

Antibacterial Activities of *Daucus Carota* Against Urinary Tract Pathogen *Escherichia Coli* Isolated from Urine Specimen Collected from The Students of Nnamdi Azikiwe University, Awka, Nigeria

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Abstract: The rising prevalence of antimicrobial resistance has prompted an increased interest in natural remedies such as plant-based antimicrobials. Among these, *Daucus carota* (carrot) is recognized for its potential antibacterial and antifungal properties. This study investigated the antibacterial activity of *Daucus carota* extracts against *Escherichia coli* isolated from urine specimens. Furthermore, the study evaluated the antimicrobial susceptibility of these pathogens using carrot extracts that quantifies the major phytochemical constituents of the carrot rhizome. The antimicrobial susceptibility testing was carried out using the *in-vitro* method, wherein varying concentrations of carrot extracts (aqueous extracts of carrot) were applied to the test pathogen. Zones of inhibition were measured to assess the sensitivity of the pathogen *Escherichia coli*. The results revealed that carrot extracts exhibited significant antibacterial activity as (7mm, 5mm, 10mm, 1mm, 8mm) against tested pathogen. The phytochemical analysis revealed that carrot contains high levels of bioactive compounds, including flavonoids, alkaloids, tannins, saponins, resins, steroids, glycosides and phenolic compounds through phytochemical analysis. These compounds maybe responsible for the observed antimicrobial properties. The findings suggest that carrot extracts possess notable antimicrobial properties, particularly against bacteria responsible for urinary tract infections. This suggests that *Daucus carota* can be used as a natural alternative to ineffective synthetic antibiotics for treating infections caused by multidrug-resistant pathogens.

I. Introduction

The background of Study

Urinary tract infections (UTIs) are among the most common bacterial infections affecting millions of individual worldwide, with a significant burden on healthcare systems and patient quality of life (Chan *et al.*, 2017). The primary causative agents of UTIs are bacteria, predominantly *Escherichia coli* (*E. coli*), followed by *Staphylococcus aureus* (*S. aureus*), and *Salmonella species* (Ejidiike *et al.*, 2022). The increasing prevalence of antibiotic resistance among these pathogens has highlighted the urgent need for alternative therapeutic strategies. In recent years, there has been growing interest in exploring natural compounds with antibacterial properties as potential alternatives to conventional antibiotics (Biriyani *et al.*, 2020).

Carrots (*Daucus carota* L.) are widely consumed vegetables known for their nutritional value and health-promoting properties (Hadyarrahman *et al.*, 2017). Beyond their well-documented antioxidant and anticancer activities, carrots have also been reported to possess antimicrobial properties against a range of pathogens, including bacteria and fungi (Haryati *et al.*, 2017). Several studies have investigated the potential antibacterial activity of carrot extracts or constituents against various bacterial strains, including those commonly associated with UTIs.

Salmonella species is a bacterial species commonly found in the genitourinary tract and is implicated in both uncomplicated and complicated UTIs, especially in immunocompromised individuals (Walker *et al.*, 2017). Traditional antibacterial agents used to treat salmonella infections often have limited efficacy and are associated with side effects and the emergence of resistant strains (Garcia-Rubio *et al.*, 2020). Therefore, there is a pressing need to explore alternative antibacterial agents, such as plant-derived compounds, to combat *Salmonella* infections effectively (Naglik., 2019). *Escherichia coli* is a Gram-negative bacterium that colonizes the gastrointestinal tract of humans and animals but can also cause UTIs when it ascends the urinary tract (Nanda *et al.*, 2017). It is the most common bacterial pathogen associated with UTIs, accounting for approximately 75-95% of cases (Mueller *et al.*, 2021). The emergence of multidrug-resistant strains of *Escherichia coli* poses a significant challenge in the treatment of UTIs, necessitating the search for novel antimicrobial agents (Vargas *et al.*, 2017). *Staphylococcus aureus* is a Gram-positive bacterium that colonizes the skin and mucous membranes of humans and animals and is a leading cause of various infections, including UTIs (Khanal LK *et al.*, 2018). Methicillin-resistant *Staphylococcus aureus* (MRSA) strains, in particular, have become a major public health concern due to their resistance to multiple antibiotics, including β -lactams, which are commonly used to treat *Staphylococcus aureus* infections (Raut S *et al.*, 2017).

