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Antibacterial Activity of Aqueous and Alcohol Extracts, of Selected Medicinal Plants and Vitamin Profiling Identification by HPLC

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ABSTRACT

Background: Urinary tract infections (UTIs) represent a significant global health concern, often complicated by the increasing resistance of uropathogens to conventional antibiotics.
Objective: This study investigates the antibacterial efficacy and vitamin content of different extracts of *Sesamum indicum* (sesame) and *Pimpinella anisum* (anise) against common UTI-causing bacteria, including *Escherichia coli*, *Klebsiella pneumoniae*, *Staphylococcus aureus*, and *Acinetobacter baumannii*.
Material and Methods: Plant seeds (*P. anisum* L. and *S. indicum* L.) were sourced locally, cleaned, ground, and used for aqueous, and alcoholic using standard maceration, distillation, and concentration methods. Bacterial isolates from UTI patients were identified and tested for antibiotic sensitivity. Antibacterial activity was assessed via agar well diffusion, and vitamin content in extracts was analyzed by HPLC.
Results: Indicated that alcoholic extracts, particularly from *P. anisum*, exhibited the highest antibacterial activity, with inhibition zones reaching up to 19.20 ± 1.095 mm against *E. coli*. *K. pneumoniae* was the most susceptible pathogen, while *A. baumannii* showed the greatest resistance. High-Performance Liquid Chromatography (HPLC) analysis revealed that both plants contained essential water-soluble (vitamins B1, B2, and C) and fat-soluble (vitamins A, D3, E, and K) vitamins. *P. anisum* demonstrated a higher total concentration of both vitamin groups compared to *S. indicum*.
Conclusion: These findings support the potential of *S. indicum* and *P. anisum* as natural sources of bioactive compounds with antibacterial properties and nutritional value, suggesting their use as complementary therapies in the management of UTIs.

Keywords- Antibacterial activity*, Sesamum indicum*, plant extracts, *Pimpinella anisum*, oil extracts, water and fat-soluble vitamins.

I. INTRODUCTION

Urinary tract infections (UTIs) are among the most common public health issues, affecting individuals from infancy to old age, with a higher prevalence in women due to anatomical and physiological factors (Raju and Tiwari, 2004; Schaeffer *et al.,* 2001). The widespread use of antibiotics in medicine and agriculture has contributed to the emergence of antibiotic-resistant pathogens, complicating the treatment of infections (Kapil, 2005). This has driven interest in discovering new antimicrobial agents from medicinal plants, which offer novel phytochemicals with fewer side effects (Lewis and Ausubel, 2006). Medicinal plants have bioactive constituents such as alkaloids, tannins, flavonoids, and terpenoids that exhibition antimicrobial properties against various pathogens (Ravi, 2011). They also provide essential nutrients, including vitamins, which are critical for cellular metabolism and disease prevention (Sheela *et al.,* 2004; Abhishekar *et al.,* 2015). *Sesamum indicum* (sesame) is widely cultivated in tropical regions and is rich in oils, proteins, and bioactive compounds like sesamin and sesamol with antioxidant, anti-inflammatory, and anticancer properties (Abou-

Gharbia *et al.,* 2000; Elleuch *et al.,* 2007; Srisayam *et al.,* 2014; Furumoto and Nishimoto, 2016; Xu *et al.,* 2015; Dar and Arumugam, 2013). *Pimpinella anisum* (anise), native to the Mediterranean region, is known for its antimicrobial and digestive properties and is commonly used in traditional medicine (Zand *et al.,* 2012; Ullah *et al.,* 2014; Cabuk *et al.,* 2003; Singh *et al.,* 2002; Tabanca *et al.,* 2003; Soliman and Badea, 2002). This study aims to evaluate the antibacterial activity of aqueous, alcoholic, and oil extracts of *Sesamum indicum* and *Pimpinella anisum* against UTI pathogens, and to identify their water- and fat-soluble vitamins using High-Performance Liquid Chromatography.

II. MATERIALS AND METHODS

Plant Samples

Seeds of *Pimpinella anisum* L. and *Sesamum* L. were attained from local markets in wassit Province, Iraq. The seeds were cleaned to remove any impurities, and after that by an electric grinder ground into a fine powder, then stored until used.

