation of the statistical differences of the antibacterial activities achieved by the aqueous and ethanolic extracts of local and imported A. cepa against the tested bacteria using Oneway-ANOVA

Bacteria	Aqueous Extract of						Ethanolic Extract of					
	Local *A. cepa*			Imported *A. cepa*			Local *A. cepa*			Imported *A. cepa*		
	df	F	Sig.	Df	F	Sig.	df	F	Sig.	df	F	Sig.
E. coli	4	14.200	0.006	4	636.00	0.000	4	0.784	0.000	4	69.308	0.000
P. aeruginosa	4	4.022	0.080	4	6.760	0.030	4	0.924	0.000	4	7.020	0.028
K. pneumonia	4	10.075	0.013	4	31.250	0.001	4	0.904	0.000	4	22.294	0.002
B. cereus	4	29.160	0.001	4	361.00	0.000	4	2.184	0.000	4	79.000	0.000
S. aureus	-	-	-	4	2.608	0.161	4	2.184	0.010	-	-	-

Notice: The tabulated F value at the degree of freedom (4) and the significance level ($\alpha \leq 0.05$) equals 6.287

Table (3) indicated that the antibacterial activity of the aqueous extracts of local and imported A. cepa against all studied bacteria was statistically significant at the level of ($\alpha \leq 0.05$) except for P. aeruginosa (Sig. 0.080) with the local A. cepa extract, and S. aureus which was not inhibited by it, and S. aureus with imported A. cepa extract (Sig. 0.161), which refers to absence of statistically significant differences. In comparison, we found that all calculated F values of the rest of the bacteria were greater than the tabulated F values, and accordingly there were statistically significant differences in the antibacterial activity of the aqueous extracts of local and imported A. cepa. Table (3) indicated also that the antibacterial activity of the ethanolic extracts of local and imported A. cepa against all studied bacteria was statistically significant at the level of ($\alpha \leq 0.05$) except for Staphylococcus which was not inhibited with the extract of imported A. cepa. In a comparison, we found that all calculated F values were smaller than the tabulated F values for the ethanolic extracts

of local A. cepa, and accordingly there were no differences in the inhibition effect. On the other hand, we found that all the calculated F values were greater than the tabulated F values of the ethanolic extracts of imported A. cepa referring to the presence of differences in their antibacterial activity (Table 3).

Discussion:

The susceptibility of the studied bacteria toward the A. cepa extracts differed regardless whether the bacteria were Gram positive or Gram negative, contrary to the results of Santas et al. [20] who reported that the Gram positive bacteria were more sensitive to A. cepa extracts than Gram negative bacteria.

The antibacterial potential of the A. cepa extract varied depending on the type of bacteria and the origin of plant, where the aqueous extract showing the best antibacterial activity was originated from the local A. cepa against E. coli, P. aeruginosa and K. pneumonia. The ethanolic extract showing the best antibacterial activity was originated from the local A. cepa against B. cereus and S. aureus. The aqueous extract showing the best antibacterial activity was originated from the imported A. cepa against E. coli and S. aureus, the ethanolic extract showing the best antibacterial activity was originated from the imported A. cepa against P. aeruginosa, K. pneumonia and B. cereus.

For the local A. cepa, the aqueous extract had the highest antibacterial activity, but in case of the imported A. cepa, the ethanolic extract was the best. The aqueous extract of local A. cepa was potential for Gram negative bacteria more than Gram positive bacteria which were highly sensitive to the ethanolic extract of local A. cepa, this result is consistent with the founding of Shinkafi and Dauda [36] and not consistent with the founding of Santas et al. [20]. The aqueous extract of imported A. cepa was more inhibitory to E. coli and S. aureus more than the ethanolic extract which showed antibacterial potential against P. aeruginosa, K. pneumonia and B. cereus.