The antibacterial activity of carrots against *Escherichia coli* (*E. coli*), *Salmonella species*, and *Staphylococcus aureus* (*S. aureus*) can be attributed to various constituents present in carrots such as carotenoids, polyacetylenes, minerals, vitamins, phenolic compounds (Ananthanarayan *et al.*, 2020).

Overall, the multifaceted antibacterial activity of carrots against *E. coli*, *Salmonella species*, and *S. aureus* is mediated by a combination of mechanisms involving membrane disruption, cell wall inhibition, oxidative stress, and enzyme inhibition (Gandra S *et al.*, 2019).

Aim of Study

The aim of this research is to investigate the antibacterial potential of carrot extracts or compounds against *Salmonella species*, *Escherichia coli*, and *Staphylococcus aureus*, the major pathogens associated with urinary tract infections.

Specific Objectives of the Study:

- to collect samples and specimen;
- to isolate the putative organisms from urine specimen;
- to screen the samples for bioactive ingredients;
- to determine the minimum inhibitory concentrations (MIC) and minimum bactericidal concentration (MBC) of carrot extract required to inhibit the growth of these (putative) pathogens;
- to evaluate the antibacterial properties of carrot extracts against *Salmonella species*, *Staphylococcus aureus*, and *Escherichia coli* and,
- to compare the antibacterial efficacy of carrot extract with conventional antibiotics;

II. Materials and Methods

Sample collection and classification

In this study, urine specimens were collected at random from students of Nnamdi Azikiwe University, Awka, Anambra state. Each was classified according to names, genders and age.

A total of 10 urine specimen were collected, consisting of 5 urine specimen from male students and 5 urine specimen from female students.

Collection of urine specimen was as follows:

Ten (10) urine specimens were collected from each of the above mentioned institution for analyses.

Each student was given one urine sample container labelled specimen A to J respectively, the container was dried, clean, wide-necked, and leak-proof. Then the student was requested to collect mid-stream urine specimen into the container (Monica Cheesbrough *et al.*, 2015).

Collection of leaf samples

Collection, authentication and processing of plant materials

3 kg root vegetables of carrot were purchased from Eke Awka market in Awka north Local Government Area, Anambra State, Nigeria. The plant materials were identified and authenticated by Dr. Okolie Christopher, a Botanist at the Botany Department of Nnamdi Azikiwe University, Awka, Nigeria. Confirmation of taxonomic identity of the plant was achieved by comparison with voucher samples kept at the Herbarium of the Department of Botany Sciences, UNIZIK. **Preparations of Media for Isolation**

The media used for this study were: Nutrient agar, blood agar, chocolate agar, Nutrient broth. The media were prepared according to the manufacturer's instruction and sterilized by autoclaving at 121 °C, 15 psi for 15 minutes.

Isolation and characterization

Each of the fresh urine specimens was inoculated onto Nutrient agar, urea agar, Simmons citrate agar and Blood agar media and incubated at 37 °C for 18–24 hours. All the plates were incubated aerobically and were initially examined for growth after 24 hours; each visible colony were visually inspected and counted manually to determine the amount of colony forming units (CFU) present in each plate.

Discrete colonies on various plates were sub-cultured onto nutrient agar and incubated for 24 hours. The various isolate underwent identification testing. Identification of the isolate was performed from pure colonies using classical biochemical tests (Gram Staining, Urease, hemolysis, citrate, oxidase and catalase). (Monica Cheesbrough *et al.*, 2015).

