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PHYTOCHEMICAL SCREENING, ANTIOXIDANT PROPERTY AND ANTIBACTERIAL TESTING OF LEMON GRASS (*Cymbopogon citratus*), ALOE VERA (*Aloe barbadensis)* AND KUCHAI (*Allium odorum*)

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ABSTRACT

Cymbopogon citratus, Aloe barbadensis and *Allium odorum* were assessed for their phytochemicals, antioxidant activity and antibacterial properties against *Escherichia coli* and *Staphylococcus aureus.* Phytochemical screening revealed that *C. citratus, A. barbadensis* and *A. odorum* had alkaloids, flavonoids, saponins, sterols, tannins, and terpenes. The antioxidant activity revealed that the extract of *C. citrates* had the highest radical scavenging activity (80.36%) and total phenolics (187.33 mg/g). Meanwhile, *C. citratus, A. barbadensis* and *A. odorum* exhibited bacterial inhibitory activity against *E. coli* and *S. aureus*. The phytochemicals, antioxidant activity, and the antibacterial properties of *C. citratus, A. barbadensis* and *A. odorum* shows that the three herbaceous plant have viable potential in fighting off causes of diseases such as free radicals and bacterial pathogens specifically, *E. coli* and *S. aureus*. This implication can be further explored for further utilization of the three plants.

Keywords: *Cymbopogon citratus*, *Aloe barbadensis, Allium odorum*, phytochemicals, antioxidant and antibacterial

INTRODUCTION

Plants are essential in people's lives thus exploration for their various potentials were explored. Wang [1] stated that plants contain a wide range of phytochemicals and antioxidants which has a protective role in the body. Wherein, phytochemicals are bioactive non-nutrient plant compounds that have been linked to reductions in the risk of major chronic diseases as stated by Liu [2]. Plants also exhibited antibacterial properties against pathogenic bacteria as stated by Roy and Lai [3].

Cymbopogon citratus, *Aloe barbadensis*and *Allium odorum*are herbal plants which consists phytochemicals [4, 5, 6, 7] that can treat various diseases. Furthermore, according to Prakash [8], herbs possess antioxidant compounds like phenolic acids and flavonoids which scavenge free radicals that inhibit oxidative mechanisms.

Thus, this study specifically aimed to; elucidate the phytochemicals present in *C. citratus, A. barbadensis* and *A. odorum* leaves extracts such as alkaloids, flavonoids, saponins, sterols, tannins and terpenes by using the presence and absence method; determine the antioxidant activity *of C. citratus, A. barbadensis* and *A. odorum* with the use of DPPH radical scavenging method and total phenolic content; and determine the antibacterial activity of *C. citratus, A. barbadensis* and *A. odorum* against two bacterial pathogens namely *Escherichia coli* and *Staphylococcus aureus*.

MATERIALS AND METHODS

Source of Plant Materials

The three herbal plants namely *C. citratus*, *A. barbadensis*, and *A. odorum* were collected, in the morning to ensure that the plants were actively photosynthesizing, at the vicinity of Central Luzon State University, Science City of Munoz, Nueva Ecija, Philippines and at Sto. Rosario, Sto. Domingo, Nueva Ecija, Philippines. After collection, the leaves were rinsed with tap water to remove unwanted materials such as dirt and other contaminants. Plants were authenticated by a taxonomist from the Department of Biological Sciences, College of Arts and Sciences, Central Luzon State University.

Hot Water Extraction

Collected plants were air-dried. Afterwards, fifty grams of powdered extracts per sample were mixed with 300 ml of dH2O in a flask. The mixture was then placed in a hot water bath for 80-90 °C for 2 hours. Then, the mixture was filtered using filter paper where the filtrate was

dispensed into a sterile amber bottle and placed in the refrigerator until use.

Crude extraction

Fresh matured leaves were sterilized with alcohol and were washed with distilled water. Afterwards, the leaves were pounded with mortar and pestle. The filtrate was first filtered using cheese cloth to remove large particles and finally filtered using filter papers [9].

Phytochemical Screening

The bioactive components of each herbs were determined based on the chemical test described by Sofowora [10], Trease and Evans [11], and Poongothai *et al*. [12]. Three replicates were prepared in each test. The screening for phytochemicals of the different plant extracts followed the standard methods [13] with minor modifications and noted as present or absent.