The aqueous and ethanolic extracts of local A. cepa showed the highest inhibition activity against K. pneumonia (20.5±0.5 mm) and B. cereus (22.5±0.5 mm), respectively, and the least inhibition activity was observed against P. aeruginosa and S. aureus (4.0±0.40 mm), respectively. It was observed that, the antibacterial activities achieved by the aqueous and ethanolic extracts of imported A. cepa were different, whereas the highest antibacterial activity was shown against S. aureus (14.0±2.0 mm) and K. pneumonia (20.0±0.0 mm), respectively, and the least antibacterial activities were observed against S. aureus (4.5±4.5 mm) and P. aeruginosa (3.5±3.5 mm), respectively. By comparing the results of Etikala et al. [37] who studied the antibacterial activity of Allium cepa extracts on B. cereus, we found that the resulting inhibition zones had the largest diameters.

The aqueous extract of the local A. cepa inhibited the growth of E. coli significantly with a concentration 100 µg mL^{-1}, while its ethanolic extract affected the growth significantly with the concentrations 100 and 200 µg mL^{-1}. In contrast to the aqueous extracts of the imported A. cepa, they inhibited the growth of E. coli significantly with the concentrations 50, 100 and 200 µg mL^{-1}, while the ethanolic extracts of imported A. cepa were inhibiting at 100 and 200 µg mL^{-1}, this means that the antibacterial activity of the aqueous extracts of imported A. cepa exceeded the antibacterial activity of the four extracts of the local and imported A. cepa. Oyawoye et al. [38] reported that the ethanolic extract of A. cepa L. showed the best antibacterial activity against E. coli, 12.5 mm higher than the aqueous extract. There was a direct proportion between the concentration of the aqueous extract of local A. cepa with the achieved antibacterial activity against E. coli, in agreement with the findings of Tahiruddin and Indriastuti [39].

There was no significant difference in the antibacterial activity achieved by the aqueous extracts of local A. cepa against P. aeruginosa with all concentrations ($p>0.05$), while the antibacterial activities achieved by the ethanolic extracts of local A. cepa were different significantly at concentrations of 50, 100 and 200 µg mL^{-1}. In contrast, the growth of P. aeruginosa was inhibited by the aqueous extract of the imported A. cepa with a concentration 200 µg mL^{-1}. The ethanolic extract of the imported A. cepa inhibited the growth with a concentration 12.5 µg mL^{-1}. Therefore, the antibacterial activity achieved by the ethanolic extract of the local A. cepa exceeded the antibacterial activity achieved by the rest extracts, such results agree with the findings of Al-Mussawi and Al-Jaber [40] study.

The powerful antibacterial activity of A. cepa extracts inhibiting K. pneumonia is attributed to the aqueous extracts of local A. cepa (20.5±0.5 mm) and to the ethanolic extracts of imported A. cepa (20.0±0.0 mm). Significant differences ($p<0.05$) were observed in the antibacterial effects, whereas the K. pneumonia showed sensitivity to the ethanolic extract of imported A. cepa greater than the aqueous extract of local A. cepa depending on Tukey Test. Enejiyon et al. [41] showed maximum activity against K. pneumonia (21.2 ± 0.5 mm) closest to our result.

The antibacterial activities achieved by the aqueous extracts of local A. cepa against B. cereus showed significant differences at concentrations of 12.5, 25, 50 and 100 µg mL^{-1}. The ethanolic extract of the local A. cepa inhibited the growth of B. cereus with all concentrations, unlike the aqueous extract of imported A. cepa which affected the growth at concentrations of 100 and 50 µg mL-1. It was noticed that, most concentrations of all extracts showed antibacterial activity, especially the aqueous extract of the local A. cepa. This investigation agree with the study of Sagar and Pareek [42] who indicated that B. cereus was inhibited by the extract of pink skin of A. cepa, while Bakht et al. [43] recorded that Bacillus subtilis was the most susceptible bacteria inhibited by all extracts of A. cepa.