Gram staining

This reaction was done to identify organisms that are Gram positive (+ve) and Gram negative (-ve)

Procedure – A drop of normal saline was placed on a clean grease free slide, using a sterile wire loop, a smear of the culture was made on the slide and heat fixed. The fixed smear was flooded with crystal violet stain (primary stain) for 60 seconds. The stain

was rapidly washed off with distilled water and drained quickly, then flooded with lugol's iodine (a mordant) for 60 seconds and was washed off with distilled water. The slide was flooded with 95% ethanol (decolorizer) for 5 seconds. After which the slide was washed with distilled water and then flooded with safranin (counterstain) for 30 seconds and then washed off. The back of the slide was cleaned and placed in a draining rack for the stained smear to dry. The standard smear was then allowed to air dry and then viewed under the microscope using x100 objectives lens with a drop of immersion oil (Anand *et al.*, 2020).

Catalase Test

Procedure— A loopful of hydrogen peroxide was dropped onto a clean, grease-free slide. The isolate was then mixed with the hydrogen peroxide on the slide. The mixture was observed for the immediate production of gas bubbles, indicating a positive reaction, while no gas bubbles indicated a negative reaction.

Hemolysis test

The hemolysis test is a biochemical test performed on bacterial species to determine the ability of the organism to break down red blood cells.

Procedure: colonies were collected then inoculated into already prepared blood agar and incubated at 37 °C for 24 hours. A positive hemolysis test indicates Beta haemolysis which indicates the complete lysis of red blood cells, or Alpha hemolysis, which is the reduction of the red blood cell haemoglobin to methemoglobin in the medium surrounding the colony, Gamma hemolysis indicates lack of hemolysis. There should be no reaction surrounding the medium.

Oxidase test

The oxidase test is a biochemical test to check if an organism produces the enzyme cytochrome c oxidase.

Procedure: Colony was suspended in a small amount of sterile water or broth. A sterile inoculation loop was used to transfer small inoculum to the centre of a filter paper and also 2-3 drops of the reagent was dropped. Colour change was observed.

Urease test

The urease test is used to determine the ability of an organism to split urea, through the production of the enzyme urease. This test is primarily used to differentiate between members of the genera *Proteus*, *Providencia*, and *Morganella*, which are urease-positive, from other Enterobacteriaceae, which are urease-negative.

Procedure: The isolate was inoculated onto a urea agar medium and incubated at 37 °C for 18-24 hours. The plate was then observed for growth and a color change in the medium. If the organism was urease-positive, the urea was hydrolyzed to ammonia, raising the pH and causing a color change to pink or magenta. If the organism was urease-negative, the medium remained yellow.

Citrate Test

The citrate test is a diagnostic test used to determine whether a bacterial isolate can utilize citrate as the sole carbon source. It is primarily used to differentiate members of the *Enterobacteriaceae* family.

Procedure: The isolate was inoculated onto a Simmons citrate agar medium. The inoculated plate was incubated at 37 °C for 18-24 hours. The plate was observed for the presence of growth and a color change in the medium. If the organism was citrate-positive, it used the citrate in the medium as the sole carbon source and produced an alkaline byproduct, causing a color change in the medium from green to blue. If the organism was citrate-negative, the medium remained green.

Maintenance of Test Organisms

The isolated test organisms were used for the antibacterial sensitivity testing. Prior to the test, the organisms were sub-cultured on nutrient agar plate and incubated at 37 °C for 24 hours. Then the 24 hour cultures were transferred into nutrient broth and incubated anaerobically using gas pack at 37 °C for 24 hours (Cheesbrough *et al.*, 2015).

Standardization of Inoculum

The inoculum was prepared from the stock cultures, which were maintained on nutrient agar slant at 4 °C and sub-cultured onto nutrient broth using a sterilized wire loop. The density of suspension inoculated onto the media for susceptibility test was determined by comparison with 0.5 McFarland standard of Barium sulphate solution. (Cheesbrough *et al.*, 2015).

Test Organisms

Escherichia coli was bacteria specie isolated from urine specimen. This was followed by washing with physiological saline and streaking urine specimen on nutrient agar medium for isolation. Cultural and morphological identification as well as biochemical characterization of isolates using protocol described by (Cheesbrough *et al.*, 2015) was carried out. Pure cultures of the isolates were maintained in appropriate medium for future use.