Test for alkaloids

Twenty ml of 10% HCH_3CO_2 (acetic acid) in C_2H_5OH (ethanol) were added to a 5 ml extract. To reach the 1/4 of the original volume, the mixture was placed in a hot water bath for 2 hours. It was observed for the formation of white precipitate or turbidity which indicated the presence of alkaloids [10].

Test for flavonoids

Ten drops of sodium hydroxide were added to a 10 ml extract. It was then observed for an intense yellow coloration which indicated the presence of flavonoids [11].

Test for saponins

In a 20 ml dH_2O, 5 ml of plant extracts were diluted and agitated for 15 minutes in a test tube for observation. At least one cm layer of foam indicated the presence of saponins [9].

Test for sterols

In a 5 ml extract with 2 ml of H_2SO_4 (sulfuric acid), 2 ml of acetic anhydride were added. It was observed for violet, blue or green precipitate which indicated the presence of steroids [9].

Test for tannins

Five drops of lead acetate were added to 5 ml of the extract. It was observed for a yellow precipitate which indicated the presence of tannins [11].

Test for terpenes

Two ml of $CHCl_3$ (chloroform) in a test tube were added to 5 ml of the plant extract. To form a layer, 3 ml of H_2SO_4 (sulfuric acid) were carefully added. It was observed for reddish to brown color which indicated the presence of terpenes [9].

DPPH radical scavenging activity

DPPH radical scavenging activity assay [14] was used. The powdered herbs were dissolved in methanol until it reaches a final concentration of 500 ppm. A stock solution containing 3.49 mg DPPH in 10 ml methanol were diluted to 100ml methanol to create 0.1mM DPPH in methanol. Afterwards, 1ml of each extract was mixed with 4ml of DPPH solution and was calculated using the equation: % DPPH scavenging effect = [(Acontrol – Asample) / Acontrol] x 100

Total phenolic content

The total phenolic content of the plant extracts was determined using the Folin – Ciocalteu method [15] with different concentrations (0.25, 0.5, 1.0, 2.0 and 4.0 mg/ml) of Ascorbic Acid using APEL-100 UV-Vis spectrophotometer (PD-303UV) were made at a calibration curve. Twenty mcL ascorbic acid solution were dispensed in vials. Two hundred mcL of Folin – Ciocalteu reagent were added to each vial and were incubated at room temperature for 5 minutes. Sodium carbonate (20 ml) with the concertation of 1 mg/ml was prepared. Then, sodium carbonate (1 ml) was added to the mixture of ascorbic acid and FC reagent were transferred to cuvettes and read using UV-Vis spectrophotometer at 680 nm wavelength. The calibration curve was standardized, then 3 mg of crude extracts were dissolved in 3 ml distilled water. Crude extracts (200 mcL) were transferred to vials (in triplicates). FC reagent (200 mcL) was added and these were incubated at room temperature for 5 minutes. Sodium carbonate (1 ml) were added to the crude extracts and FC reagent mixtureand read using the APEL-100 UV-Vis spectrophotometer (PD-303UV) at 680 nm wavelength. The crude extracts' absorbance values were compared with the calibration curve using the ascorbic acid. The total phenolics were calculated based on the standard curve of the ascorbic acid and its linear regression as shown in this equation:y = mx+b

Antibacterial Property

Test organism

*S. aureus*and *E. coli*were used as bacterial test pathogensfor the antibacterial activity screening of the three plants. Test organisms were obtained from the Department of Biological Sciences, College of Arts and Sciences, Science City of Munoz Philippines.

Preparation of inoculum

Three to five well-isolated colonies of the same morphological type of the bacteria were selected from an agar slant culture. A loophole of isolate was transferred into a test tube containing 10 milliliters nutrient broth.

The broth culture was incubated at room temperature for 24 hours.

The turbidity of the actively growing broth culture was adjusted with sterile broth to obtain turbidity optically to that of the 0.5 McFarland standards. The comparison was done visually comparing the inoculum tube and the 0.5 McFarland standards against a printed paper with a white background and contrasting black lines under sufficient light conditions.