S. aureus was not inhibited by all concentrations of the aqueous extracts of local A. cepa, and similarly it was not inhibited by the ethanolic extracts of the imported A. cepa. S. aureus was inhibited by the ethanolic extract of the local A. cepa with the higher concentrations 50, 100 and 200 µg mL^{-1} with significant differences, in agreement with the results of Benkeblia [23], unlike the aqueous extract of imported A. cepa which inhibited the growth of S. aureus without significant differences at all concentrations. In general, the antibacterial activities of the aqueous and ethanolic extracts of local and imported A. cepa were weak against S. aureus. Bag and Chattopadhyay [44] discovered different findings, S. aureus had an inhibitory impact larger than that of E. coli. The higher concentrations of the studied extracts of A. cepa inhibited the growth of S. aureus more than the lower

concentrations, in agreement with the results of Tahiruddin and Indriastuti [39]. Oyawoye et al. [38] found that the zone of inhibition of each ethanolic section ranged from 3 to 12.5 mm, while the aqueous extracts ranged from 4 to 10 mm.

The MIC values were different, indicating that the type of bacteria, the type of solvent, and the origin of the A. cepa plant have a great influence in the determination of the MIC values. The MIC reached the lowest value (12.5 µg mL^{-1}) when the aqueous extract of local A. cepa was applied against E. coli and B. cereus, while the ethanolic extract of the local A. cepa reached the lowest MIC value (25 µg mL^{-1}) when applied to K. pneumonia, B. cereus and S. aureus. Enejiyon et al. [41] reported that all extracts of A. cepa showed MIC ranged between 10 and 20 mg/mL against the test bacteria as a result close to this study. Bag and Chattopadhyay [45] reported a distant result, they showed that the MIC of A. cepa extract against E. coli equals 93.8 ± 44.2 g mL^{-1}.

Conclusion

The susceptibility of the five human pathogenic Gram positive and Gram negative bacteria toward the Aqueous and Ethanolic extracts of Yemeni and Indian Allium cepa was different regardless whether the bacteria were Gram positive or Gram negative depending on the bacteria type, solvent type and plant origin. For the Yemeni A. cepa, the aqueous extract exhibited the most effective antibacterial activity against K. pneumonia (20.5±0.5 mm), E. coli and P. aeruginosa, while the ethanolic extract exhibited the most effective antibacterial activity against B. cereus (22.5±0.5 mm) and S. aureus. For the Indian A. cepa, the aqueous extract exhibited the most effective antibacterial activity against S. aureus (14.0±2.0 mm) and E. coli, the ethanolic extract exhibited the most effective antibacterial activity against K. pneumonia (20.0±0.0 mm), P. aeruginosa and B. cereus. The aqueous extracts of Yemeni A. cepa achieved the more efficient antibacterial activity than that of the aqueous extracts of Indian A. cepa, while the most effective ethanolic extract was that of the Indian A. cepa. The aqueous Yemeni extracts inhibited the Gram negative bacteria more than Gram positive bacteria which were highly sensitive to the ethanolic Yemeni extracts. The MIC values were different, the lowest value (12.5 µg mL^{-1}) was recorded by the Yemeni aqueous extracts against E. coli and B. cereus, while the lowest value (25 µg mL-1) was recorded by the Yemeni ethanolic extracts against K. pneumonia, B. cereus and S. aureus.

The researchers recommend to continue the study for other plants, and they recommend to conduct extensive and comprehensive studies against parasites and other organisms harmful to the human body.

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Conflicts of Interest

The authors declare that they have no conflicts of interest to report regarding the present study.

References:

[1] M.S. Bin-Masalam, A. Bakhlh, A. Bashab, and M. Alsaiyli, "In Vitro antibacterial activity of Yemeni medicinal plants (Ocimum basilicum and Peganum harmala) against some human pathogenic bacteria," Journal of Physics, vol. 012021, pp. 1-10, 2021.

[2] A. J. Chakraborty, T. M. Uddin, B. M. R. Matin Zidan, S. Mitra, R. Das, F. Nainu, K. Dharma, A. Roy, M. J. Husain, A. Khusro, and T.B. Emran, "Allium cepa: A Treasure of Bioactive Phytochemicals with Prospective Health Benefits," Evidence-Based Complementary and Alternative Medicine, vol. 4586318, 2022, doi: 10.1155/2022/4586318

[3] D. Saleheen, A. S. Ali, and M. Y. Masoom, "Anti-leishmanial activity of aqueous onion extract in vitro," Fitoterapia, vol. 75, pp. 9-13, 2004.

