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Activity Of Sodium Bicarbonate Against *Escherichia Coli*

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ABSTRACT

Background: *Escherichia coli (E. coli) are one of the most common bacteria that can be pathogenic and develop resistance to various antibiotics by different ways, making them difficult to treat with standard therapies. So, using alternative strategies in management are urgent.*
Material and methods: *The bacteria (E. coli) was isolated from urinary tract and wounds; cultured in three media (blood agar, macConkey agar, and eosin methylene blue agar). Sodium bicarbonate (SBC) with three concentrations (20%, 10%, and 5%) evaluated as antimicrobial agents against isolated E. coli by well diffusion method. The antibiotics discs (Gentamicin) were used by disc diffusion method as control agents. All the statistical analysis was done by using SPSS 26 software and Excel app.*
Results: *Out of the 24 specimens in the study, 66.6% were women, while 33.4% were men with significant differences (P< 0.05). E. coli revealed 70.8 % sensitivity to gentamicin. 66.6 %, 62.5 %, and 58.33 % of E. coli were sensitive to 20%, 10%, and 5% SBC respectively. The mean comparison of inhibition zone of 20 % SBC 13.42± 11.75 mm with gentamicin 15± 6.43 mm showed no significant statistical differences (P= 56) that's mean 20% SBC is equal in antibacterial activity to gentamicin. Other concentrations of SBC (10% and 5 %) also showed no significant differences compared to gentamicin (P= 21 and P= 0.16) respectively.*
Conclusions: *The antibacterial activity of SBC makes it a promising candidate for the development of new antimicrobial agents.*
Keywords: Sodium Bicarbonate (NaHco3), E. Coli, Gentamicin, Microbial Resistance, Antibiotics Sensitivity.

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INTRODUCTION

Sodium bicarbonate (NaHCO3), also known as baking soda, is a white crystalline powder that is soluble in water and has a slightly salty and alkaline taste [1]. It is commonly used in the food industry as a leavening agent and in medicine as an antacid to neutralize stomach acid [2]. Sodium bicarbonate (SBC) has been reported to have antibacterial activity against various clinically isolated bacteria [3]. The mechanism of action is thought to be due to the alkaline pH created by the bicarbonate ions, which disrupts the

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bacterial membrane and inhibits bacterial growth [4-5].

Gentamicin is an aminoglycoside antibiotic used in the treatment of several gram-negative infections. It should be indicated based on patient age, symptoms, signs at presentation, and local antimicrobial resistance patterns to enhance the probability of successful treatment in bacterial septicemia, meningitis, urinary tract infections, gastrointestinal tract infections, and soft tissue infections [6-8].

Escherichia coli is the gram-negative organism most frequently isolated in adult patients with bacteremia and in severe cases it may lead to death [9-10].

E. coli cells may grow on a solid or in a liquid growth medium under laboratory conditions. It may be grown in a basic minimum of media, which includes glucose as a carbon and energy source, ammonium salts as a nitrogen source, other salts, and trace elements. As *E. coli* have simple nutritional requirements it can be easily cultured on a common medium, such as Nutrient agar, MacConkey agar, and EMB agar [11-12].

Aim of the study to detection the effect of antimicrobial activity of gentamicin and Sodium bicarbonate at different concentrations on the growth of *E. coli*.

METHODS

A total number of 24 positive culture patients (subjects) were enrolled in this study during the period 1/2/2022 to 8/5/2023.These patients from the urology department, each patient suffering from complaint of frequent urge to urinate and painful, burning feeling in the bladder or urethra during urination. As well as, patients suffering from wound infections. The isolates were identified at first by standard microbiological and biochemical tests [13].

All isolates were identified based on their morphology, Gram staining, biochemical tests, and culture on selective media (EMB agar). Then isolates confirmed by VITEK 2 automated systems (bioMerieux, France).

To reduce the risk of contamination, participants were informed to clean their hands with water and their genital area with swab soaked in normal saline before collection of the clean catch mid-stream urine samples. After the urethra is properly cleaned, the collection may begin by discarding the initial stream of urine into the toilet. Then, 10-15 milliliters (ml) of urine collected in the provided sterile specimen cup by directly urinating into the cup. Once an adequate amount is collected, then the remaining urine should be voided in the toilet. For men, the opening of the urethra (tip of the penis) should be wiped clean with a cleansing wipe before the collection is begun. The collected urine sample should be analyzed soon within 1 hour after collection.

Agar well diffusion method is widely used to evaluate the antimicrobial activity of plants or microbial extracts; Adjust the bacterial suspension to match the turbidity of a (0.5) McFarland standard. The agar plate surface is inoculated by spreading a volume of the microbial inoculum over the entire agar surface. Then, a hole with a diameter of 6 mm is punched aseptically with a sterile cork borer or a tip, and a volume (50 µL) of the antimicrobial agent at desired concentration is introduced into the well. Then, agar plates are incubated under suitable conditions. The antimicrobial agent diffuses in the agar medium and inhibits the growth of the microbial strain tested.