Antibiotics sensitivity Testing:

Under sterile condition, isolates of gram-negative bacteria, that has been standardized using McFarland standard of concentration (0.5 colony forming units per ml), was spread plated on all labeled Mueller hinton agar plates accordingly, using a sterile swab glass spreader, and allowed for few minutes to dry. Antibiotic sensitivity discs containing Rifampicin, Cefuroxime, Ceftezole, Azithromycin, Amoxicillin, Ciprofloxacin, Erythromycin, Levofloxacin and Gentamycin, were placed on each agar plate and gently pressed with a sterile wire loop to ensure it was firmly attached to the agar medium. Plates were incubated for 24 hours, at room temperature. After that, plates were observed for zones of inhibition around the discs; zones were measured using a transparent ruler and values were recorded.

Antibacterial Assay**Medicinal plants using agar well diffusion method.**

This was carried out by using agar well diffusion techniques. In this method, each of the labelled plates was uniformly inoculated with the organisms using pour plate techniques. A sterile cork-borer of 6mm diameter was used to make wells on the medium. 0.1 milliliter of the various extract concentrations were dropped into each labelled well. After that, the plates were incubated anaerobically at 37 °C for 24 hours. Antibacterial activity was determined by measuring the diameter of zones of inhibition (mm) produced after 48 hours of incubation. The diameter of the zone of inhibition around each well was measured in millimeters. The results were recorded and compared with standard values for antibiotic susceptibility testing.

A Negative control was filled with an antibiotic disc.

Determination of minimum inhibitory concentration (MIC)

Here, various concentrations of the extracts were obtained using double- fold serial dilution. Each dilution was assayed against the test bacterial using tube dilution techniques. One milliliter of test organism was added into each dilution incubated anaerobically at 37 °C for 24 hours. The MIC was defined as the lowest concentration able to inhibit any visible bacterial growth. This was determined and recorded. (Shahidi-Bunjar, 2017).

Extraction

The powdered carrot (20g) leaf was percolated in ethanol (200 ml) in 11 capacity conical flask, stoppered and kept for two weeks with intermittent shaking. The percolates were filtered with Whatman's No. 1 filter paper. The extracts were concentrated at 40 °C under reduced pressure using rotary evaporator (RI-10). The same quantity of carrot was again percolated with distilled water for one week and after filtration, the aqueous carrot extract was concentrated in hot oven at 40 °C (Nwobu *et al.*, 2016). The concentrated extracts were labelled DCA (*Daucus carota* aqueous) and DCE (*Daucus carota* ethanol).

Phytochemical Analysis

Phytochemical analysis for qualitative detection of alkaloids, flavonoids, tannins and saponins was performed on the extracts as described. (Trease and Evans, 2019).

Quantitative determination of the presence of phytochemicals**Alkaloids**

Five milliliters (5 ml) of the sample was mixed with 96% ethanol-20% tetraoxosulphate (vi) acid (1:1). One milliliter (1 ml) of the filtrate from the mixture was added to 5 ml of 60% H₂SO₄ and allowed to stand for 5 minutes, reading was taken at absorbance of 565 nm.

Glycosides

This was carried out using Buljet's reagent. One gram (1 g) of the fine powder of the sample was soaked in 10 ml of 70% alcohol for 2 h and then filtered. The extract was then purified using lead acetate and disodium hydrogen tetraoxosulphate (vi), (Na₂HPO₄) solution before the addition of freshly prepared Buljet's reagent. The absorbance was taken at 550 nm.

Flavonoids

Five millilitres of the extract was mixed with 5 ml of dilute hydrochloric acid (HC1) and boiled for 30 minutes. The boiled extract was allowed to cool and then filtered. One millilitre (1 ml) of the filtrate was added to 5 ml of ethyl acetate and 5 ml of 1% ammonia solution. The absorbance was taken at 420 nm.

Phenolics

Ten millilitres (10 ml) of the sample was boiled with 50ml acetone for 15 minutes. Five millilitres of the solution was pipette into a 50 ml flask. Then, 10 ml of distilled water was added. This was followed by the addition of 2 M NH₄OH and 5ml of concentrated amyl alcohol. The mixture was left for 30 minutes and absorbance was taken at 505 nm.