[4] P. S. Bisen, and M. Emerald, "Nutritional and Therapeutic Potential of Garlic and Onion (Allium sp.)," Current Nutrition and Food Science, vol. 12, no. 3, pp. 1-10, 2016, doi: 10.2174/1573401312666160608121954.

[5] T. A. Aghajanzadeh, M. Reich, M. J. Hawkesford, and M. Burow, "Sulfur metabolism in Allium cepa is hardly affected by chloride and sulfate salinity," Archives of Agronomy and Soil Science, vol. 65, no. 7, pp. 945-956, 2019.

[6] X. Zhao, F. J. Lin, H. Li, H. B. Li, D. T. wu, F. Ging, W. Ma, Y. Wang, B. H. Miao, and R. Y. Gan, "Recent Advances in Bioactive Compounds, Health Functions, and Safety Concerns of Onion (Allium cepa L.)," Frontiers in Nutrition, vol. 8, pp. 1-16, 2021, doi: org/10.3389/fnut.2021.669805

[7] R. A. Ludlow, M. Pacenza, A. Chiapetta, s. R. Christofides, G. Evans, M. Graz, G. Marti, H. J. Rogers, and C. T. Muller, "Storage time and temperature affects volatile organic compound profile, alliinase activity and postharvest quality of garlic," Postharvest Biology and Technology, vol. 177, no. 111533, 2021.

[8] S. Beigoli, S. Behrouz, A. Memarzia, S. Z. Ghasemi, M. Boskabady, N. Marefati, F. Kianian, M. R. Khazdair, H. El-Seedi, and M. H. Boskabady, "Effects of Allium cepa and Its Constituents on Respiratory and Allergic Disorders: A Comprehensive Review of Experimental and Clinical Evidence," Evidence-Based Complementary and Alternative Medicine, vol. 2021, id 5554259, pp. 1-22, 2021, doi: 10.1155/2021/5554259.

[9] M. Kumar, M. D. Barbhai, M. Hasan, S. Punia, S. Dhumal, Radha, N. Rais, D. Chandran, R. Pandiselvam, A. Kothakota, M. Tomar, V. Satankar, M. Senapathy, T. Anitha, A. Dey, A. Sayed, F. M. Gadallah, R. Amarowicz, and M. Mekhemar, "Onion, (Allium cepa L.) peels: A review on bioactive compounds and biochemical activities," Biomedicine and Pharmacotherapy, vol. 146, no. 112498, pp. 1-15, 2022.

[10] E. Y. Ko, S. H. Nile, Y. S. Jung, and Y. S. Keum, "Antioxidant and antiplatelet potential of different methanol fractions and flavonols extracted from onion (Allium cepa L.)," 3Biotech, vol. 8, no. 3, 2018, doi: 10.1007/s13205-018-1184-4.

[11] S. Krstin, M. Sobeh, M. Braun, and M. Wink, "Anti-parasitic activities of Allium sativum and Allium cepa against Trypanosoma b. brucei and Leishmania tarentolae," Medicine, vol. 5, no. 2, pp. 37, 2018.

[12] S. Jain, H. S. Buttar, M. Chintameneni, and G. Kaur, "Prevention of cardiovascular diseases with anti-inflammatory and anti- oxidant nutraceuticals and herbal products: an overview of pre-clinical and clinical studies,"