Preparation of Plant Extracts

A- Crude Aqueous Extract

Aqueous extract of plants were prepared, weight 100 g of dry powder of plant and placed in a conical flask, and 500 ml of distilled water added in percentage 1:5 w: v after that the mixture shacked by an electric shaker for 2 hours and the mixture left in room temperature. After 24 hours, the mixture was filtered by four layer of gauze and put in a tube and mixture centrifuged in centrifuge at 2000 rpm for 10 min. The supernatant was filtered by Whatman no. 4 filter paper. Filtrate mixture was concentrated by oven for 72 hours to obtain crud extract. This extract was stored in a dark sterile screw bottle at 4°C until use (Zheng Mu *et al*., 1990).

B- Crude Alcoholic Extract

An amount of 500 g dried of plants seed were crushed in a blender, then macerated in ethanol 80 % for 5 days thereafter continue to remecerated for 2 days. The solvent was evaporated at low pressure with a temperature of not more than 40 ° C using a Rotary evaporator, then dried using freeze dryer (Nugraha *et al,* 2018).

Preparation of Different Concentrations of Plant Extract

The following equation was used to create different quantities of aqueous and alcoholic extracts (100, 200 and 400 mg/ml) of plant extracts according (Shoker *et al.*, 2021).

$$\textbf{Concentration mg/ml} = \frac{\textbf{Weight}}{\textbf{Volume}} \textbf{ X 1000}$$

Collection and Identification of Bacterial Isolates

Urine samples were collected from patients diagnosed with urinary tract infections (UTIs) at a local hospital under aseptic conditions. The samples were cultured on MacConkey agar and blood agar, and incubated at 37°C for 24 hours. Bacterial colonies were isolated and identified based on colony morphology, Gram staining, and standard biochemical tests.

Antibiotic Sensitivity Test

The antibiotic susceptibility of the bacterial isolates was determined using the VITEK® 2 Compact System (bioMérieux, France). Bacterial suspensions were prepared from pure colonies and adjusted to the 0.5 McFarland standard. Based on the Gram reaction of the isolates, the appropriate AST (Antibiotic Susceptibility Testing) cards were used. The VITEK system automatically processed the cards, provided minimum inhibitory concentrations (MICs), and interpreted results according to CLSI guidelines, classifying isolates as susceptible, intermediate, or resistant.

Antibacterial Activity Assay

The antibacterial activity of the plant extracts was assessed using the agar well diffusion technique. Mueller-Hinton agar plates were with standardized bacterial suspensions (equivalent to 0.5 McFarland standard). Wells (6 mm) in diameter were pressed into the agar and occupied with 100 µL of each plant extract. After that plates were incubated at 37°C for 24 hours. Zones of inhibition were measured in millimeters and compared to those of standard antibiotics used as positive controls.

Analysis Multi-Vitamins by HPLC

The composition of water- and fat-soluble vitamins in the plant extracts was analyzed using High-Performance Liquid Chromatography (HPLC), the method done by Shoker *et al.* (2021).

Statistical Analyses

Statistical analyses were achieved through utilizing SPSS (version 27). Least significant difference (LSD) was utilized to compare the significant variances between means. P value of less than ($P \leq 0.05$) was known to show statistical significance for each test.

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III. RESULTS

Different extracts types of *S. indicum* and *P. anisum* seed were extracted, and the total weight of each extract in (g) were presented as shown in figure (1).