Preparation of assay plates

Thirty-eight grams of nutrient agar were dissolved in one liter of distilled water and sterilized by autoclaving at 15 psi for 20 minutes at 121 ˚C and allowed to cool. Approximately twenty milliliters of sterilized media were poured at the sterilized petri plates and allowed to solidify. One hundred microliter of adjusted bacterial broth culture was pipetted and was aseptically swab using sterile cotton swab.

Preparation of paper discs

Paper discs were made from Whatman filter paper #1 measuring approximately 6 millimeters using a paper puncher. The paper discs were placed in a petri plate and then sterilized in an autoclave for 15 psi for 20 minutes at 121 ˚C.

Screening of antibacterial activity

The disc diffusion test method based on "Manual on Antimicrobial Susceptibility Testing: Disk Diffusion Test" [16] were used for the antibacterial property test. Six filter paper discs of approximately 6 millimeters in diameter were impregnated with each treatment. The paper discs were air dried for one hour inside the chamber. The plates were incubated at room temperature. Diameters of zone of inhibition were measured and recorded in millimeters (mm) using a Vernier caliper after 4, 8, 12, 18, and 24 hours of incubation.

Statistical Analysis

Experiment was laid out in a Completely Randomized Design (CRD). Data were analyzed using analysis of variance (ANOVA). Duncan's Multiple Range Test (DMRT) was carried out to compare the treatment effects at 5% level of significance.

RESULTS AND DISCUSSION

Phytochemical Screening of *C. citratus, A. barbadensis*and *A. odorum*

In the phytochemical screening, various phytochemicals showed positive result as shown in Table 1. In *C. citrates* and *A. barbadensis*, only alkaloids, flavonoids, sterols, tannins, and terpenes were present which match to the other findings of previous studies [4, 7]. The results also conformed to

Praditvarn and Samhandharaksa (1990) [17] who reported the presence of the aforementioned phytochemicals in the lemongrass extracts. However, saponins were not detected in *C. citrates* and *A. barbadensis*. In *A. odorum* only alkaloids, flavonoids, saponins, sterols, tannins, and terpenes were present. In which Lanzotti (2006) [8] indicated that *Alliums* are a rich source of phytonutrients and are used in treatment and prevention of a number of diseases, including a cancer, coronary heart disease, diabetes, disorders of a digestive tract, etc.

Alkaloids are naturally synthesized by many organisms, including animals, plants, bacteria and fungi which is significant in the protection and survival of plant because it ensures their survival against microorganisms as antibacterial and are reported to possess a variety of activities including antioxidant effects [18, 19].

Another phytochemical which was detected was flavonoids. Flavonoids found in many plants exhibits a range of biological activities like antioxidant properties and evidences prove that there is a diverse range of antibacterial properties due to it interfering with various bacterial virulence factors, including enzymes, toxins and signal receptors [20, 21].

Saponins were also detected in *A. odorum* which showed presence through one-centimeter layer of foam. This compound that was tested had strong radical scavenging activity that can be used as accessible sources of natural antioxidants [22]. It also showed prominent antibacterial activity according to other researches [23].

Sterols are also detected in the three plants and have been detected in a range of plant species [24]. The effectiveness of sterols as antioxidants was concluded due to free radicals reacting rapidly with sterols. In addition, high antibacterial potentials were observed for the sterols hence may be exploited for future antimicrobial drugs [25, 18].

Next, bioactive compound which can be detected by a yellow precipitate is tannins. This phytochemical can be found in localized area of plants such as leaves, bark, fruit, wood and root [26]. Many microbial enzymes in raw culture filtrates or in purified forms are inhibited when mixed with tannins therefore causing it to be inhibitory to the growth of intestinal bacteria [27]. In addition, tannins is also an effective natural antioxidant component that can be used as food preservative agents or nutraceuticals [28].

Lastly, terpenes which was present in the three plants as well. It is considered as the largest number of compound that naturally occurs in plants [29] which can be detected by reddish to brown color. According to Zengin & Baysal (2014) [30], antimicrobial and antioxidant activities of terpenes are highly affected by their chemical nature and interactions.