Recent Patents on Inflammation & Allergy Drug Discovery, vol. 12, no. 2, pp. 145–157, 2018.
[13] N. Marefati et al., "A review of anti-inflammatory, antioxidant, and immunomodulatory effects of Allium cepa and its main constituents," Pharmaceutical Biology, vol. 59, no. 1, pp. 287–302, 2021.
[14] V. Lanzotti, "The analysis of onion and garlic," Journal of Chromatography A., vol. 1112, no. 1–2, pp. 3–22, 2006.
[15] M. Dorrigiv, A. Zareiyan, and H. Hosseinzadeh, "Onion (Allium cepa) and its main constituents as antidotes or protective agents against natural or chemical toxicities: a comprehensive review," Iranian Journal of Pharmaceutical Research, vol. 20, no. 1, pp. 3-26, 2020.
[16] V. Brüll, C. Burak, B. Stoffel-Wagner, G. Nickenig, C. Muller, P. Langguth, B. Alteheld, R. Fimmers, S. Naaf, B. F. Zimmermann, P. Stehle, and S. Egert, "Effects of a quercetin-rich onion skin extract on 24 h ambulatory blood pressure and endothelial function in overweight-to-obese patients with (pre-)hypertension: a randomised double-blinded placebo-controlled cross-over trial," British Journal of Nutrition, vol. 114, no. 8, pp. 1263–1277, 2015.
[17] J. S. Sidhu, M. Ali, A. Al-Rashdan, and N. Ahmed, "Onion (Allium cepa L.) is potentially a good source of important antioxidants," Journal of Food Science & Technology, vol. 56, no. 4, pp. 1811–1819, 2019.
[18] C. I. Wright, "Natural Remedies for the Relief of Cold and Flu Symptoms: The Evidence for Garlic, Onion, Chilli and Chocolate," Journal of Traditional Medicine and Clinical Naturopathy, vol. 4, no. 1, 2015.
[19] J. D. Teshika, A. M. Zakariyyah, T. Zainab, G. Zengin, K. R. Rengasamy, S. K. Pandian, and M. M. Fawzi, "Traditional and modern uses of onion bulb (Allium cepa L.): a systematic review," Critical Reviews in Food Science and Nutrition, vol. 59, no. 1, pp. S39–S70, 2019.
[20] J. Santas, M. P. Almajano, and R. Carbó, "Antimicrobial and antioxidant activity of crude onion (Allium cepa, L.) extracts," International Journal of Food Science and Technology, vol. 45, no. 2, pp. 403–409, 2010.
[21] V. Kuete, "Medicinal Spices and Vegetables from Africa: Therapeutic Potential against Metabolic, Inflammatory, Infectious and Systemic Diseases," Amsterdam: Academic press, vol. 3, pp. 363-377, 2017.
[22] S. Kocic-Tanackov, G. Dimic, A. Tepic, and B. Vujicic, "Influence of Allium ampeloprasum L. and Allium cepa L. essential oils on the growth of some yeasts and moulds," Zbornik Matice srpske za prirodne nauke, vol. 116, no. 116, pp. 121–130, 2009.
[23] N. Benkeblia, "Antimicrobial activity of essential oil extracts of various onions (Allium cepa) and garlic (Allium sativum)," LWT- Food Science and Technology, vol. 37, no. 2, pp. 263–268, 2004.
[24] M. Al-Fatimi, M. Wurster, G. Schroeder, and U. Lindequist, "Antioxidant, antimicrobial and cytotoxic activities of selected medicinal plants from Yemen," Journal of Ethnopharmacology, vol. 111, pp. 657–666. 2007.
[25] R. A. A. Mothana, R. Grünert, U. Lindequist, and P. J. Bednarski, "Study of the anticancer potential of Yemeni plants used in folk medicine," Pharmazie, vol. 62, pp. 305–307, 2007.
[26] R. M. Ismail, A. H. A. Saleh, and K. S. Ali, "GC-MS analysis and antibacterial activity of garlic extract with antibiotic," Journal of Medicinal Plants Studies, vol. 8, no. 1, pp. 26-30, 2020.
[27] A. A. Humaid, S. M. Alghalibi, R. R. Taha, Y. N. Al-Ammari, and W. H. Edrees, "Study of Effect Spices on Salmonella Contaminated food as Natural Antimicrobial Agents In Yemen's Food," International Journal of Nutritional Science and Food Technology, vol. 6, no. 2, pp. 16-21, 2020.
[28] F. A. Al-Bayati, and K. D. Suliman, "In vitro antimicrobial activity of Salvadora persica L. extracts against some isolated oral pathogens in Iraq," Turkish Journal of Biology, vol. 32, pp. 57–62, 2008.
[29] M. Abhary, and A. Al-Hazmi, "Antibacterial activity of Miswak (Salvadora persica L.) extracts on oral hygiene," Journal of Taibah University for Science, vol. 10, pp. 513–520, 2016.
[30] J. D. Ilić, B. G. Nikolovski, L. B. Petrović, P. S. Kojić, I. S. Lončarević, and J. S. Petrović, "The garlic (A. sativum L.) extracts food grade W1/O/W2 emulsions prepared by homogenization and stirred cell membrane emulsification," Journal of Food Engineering, vol. 205, pp. 1–11, 2017.
[31] CLSI (Clinical Laboratory Standard Institute) Performance standards for antimicrobial disk susceptibility test, Fifteenth informational supplement CLSI document M100-S15, Wayne, USA 112. 2011.
[32] A. Smânia, F. D. Monache, E. F. A. Smânia, and R. S. Cuneo, "Antibacterial activity of steroidal compounds isolated from Ganoderma applanatum (Pers.) Pat. (Aphyllophoro-mycetideae) Fruit body," International Journal of Medicinal Mushrooms, vol. 1, no. 4, pp. 325-330, 1999.
[33] C. Valgas, S. M. de Souza, E. F. A. Smânia, and A. Smânia Jr, "Screening methods to determine antibacterial activity of natural products," Brazilian Journal of Microbiology, Brazilian Journal of Microbiology, vol. 38, pp. 369-380, 2007.
[34] H. Liu, T. H. Taylor Jr, K. Pettus, S. Johnson, J. R. Papp, and D. Trees, "Comparing the disk-diffusion and agar dilution tests for Neisseria gonorrhoeae antimicrobial susceptibility testing," Antimicrobial Resistance and Infection Control, vol. 5, no. 46, 2006.
[35] G. R. Carter, and J. R. Cole, "Diagnostic procedure in veterinary bacteriology and mycology," Academic Press, Fifth Edition, Kindle Edition, The Canadian Veterinary Journal, vol. 33, no. 6, PMC1481267, 1992.
[36] S. A. Shinkafi, and H. Dauda, "Antibacterial activity of Allium cepa (onion) on some pathogenic bacteria associated with ocular infections," Sch. J. Appl. Med. Sci., vol. 1, no. 3, pp. 147–151, 2013.
[37] A.Etikala, S. Thamburaj, A. M. Johnson, C. Sarma, G. Mummaleti, and S. K. Kalakandan, "Incidence, toxin gene profile, antibiotic resistance and antibacterial activity of Allium parvum and Allium cepa extracts on Bacillus cereus isolated from fermented millet-based food," LWT – Food Science and Technology, vol. 160, no. 15, pp. 113314, 2022. https://doi.org/10.1016/j.lwt.2022.113314
[38] O.M. Oyawoye, T.M. Olotu, S.C. Nzekwe, J.A. Idowu, T.A. Abdullahi, S.O. Babatunde, I.A. Ridwan, G.E. Batiha, N. Idowu, M. Alorabi, and H. Faidah, "Antioxidant potential and