Tannins

Ten millilitres (10 ml) of the sample was pipette into 50 ml plastic bottle containing 50 ml of distilled water. This was shaken for 1 h on a mechanical shaker. The solution was filtered and 5 ml of the filtrate was mixed with 2 ml of FeCl_3 in 0.1 NHCL. The absorbance was read at 120 nm.

Steroids

The extract was eluted with normal NH_4OH solution. Two millilitres (2 ml) of the eluate was mixed 2 ml of chloroform in a test tube. Three (3 ml) of ice cold acetic anhydride was added to the mixture and two drops of concentrated H_2SO_4 was continuously added to the mixture and allowed to cool. The absorbance was taken at 420 nm.

Saponins

Five millilitres (5 ml) of the sample was dissolved in aqueous methanol. Then, 0.25 ml of aliquot was taken for spectrophotometric determination for total saponins at 544 nm.

III. Results

Table 1: Morphology characteristics of isolate from urine.

This table shows the results of the morphology characteristics of isolates from urine.

The isolates exhibited a raised elevation, except isolate 1A, which was flat.

The isolates exhibited an entire margin morphology, except isolate 1A and 8B, which had undulate margins, and isolate 3B, which had a lobate margin.

The isolates exhibited a circular morphology form, except isolate 1A, 2B and 3B, which had irregular forms.

The colony forming unit count revealed significant growth for all isolates except isolate 2B and 6A.

The sizes of all isolates were small and they all had a growth rate of 24 hours.

Isolate	Elevation	Margin	Size	Form	CFU	Growth rate
1A	Flat	Undulate	Small	Irregular	10.8	24 hours
2A	Raised	Entire	Small	Circular	12.1	24 hours
2B	Raised	Entire	Small	Irregular	7.2	24 hours
3A	Raised	Lobate	Small	Circular	19.6	24 hours
3B	Raised	Entire	Small	Irregular	10.9	24 hours
6A	Raised	Entire	Small	Circular	4.2	24 hours
7A	Raised	Entire	Small	Circular	18.2	24 hours
8B	Raised	Undulate	Small	Circular	15.1	24 hours

Table 2: Biochemical Characteristics of the Isolates

This table shows the result of the biochemical characteristics of the isolates.

All isolates were Gram positive, with the exemption of isolate 2B, which was Gram negative.

The isolates exhibited a biochemical profile of catalase positive, oxidase negative, urease negative and hemolysis negative.

All isolates were citrate positive, with the exemption of isolate 2B, 6A, 7A, and 8B which tested negative.

	Grams	Catalase	Oxidase	Citrate	Hemolysis	Urease
Isolate	Reaction	Test	Test	Test	Test	Test
1A	Positive	Positive	Negative	Positive	Negative	Negative
2A	Positive	Positive	Negative	Positive	Negative	Negative
2B	Negative	Positive	Negative	Negative	Negative	Negative

3A	Positive	Positive	Negative	Positive	Negative	Negative
3B	Positive	Positive	Negative	Positive	Negative	Negative
6A	Positive	Positive	Negative	Negative	Negative	Negative
7A	Positive	Positive	Negative	Negative	Negative	Negative
8B	Positive	Positive	Negative	Negative	Negative	Negative

Table 3: Antimicrobial Susceptibility Testing Using Antibiotic Disc

The table shows the results of the negative control for the degree of susceptibility of *Escherichia coli* to various antibiotics (Rifampicin, Cefuroxime, Ceftezole, Azithromycin, Amoxicillin, Ciprofloxacin, Erythromycin, Levofloxacin and Gentamycin.) expressed in millimeters.

The antibiotics used in this study showed susceptibility against *Escherichia coli* with measurement of zone of inhibition.

Levofloxacin and showed moderate susceptibility against *Escherichia coli* with a zone of inhibition of 8 mm.