The disc diffusion method, also known as the Kirby-Bauer method, is a widely used technique to determine the sensitivity of bacteria to different antibiotics. The method involves placing a small paper disc containing a specific antibiotic on a culture of the bacteria and observing whether the antibiotic inhibits the growth of the bacteria. Gentamicin (30 µg) used as control agent in this study [14].

For statistical analysis, SPSS software 26 (SPSS Inc., Chicago, USA) was used. Means and standard deviations were used to represent the data. T test was used to examine measurement data with a normal distribution. Chi- square was used for non- parametric variables, P value < 0.05 considered significant.

RESULTS

The out of 24 participants in the study, 66.6% were women, while 33.4% were men with significant differences ($P< 0.05$) [Figure 1].

[Figure 2] showed the distribution of bacteria according to sites of infection. The study showed that 75% of bacteria isolated from urinary tract and 25% isolated from wounds. The study showed that 70.8% of bacteria sensitive to gentamicin.

66.6 % of bacteria sensitive to 20% Sodium bicarbonate, also showed that 62.5 % of bacteria sensitive to 10% Sodium bicarbonate. The study showed that 58.33 % of bacteria sensitive to 5% Sodium bicarbonate [Figure 3].

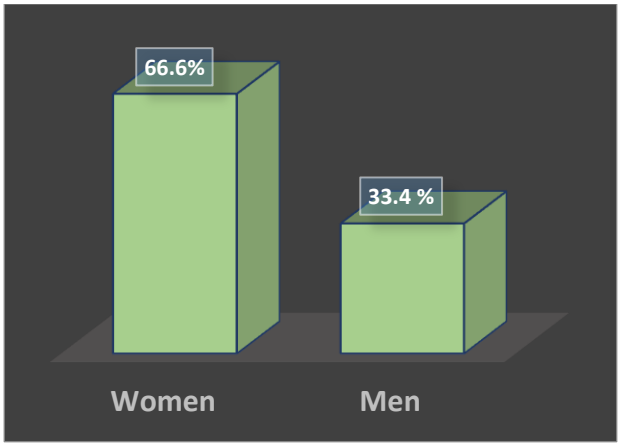

Figure 1: The distribution of gender.

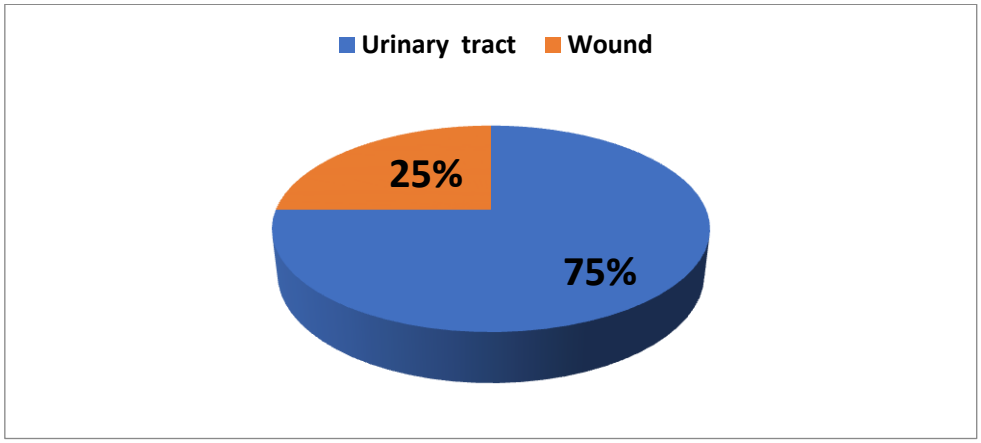

Figure 2: Distribution of bacteria according to sites of infection

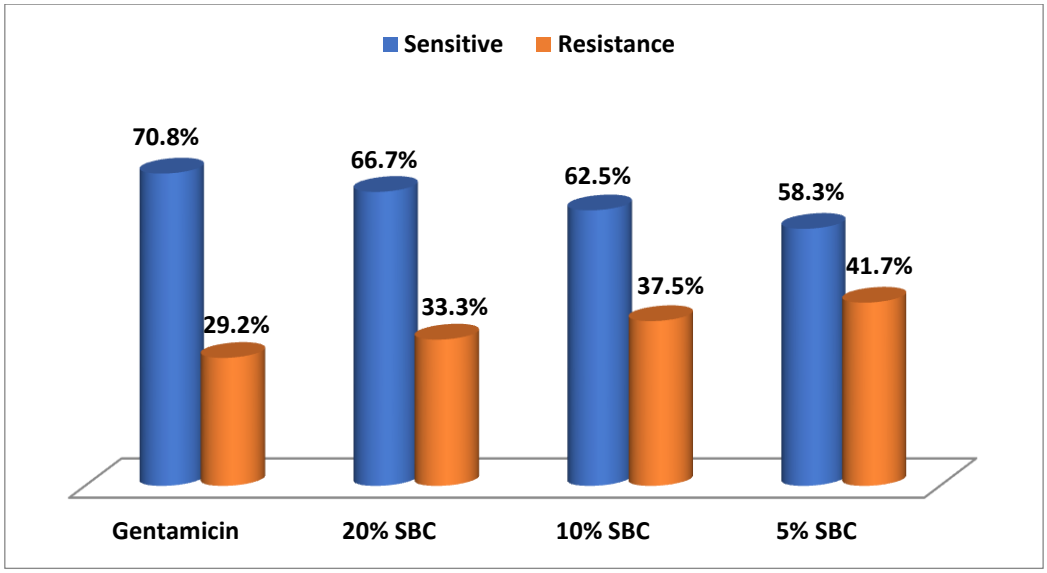

Figure 3: Antibiotic sensitivity of gentamicin and sodium bicarbonate (SBC)