antibacterial activities of Allium cepa (onion) and Allium sativum (garlic) against the multidrug resistant bacteria," Bulletin of the National Research Centre, vol. 46, no. 1, pp. 1-7, 2022.
[39] T. Tahiruddin, and D. Indriastuti, "Inhibitory effect of onion (Allium cepa linn) and sugar paste mixture on Staphylococcus aureus and Escherichia coli by in vitro," Public Health of Indonesia, vol. 5, no. 4, pp. 131-137, 2019. DOI:10.36685/phi.v5i4.310
[40] A.A. Al-Mussawi, and G. T. Al-Jaber, "Antibacterial Activity of Allium cepa L. and Frankenia pulverulenta L. Extracts," Basrah Journal of Veterinary Research, vol.7, no.2, pp. 48-56, 2008.
[41] S. O. Enejiyon, A. A. Abdulrahman, A. S. Adedeji, R. Abdulsalam, and M. U. Oyedum, "Antibacterial Activities of the Extracts of Allium sativum (Garlic) and Allium cepa (Onion) Against Selected Pathogenic Bacteria," Tanzania Journal of Science, vol. 46, no. 3, pp. 914-922, 2020.
[42] N. A. Sagar, and S. Pareek, "Antimicrobial assessment of polyphenolic extracts from onion (Allium cepa L.) skin of fifteen cultivars by sonication-assisted extraction method," Heliyon, vol. 6, no. 11, pp. e05478, 2020.
[43] J. Bakht, S. Khan, and M. Shafi, "Antimicrobial Potentials of Fresh Allium cepa against Gram Positive and Gram Negative Bacteria and Fungi," Pakistan Journal of Botany, vol. 45, no. S1, pp. 1-6, 2013.
[44] A. Bag, and R. R. Chattopadhyay, "Evaluation of synergistic antibacterial and antioxidant efficacy of essential oils of spices and herbs in combination," PLoS One, vol. 10, no. 7, 2015.