Amoxicillin, Ciprofloxacin, and Azithromycin showed moderate to high susceptibility against *Escherichia coli* with zone of inhibition of 10 mm, 12 mm, and 14 mm, respectively.

Ceftezole showed low susceptibility against *Escherichia coli* with a zone of inhibition of 4 mm.

Erthromycin showed low susceptibility against *Escherichia coli* with a zone of inhibition of 2 mm.

Rifampicin showed moderate susceptibility against *Escherichia coli* with zone of inhibition of 10 mm.

Antimicrobial								
Agent	1A	2A	2B	3A	3B	6A	7A	8B
Cefuroxime	2mm	2mm	2mm	2mm	10mm	2mm	4mm	10mm
Rifampicin	2mm	10mm	10mm	10mm	12mm	2mm	4mm	2mm
Ceftezole	10mm	2mm	4mm	8mm	5mm	2mm	4mm	2mm
Azithromycin	14mm	10mm	12mm	12mm	8mm	10mm	8mm	2mm
Amoxicillin	10mm	8mm	10mm	12mm	8mm	10mm	2mm	2mm
Ciprofloxacin	10mm	10mm	10mm	10mm	12mm	10mm	2mm	2mm
Erythromycin	8mm	2mm	2mm	8mm	4mm	4mm	10mm	2mm
Levofloxacin	8mm	8mm	10mm	8mm	8mm	8mm	10mm	2mm
Gentamycin	8mm	2mm	2mm	8mm	2mm	2mm	10mm	10mm

Table 4: Antimicrobial Susceptibility Testing Using Plant Extract, *Daucus carota*

Isolate	1A	2A	2B	3A	3B	6A	7A	8B
MIC	7 mm	5 mm	10 mm	10 mm	1 mm	8 mm	8 mm	1 mm

MIC: Microbial Inhibitory Concentration.

Table 5: Quantitative Phytochemical constituents of Carrot (*Daucus carota*) root extracts.

This table shows the natural constituents of carrot. It shows that carrot consists of alkaloids, flavonoids, saponins, tannins, phenolic, resins, steroids and glycosides.

DCA: *Daucus carota* Aqueous,

DCE: *Daucus carota* ethanol.

+: present,

-. absent.

The phytochemical constituents of Carrot (*Daucus carota*) extracts Aqueous showed positive to all the phytochemicals used in this study. But on the other hand *Daucus carota* ethanol showed positive to all the phytochemicals used in this study except alkaloid, tannins and resins.

Phytochemicals	DCA	DCE
Alkaloids	++	-
Flavonoids	+	+
Saponins	++	+
Tannins	++	-
Phenolics	++	+
Resins	+	-
Steroids	+	++
Glycosides	+	+

IV. Discussion, Conclusion, Recommendation and Contribution to Science

Discussion

In the present study, it showed that carrot (*Daucus carota*) had antibacterial activity against the organism *Escherichia coli* which is a common bacteria isolated from urine. *Escherichia coli* was susceptible to the carrot sample at a uniform concentration of 100% of the carrot.

Among the organisms tested, *Escherichia coli* exhibited a zone of inhibition with a diameter of 10 mm, indicating a considerable level of susceptibility to carrot. This finding aligns with previous studies that have reported the antibacterial potential of carrot against *Escherichia coli* (Demuth *et al.*, 2020). The ability of carrot to inhibit the growth of *Escherichia coli* may be attributed to its various components, including hydrogen peroxide, low pH, and osmolality, which create an unfavorable environment for bacterial growth (Henkel, 2021).

However, it is important to note that the antibacterial activity of carrot can be influenced by various factors, including its geographical origin, floral source, and processing methods, which may explain the discrepancy in results between studies (Schwebke *et al.*, 2021).

For the phytochemical constituents of *Daucus carota* Aqueous extracts showed positive to all the phytochemicals used in this study. But on the other hand *Daucus carota* ethanol showed positive to all the phytochemicals used in this study except alkaloid, tannins, and resins.