In the wide diversity of compounds, especially secondary metabolites, found and isolated from plants, studies have shown that these compounds have anticancer, antibacterial, analgesic, anti-inflammatory, antitumor, antiviral, and many other activities to a greater or lesser extent [31]. Alkaloids, flavonoids, saponins, sterols, tannins, and terpenes are just a few of the most common example of these compounds.

DPPH Radical Scavenging Analysis of *C. citratus*, *A. barbadensis* and *A. odorum*

Antioxidant compounds which mostly can be found in foodhasan ability to trap free radicals that plays an important role as a health-protecting factor. Antioxidant compounds like phenolic acids, polyphenols and flavonoids scavenge free radicals that inhibit oxidative mechanisms that lead to degenerative diseases and other chronic diseases such as cancer, heart disease, stroke, rheumatoid arthritis and cataracts [33]. DPPH scavenging assay was used to evaluate the antioxidant activity of the three plants.

The radical scavenging activity of the extracts of *C. citratus*, *A. barbadensis* and *A. odorum* on DPPH was determined as shown in Table 3. All the plants have exhibited radical scavenging activity. *C. citratus* have exhibited the highest DPPH scavenging activity (80.36%) close to the Cathechin (81.35%). On the other hand, *A. barbadensis* and *A. odorum* exhibited 46.84% and 38.29%, respectively, which is below the Cathechin implying a lower DPPH scavenging activity.

In addition, the total phenolic content of the three plants were also analyzed and is also shown in Table 3. The results showed that the extract of *C. citratus* have the highest phenolic content among the three plants with 187.33 mg/g. Interestingly, *A. barbadensis*(55.46 mg/g) has a higher total phenolic content than the extract of *A. odorum* (46.50 mg/g).

Free radicals contribute to more than one hundred disorders in humans including atherosclerosis, arthritis, ischemia and reperfusion injury of many tissues, central nervous system injury, gastritis, cancer and AIDS [34,35].The results of the antioxidant activity of *C. citratus*, *A. barbadensis*, and *A. odorum* implies that they have the potential

to counteract the effects of free radicals. In addition, phenolic compounds are present in plants as a secondary metabolite, where they have a high tendency to chelate metals due to their hydroxyl and carboxyl groups making them excellent antioxidants [36, 37].

The antioxidant activity of plants has correlation to the phytochemicals that it has. Flavonoids, which are one of the phytochemicals screened and detected are a group of polyphenolic compounds which includes the free radical scavenging properties, inhibition of hydrolytic and oxidative enzymes and anti-inflammatory action [38]. Suggests that the biological actions of these compounds are related to their antioxidant activity [39].

Antibacterial Testing of *C. citratus*, *A. barbadensis*, and *A. odorum*

Antibacterial testing of three herb plants using two extraction methods against *Escherichia coli* and *Staphylococcus aureus* were conducted as shown in Tables 3 and 4.

As shown in Table 3, after 4 hours of incubation, different plant extracts showed zones of inhibition. The highest zone of inhibition was observed in T_7 (Streptomycin sulfate) with a mean value of 14.00±1.73 mm, followed by T_6 (*A. odorum* CE), T_2 (*C. citratus* CE), T_3 (*A. barbadensis* HWE) and T_1 (*C. citratus* HWE) with 2.83±1.15 mm, 1.83±3.18 mm, 0.97±0.03 mm, 0.95± 0.03 mm, respectively. T_4, T_5, and T_6, on the other hand, showed no zones of inhibition. Analysis of Variance shows that T_7 (Streptomycin sulfate) was significantly different with T_6 (*A. odorum* CE), T_2 (*C. citratus* CE), T_3 (*A. barbadensis* HWE) and T_1 (*C. citratus* HWE) but T_6 (*A. odorum* CE) was comparable to T_2 (*C. citratus* CE) and T_3 (*A. barbadensis* HWE).

However, during 8 hours of incubation T_1 (*C. citratus* HWE) and T_3 (*A. barbadensis* HWE) showed no inhibition.Compared to T_7 (Streptomycin sulfate), T_6 (*A. odorum* CE), and T_2 (*C. citratus* CE) with 18.70±0.26 mm, 6.18±1.26 mm, and 2.33±4.04 mm, respectively. Analysis of Variance shows that T_7 (Streptomycin sulfate) was significantly different with T_6 (*A. odorum* CE), and T_2 (*C. citratus* CE) while T_6 (*A. odorum* CE) was comparable to T_2 (*C. citratus* CE).