دراسة نشاط المستخلصات المائية والإيثانولية للبصل اليمني والهندي المضاد لبعض البكتيريا المسببة لأمراض الإنسان

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الملخص: يستخدم اليمنيون منذ آلاف السنين عدداً كبيراً من النباتات الطبية، من أهمها نبات البصل الأحمر .(Allium cepa) اعتمدت هذه الدراسة على تقدير النشاط التثبيطي لتراكيز مختلفة (12,5، 25، 50، 100، 200 ميكروجرام لكل ملليلتر من المستخلصات المائية والإيثانولية للبصل اليمني ومقارنته بنفس المستخلصات للبصل الهندي ضد خمسة أنواع من البكتيريا السالبة الجرام والموجبة الجرام، الإشريكية القولونية، الكلبسيلا الرئوية، الزائفة الزنجارية، العصوية الشمعية و المكورة الذهبية العنقودية باستخدام طريقة الانتشار في حفر الأجار. استخدمت طريقة التخفيف على الأجار لتحديد قيمة التركيز التثبيطي الأدنى .(MIC) واستنتجت الدراسة أن مستخلصات البصل اليمني سجلت نشاطاً تثبيطياً أكبر من مستخلصات البصل الهندي، وأن المستخلصات الإيثانولية أقوى من المستخلصات المائية لكلا النوعين من البصل. وقد أظهرت المستخلصات المائية والإيثانولية للبصل اليمني نشاطاً تثبيطياً أكبر ضد بكتيريا الكلبسيلا الرئوية (20,5±0,5مم) و بكتيريا العصوية الشمعية (22,5±0,5مم)، على التوالي، بينما المستخلصات المائية والإيثانولية للبصل الهندي أظهرت نشاطاً تثبيطياً أكبر ضد المكورة الذهبية العنقودية (14,0±2,0مم) والكلبسيلا الرئوية (20,0±0,0مم)، على التوالي. اتضح وجود فروقات معنوية بين النشاطات التثبيطية لجميع المستخلصات (P>0,05) ماعدا عند تطبيق المستخلصات المائية للبصل اليمني ضد الزائفة الزنجارية. أشارت الدراسة أن جميع تراكيز المستخلصات المائية للبصل اليمني وتراكيز المستخلصات الإيثانولية للبصل الهندي لم تثبط نمو المكورة الذهبية العنقودية الذي كان تثبيطه ضعيفاً جداً باستخدام بقية المستخلصات. وأشارت الدراسة الحالية إلى اختلاف قيم التراكيز التثبيطية الدنيا (MIC) للمستخلصات المختلفة حيث حقق المستخلص المائي للبصل اليمني أصغر قيمة (12,5 ميكروجرام لكل ملليلتر) ضد الإشريكية القولونية والعصوية الشمعية، وحقق المستخلص الإيثانولي للبصل اليمني أصغر قيمة (12,5 ميكروجرام لكل ملليلتر) ضد الكلبسيلا الرئوية، العصوية الشمعية والمكورة الذهبية العنقودية. وأخيراً، يوصي الباحثون باستمرار البحث وإجراء دراسات مكثفة وشاملة حول قوة وطبيعة النشاط التثبيطي للبصل اليمني ضد الفطريات وأنواع مختلفة من الكائنات الدقيقة الضارة الأخرى.

الكلمات المفتاحية: البصل الأحمر، طبي، مضاد للبكتيريا، المستخلص الإيثانولي، الإشريكية القولونية.