Flavonoids are prominent antioxidants, which protect the body from oxidative stress by scavenging free radicals. Carrot contains flavonoids, which may help in reducing oxidative damage and inflammation. According to research conducted by Ghasemzadeh *et al.* (2016), the high flavonoid content in carrot contributes to its antioxidant potential, making it effective in preventing chronic diseases associated with oxidative stress. Tannins, recognized for their astringent and antioxidant properties, are present in carrot. They may contribute to its ability to prevent microbial growth and enhance wound healing. (Adegboye *et al.*, 2019). Research showed that the tannin content in carrot could inhibit the growth of various pathogens, supporting its traditional use in treating infections.

Conclusion

The findings suggest that carrot holds promise as a natural alternative for the treatment of bacterial infections, offering advantages such as widespread availability, cost-effectiveness, and potentially reduced antibiotic resistance development.

Recommendation

In this study, I successfully utilized *Daucus carota* as an antimicrobial agent to inhibit *Escherichia coli* isolated from urine. Therefore, I recommend that this work should be furthered to find out the active ingredients of *Daucus carota* that is responsible for the inhibition.

References

- Aggarwal, N., Leslie, S. (2024). *Escherichia coli* in the urinary tract. Encyclopedia of medicine, 5(2), 111-5.
- Akhtar, S., Rauf, A., Imran, M. (2019). Dietary and health promoting perspective of carrot polyphenol. Trends in food science technology, 66, 36-47.
- Anger, J., Ackerman, L. (2019). Urinary tract infections. International journal of urology, 202, 282-289.

4. Aohajer, M., Musher, D. (2018). Clinical significance of Staphylococcus aureus. Scandinavian journal of infectious diseases, 45, 688-95.
5. Behzadi, P., Aghapour, R., Akbari, C. (2017). Effect of Salmonella species on urinary tract. Encyclopedia of medicine, 15, 3-4.
6. Carlsson, S., Wiklund, P., Engstrand, L. (2019). Bacterial growth in urine. British Journal of experimental pathology, 69, 759-70.
7. Carolina, A., Benita., Martinez, G. (2017). Pytochemical properties of Daucus carota L. post harvest biological technology, 127, 99-104.
8. Cortes, C., Esteve, M., Frigola, A. (2021). Changes in carotenoids. European food research technology, 221, 125-131.
9. Cornish, J., Lecamwahsam, J., Harrison, G. (2018). Host defense mechanisms in the urinary tract. Journal of clinical urology, 81, 83-6.
10. Elvira, I., Garcia, J. (2019). Nutritional importance of carotenoids and their antioxidant properties. Journal of clinical medicine, 8, 229.
11. Ipe, D., Horton, E., Utett, G. (2018). Strategies of microbes for persistence in urine. Front cell infection microbiology, 26, 11-6.
12. Kochiashuili, D., Khuskivadze, A. (2022). Prevention and treatment of urinary tract infection. Journal of clinical urology, 190, 1981-1989.
13. Kucheria, R., Dasgupta, P., Sacks, S. (2021). New surfacing urinary tract infections. Postgraduate medical journal, 952, 83-6.
14. Lala, V., Leslie, W., Minter, D. (2018). Disruption of the layer of mucus. British journal of molecular biology, 474, 49-53.
15. May, M., Schostak, M., Lebentrau, S. (2017). Recurrent urinary tract infections. Journal of medical microbiology, 15, 3-4.
16. Petrin, F., Hartman, L., Dubios, C. (2017). Morphological and biochemical characteristics of Daucus carota L. Journal of plant pathology, 245, 737-747.
17. Phan, G., Remaut, H., Wang, T., Allen, W. (2017). Pathogenesis of urinary tract infection. Journal of molecular biology, 474, 49-53.
18. Subashchandrabose, S., Mobley, H. (2019). virulence and fitness determinants of uropathogenic Escherichia coli. Journal of microbiological spectrum, 3, 235-261.
19. Wang, L., Staner, G. (2022). Anthocyanins and their role in the prevention of cancer. Journal of medical health, 269, 281-290.
20. Wellenberg, L., Johansson, E., Olson, M. (2017). Antimicrobial activity of Daucus carota L. Journal of clinical and food microbiology, 5, 60.