The mean comparison of inhibition zone of 20 % sodium bicarbonate 13.42± 11.75 mm with gentamicin 15± 6.43 mm showed no significant statistical differences (P= 56) that's mean 20% sodium bicarbonate is equal in antibacterial activity to gentamicin.
The mean comparison of inhibition zone of 10 % sodium bicarbonate 12.17± 8.84 mm with gentamicin 15± 6.43 mm showed no significant statistical differences (P= 21) that's mean 10% sodium bicarbonate is equal in antibacterial activity to gentamicin.
The mean comparison of inhibition zone of 5 % sodium bicarbonate 12± 9.13 mm with gentamicin 15± 6.43 mm showed no significant statistical differences (P= 19) [Table 1].

Table 1: Comparison means of gentamicin and different concentrations of sodium bicarbonate

Variables comparison	Mean in millimeter	Std. Deviation	P value
20% sodium bicarbonate	13.42	11.75	0.56
Gentamicin	15	6.43	
10% sodium bicarbonate	12.17	8.84	0.21
Gentamicin	15	6.43	
5% sodium bicarbonate	12	9.13	0.19
Gentamicin	15	6.43	

DISCUSSION

The comparison of mean inhibition zone of different agents is an important aspect of antimicrobial susceptibility testing. The inhibition zone is the clear area surrounding a disc containing an antibiotic or other antimicrobial agent, which indicates the extent to which the agent can inhibit the growth of a particular microorganism. The mean inhibition zone is the average size of the inhibition zones across multiple tests [15].
Overall, the comparison of mean inhibition zone of different agents can provide valuable information for clinicians and researchers in selecting the most effective antimicrobial agents for treating specific infections [16-17].
The distribution of gender in studies can vary depending on various factors such as the research topic, sample size, and recruitment method. In some studies, the gender distribution may be more balanced, while in others, one gender may be overrepresented.
In the current study, the statement indicates that out of the total number of participants in the study, 66.6% were women, while 33.4% were men with significant differences (P< 0.05). Because women tend to have UTI more often than man due to the short and wider female urethra and its travelling from the anus to the urethra [18]. Furthermore, women lack the bacteriostatic properties of prostatic secretions that have bactericidal activity against bacteria [19].
Gentamicin is an antibiotic commonly used to treat infections caused by *E. coli*. However, the resistance of *E. coli* to Gentamicin has been increasing in recent years. In this study, 70.8% of bacteria were sensitive to gentamicin and 29% of bacteria resistant to it.
A study mentioned that the resistance in 2019 of *E. coli* to gentamicin was high in some regions of India [20]. Another study published in 2020 reported a similar trend of increasing resistance of *E. coli* to gentamicin in hospitals in Iran [21].
On the other hand, some studies have reported a lower level of resistance of *E. coli* to gentamicin [22-23]. A study found that only small rate of *E. coli* isolates from a hospital was resistant to gentamicin [24].
Overall, the resistance and sensitivity of *E. coli* to gentamicin may vary depending on various factors such as geographic location, antibiotic use, and bacterial strain. Regular monitoring of antibiotic resistance patterns is crucial to guide appropriate treatment decisions.

Several studies have demonstrated the antibacterial activity of sodium bicarbonate (SBC) against a variety of bacterial strains. The current study showed that 66.6 % of bacteria sensitive to 20% SBC. Also showed that 62.5 % of bacteria sensitive to 10% SBC; and 58.33 % of bacteria sensitive to 5% SBC.

One study found that SBC inhibited the growth of Streptococcus mutans, a bacterium commonly associated with dental caries [25]. Another study reported that SBC showed antibacterial activity against *Staphylococcus aureus*, a bacterium responsible for a range of infections [26]. SBC has also been found to have activity against *Helicobacter pylori*, a bacterium associated with peptic ulcer disease [27].

The mechanism of action of sodium bicarbonate's antibacterial activity is not fully understood, but it is believed to be related to its ability to alter the pH of the bacterial environment. Bacteria have specific pH requirements for growth, and when the pH of their environment is altered, it can disrupt their metabolism and lead to cell death [28].

Furthermore, SBC has been found to be effective against drug-resistant bacteria such as methicillin-resistant S. aureus and vancomycin-resistant enterococci [29]. This suggests that SBC could be a promising alternative to conventional antibiotics in the treatment of bacterial infections.

CONCLUSION

The different concentrations of SBC showed well activity to *E. coli* that may be used in clinical practices in vivo.

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