After 12 hours of incubation, the measured zones of inhibition of the treatments decreased except for T_7 (Streptomycin sulfate) with 19.00±2.29 mm. T_6 (*A. odorum* CE) and T_2 (*C. citratus* CE) decreased their zones of inhibition with 3.17±1.53 mm and 1.67±2.89, respectively. Analysis of Variance still shows that T_7

(Streptomycin sulfate) was significantly different with T_2 (*C. citratus* CE).

Then, after 24 hours of incubation, the measured zones of inhibition of the treatments decreased, where T_6 (*A. odorum* CE) had 2.67±0.58 mm and T_2 (*C. citratus* CE) with 1.50±2.60 mm, except for T_7 (Streptomycin sulfate) with 21.78±2.89 mm. T_7 (Streptomycin sulfate) was significantly different with T_2 (*C. citratus* CE). Analysis of Variance revealed that there is a significant difference between each treatment, T_7 were significantly different at 5% level of significance with T_2 and T_6.

As shown in Table 4, after 4 hours of incubation, different plant extracts did not show zones of inhibition. But after 8 hours of incubation, the highest zone of inhibition was observed in T_7 (Streptomycin sulfate) with a mean value of 16.17±14.00 mm, followed by T_2 (*C. citratus* CE), T_3 (*A. barbadensis* HWE), and T_6 (*A. odorum* CE) with 8.00±2.00, 2.80±1.21, and 0.50±0.87, respectively. T_7 (Streptomycin sulfate) was significantly different with T_3 (*A. barbadensis* HWE) but comparable with T_2 (*C. citratus* CE). Meanwhile, T_3 (*A. barbadensis* HWE) was comparable to T_6 (*A. odorum* CE) at 5% level of significance.

On the other hand, T_6 (*A. odorum* CE) lost its effectivity after 12 hours of incubation, compared to T_7 (Streptomycin sulfate), T_2 (*C. citratus* CE) and T_3 (*A. barbadensis* HWE) with 28.17±4.62, 8.92±1.70 and 0.33±0.58, respectively. T_7 (Streptomycin sulfate) was significantly different with T_2 (*C. citratus* CE) and T_3 (*A. barbadensis* HWE). In addition, T_2 (*C. citratus* CE) was significantly different with T_3 (*A. barbadensis* HWE).

Lastly, after 24 hours of incubation T_3 (*A. barbadensis* HWE) lost its effectivity compared to T_7 (Streptomycin sulfate) with 26.27±3.91 mm, T_6 (*A. odorum* CE) with 4.67±0.58 and T_2 (*C. citratus* CE) with 4.50±3.97 mm zones of inhibition. Analysis of Variance showed that T_7(Streptomycin sulfate) was significantly different with T_6 (*A. odorum* CE) and T_2 (*C. citratus* CE) but T_6 (*A. odorum* CE) was comparable with T_2 (*C. citratus* CE) at 5% level of significance.

Other pathogens like *S. agalactiae* are more susceptible to *C. citratus* than *S. aureus* and *E. coli*. Moreover, it appears that *C. citratus* have multiple targets in the bacterial cell, depending on the concentration used as well as the amount of its components [40]. The antibacterial activity of *A. barbadensis* plant fractions, on the other hand, were evaluated against bacterial strains *E. coli* and *S. aureus*, where it has shown strong antibacterial activity [41, 42]. *Allium* species

were also studied against pathogenic microbes. Despite the great number of antimicrobial compounds isolated, *Allium* species may still be an important source of molecules that have antibacterial activity [8].

The effectivity of the extracts after different incubations is similar to a study where an intragroup quantitative analyses revealed that SAF (Self-Adjusting File) operating at 2, 4, or 6 minutes yielded a highly significant bacterial reduction [43]. This implies that the extracts had fast effectivity against the two bacterial pathogens. But like the T7 (Streptomycin Sulfate) and any other established antibacterial drugs, the antibacterial activity decreases through hours that is why humans that take antibiotics without prescription are more susceptible to being immune to the antibiotic itself.

In addition, the impurities of the extracts can affect their effectivity. According to Mulyono *et al*. (2012) [44], purification might be a good strategy to increase the effectivity of extracts to inhibit the growth of pathogens. This implies that the effectivity of the extracts did not last long because it was not in their purest form. The extraction procedure could also affect the effectivity because according to Hsu et al. (2006) [45], the amount of materials that can be extracted from a plant depends on the vigor of the extraction procedure and the possibility of sample-to-sample variation in extracted materials. The results exhibited in both bacterial pathogens that crude extracts are far more effective due to crude preparations of plant parts have been suggested to have higher efficiency than semi-crude or pure plant substances leaving hot water extraction less effective [46, 47].

These results have correlation to phytochemical screening because it is said that tannins also have antibacterial properties against different types of bacteria [48]. This substance in plants maybe the reason for the antibacterial activity against the pathogens causing the formation of zones of inhibitions.

Table 1: Phytochemicals analysis of hot water extracts and crude extracts of the three plants

Phytochemicals	*C. citratus*		*A. barbadensis*		*A. odorum*	
	HWE	CE	HWE	CE	HWE	CE
Alkaloids	+	-	+	+	+	+
Flavonoids	+	+	+	+	+	-
Saponins	-	-	-	-	-	+
Sterols	+	+	+	-	+	-
Tannins	+	+	+	-	+	-
Terpenes	+	+	+	-	+	+

Legend: (+) present in plant and (-) absent in plant.

Table 2: Radical scavenging activity and total phenolics of *C. citratus, A. barbadensis,* and *A. odorum*		
Extracts	**%RSA**	**Total Phenolic (mg/g)**
***C. citrates* extract**	**80.36**	**187.33**
***A. Barbadensis* extract**	**46.84**	**55.46**
***A. odorum* extract**	**38.29**	**46.50**
Cathechin	**81.35**	

Table 3: Comparison of zone of inhibition (mm) of the different treatments against *E. coli* after 4, 8, 12, 18 and 24 hours of incubation using hot water and crude extracts					
Treatments		**Hours of Incubation**			
	4	**8**	**12**	**18**	**24**
T_1*C. citrates* HWE	0.95 ± 0.00^{bc}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}	0.00 ± 0.00^{b}	0.00 ± 0.00^{b}
T_2*C. citrates* CE	1.83 ± 3.18^{bc}	2.33 ± 4.04^{c}	1.67 ± 2.89^{bc}	1.33 ± 2.31^{b}	1.50 ± 2.60^{b}
T_3*A. barbadensis* HWE	0.97 ± 0.03^{bc}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}	0.00 ± 0.00^{b}	0.00 ± 0.00^{b}
T_4*A. barbadensis* CE	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}	0.00 ± 0.00^{b}	0.00 ± 0.00^{b}
T_5*A. odorum* HWE	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}	0.00 ± 0.00^{b}	0.00 ± 0.00^{b}
T_6*A. odorum* CE	2.83 ± 1.15^{b}	6.18 ± 1.26^{b}	3.17 ± 1.53^{b}	3.00 ± 1.50^{b}	2.67 ± 0.58^{b}
T_7 Streptomycin Sulfate (+) control	14.00 ± 1.73^{a}	18.70 ± 0.26^{a}	19.00 ± 2.29^{a}	19.82 ± 3.78^{a}	21.78 ± 2.89^{a}
T_8 Distilled water (-) control	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}	0.00 ± 0.00^{b}	0.00 ± 0.00^{b}
Values are expressed as mean of three replicates each concentration of extracts. Means with the same letter of superscript are not significantly different at P<0.05 using DMRT.					

Table 4: Comparison of zone of inhibition (mm) of the different treatments against *S. aureus* after 4, 8, 12, 18 and 24 hours of incubation using hot water and crude extracts					
Treatments		**Hours of Incubation**			
		8	**12**	**18**	**24**
T_1*C. citratus*HWE	0.00 ± 0.00^{c}	0.00 ± 0.00^{b}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}
T_2*C. citratus*CE	0.00 ± 0.00^{c}	8.00 ± 2.00^{ab}	8.92 ± 1.70^{b}	7.40 ± 1.85^{b}	4.50 ± 3.97^{b}
T_3*A. barbadensis*HWE	0.00 ± 0.00^{c}	2.80 ± 1.21^{b}	0.33 ± 0.58^{c}	0.51 ± 0.25^{c}	0.00 ± 0.00^{c}
T_4*A. barbadensis*CE	0.00 ± 0.00^{c}	0.00 ± 0.00^{b}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}
T_5*A. odorum* HWE	0.00 ± 0.00^{c}	0.00 ± 0.00^{b}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}
T_6*A. odorum* CE	0.00 ± 0.00^{c}	0.50 ± 0.87^{b}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}	4.67 ± 0.58^{b}
T_7 Streptomycin Sulfate (+) control	0.00 ± 0.00^{c}	16.17 ± 14.00^{a}	28.17 ± 4.62^{a}	26.75 ± 3.54^{a}	26.27 ± 3.91^{a}
T_8 Distilled water (-) control	0.00 ± 0.00^{c}	0.00 ± 0.00^{b}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}
Values are expressed as mean of three replicates each concentration of extracts. Means with the same letter of superscript are not significantly different at P<0.05 using DMRT.					

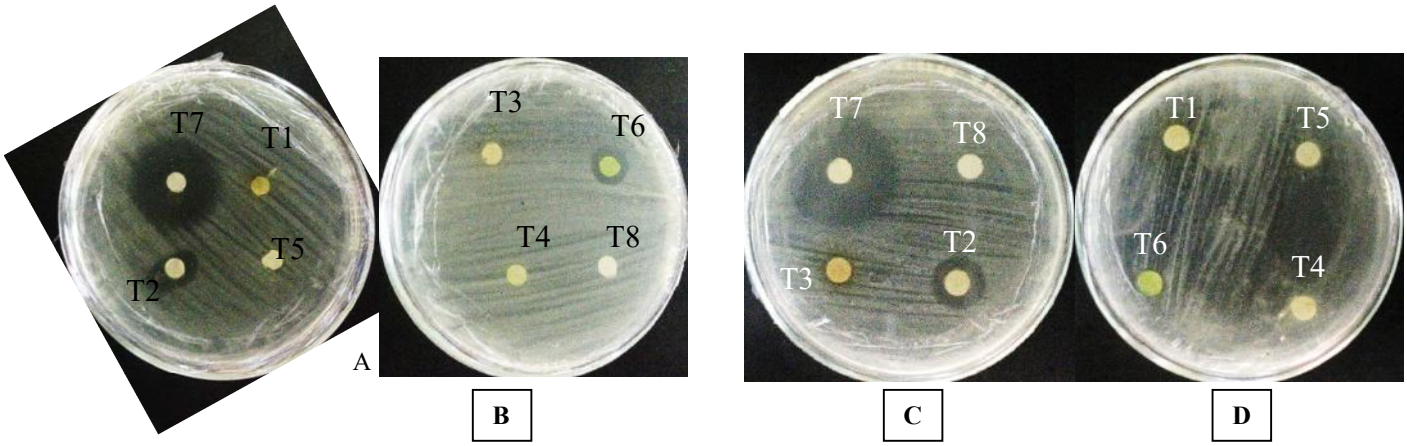

Figure 1: Antibacterial testing after 8 hours of incubation against (A and B) *E. coli* and (C and D) *S. aureus* with treatments (T_1) *C. citratus* HWE, (T_2) *C. citratus* CE, (T_3) *A. barbadensis* CE, (T_4) *A. barbadensis* HWE, (T_5) *A. odorum* CE, (T_6) *A. odorum* CE, (T_7) positive control and (T_8) negative control

CONCLUSION

Phytochemical screening revealed that the three plants possessed phytochemicals: alkaloids, flavonoids, sterols, tannins and terpenes. In addition, the antioxidant activity determination showed that *C. citrates* have the highest radical scavenging activity and total phenolics followed by *A. barbadensis* and *A. odorum*. Lastly, on antibacterial testing against *E. coli* and *S. aureus, C. citratus, A. barbadensis* and *A. odorum* showed zone of inhibition. Thus, the plants can further be explored for its ability to cure various diseases, as an antioxidant due to its ability to scavenge free radicals and to fight pathogens such as *E. coli* and *S. aureus*.

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