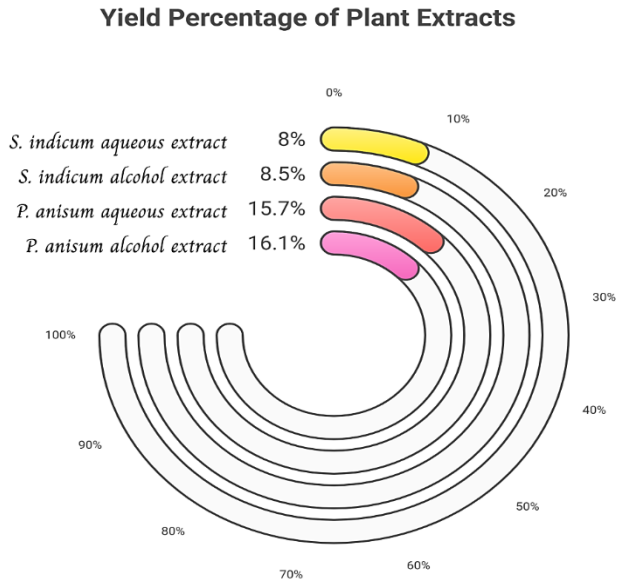

Figure (1) yielded of extracts types of selected plants expressed as %

Identification of Bacterial Isolates

A urine samples were collected from patients with confirmed UTIs. After culturing on MacConkey and blood agar and incubating at 37°C for 24 hours, distinct bacterial colonies were observed. The isolates were identified using colony morphology, Gram staining, and biochemical tests. The predominant pathogens included *E. coli*, *K. pneumoniae*, ***A. baumannii*** and *S. aureus*.

The antibiotic sensitivity profiles of the bacterial isolates revealed varied responses to commonly used antibiotics. *E. coli* isolates were sensitive to Imipenem, Amikacin, Nitrofurantoin, and Tigecycline, indicating these antibiotics remain effective treatment options. However, resistance was noted against Cefazolin, Cefepime, and Ciprofloxacin. *K. pneumoniae* isolates showed susceptibility to Imipenem and Meropenem, while they were resistant to Piperacillin, Amikacin, and Ciprofloxacin, highlighting a concerning resistance trend. *A. baumannii* exhibited a multidrug-resistant profile, showing sensitivity only to Minocycline and Colistin, which suggests limited therapeutic alternatives. In contrast, *S. aureus* isolates were sensitive to Linezolid, Tigecycline, and Nitrofurantoin, indicating these drugs are potentially effective in treating infections caused by this organism.

In vitro, antibacterial activity of the plant extracts against bacterial isolated which estimated depending on the inhibition zones diameters (mm) according to agar-well diffusion methods. Inhibition zones were diverse according to plant species, extract types, concentration and isolated bacterial types. The results in table (1, 2, 3, 4) showed that alcoholic and aqueous extracts from *S. indicum* and *P. anisum* seed were revealed significant inhibition at $p \leq 0.05$ against *k. pneumoniae, S. aureus, E. coli,* and *A. baumannii* in all concentrations. Alcoholic extracts of *P. anisum* were having highest significantly of antibacterial activity at $p \leq 0.05$ against *k. pneumoniae*, *S. aureus, E. coli,* and *A. baumannii*, the inhibition zone were (18.60±0.894 mm), (19.20±1.095 mm), (17.80±1.095 mm), and (15.60±1.516 mm) respectively, at higher concentration 400 mg/ ml compare with the control. The results showed the *k. pneumoniae* more sensitive when treatment with plant extracts in all concentration, while *A. baumannii* more resistance.

Table (1) Diameters in mm of inhibition zone caused by diverse concentrations of plant extract type (mg/ml) of plants against *k. pneumoniae* (Mean ± SD).
*** p≤ 0.05**

Plant type	Extract type	Concentration of the extract (mg / ml)				plant type * Extract type
		Control	100	200	400	
S. indicum	**Aqueous extract**	0.00±0.000	9.00±0.707	10.40±0.894	15.80±0.836	8.80±5.863
	Alcoholic extract	0.00±0.000	12.00±1.414	8.80±0.836	15.40±0.894	9.05±5.933

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P. anisum	**Aqueous extract**	0.00±0.000	10.20±0.836	12.40±0.547	16.40±0.547	9.75±6.231
	Alcoholic extract	0.00±0.000	10.80±0.806	15.40±1.516	18.60±0.894	11.20±7.273
L.S.D. 1.0284 P-Value: 0.008						L.S.D. 0.2574 P-Value:0.001
Plants type * Con.		**Control**	**100**	**200**	**400**	**Average Plant type**
S. indicum		0.00±0.000	8.13±3.814	7.13±3.739	12.26±5.006	6.88±5.704
P. anisum		0.00±0.000	7.00±5.168	10.53±5.180	13.60±5.816	7.78±6.842
L.S.D. 0.7272 P-Value: 0.002						L.S.D. 0.3636 P-Value:0.001
Extract type * Con.		**Control**	**100**	**200**	**400**	**Average Extract type**
Aqueous extract		0.00±0.000	9.60±0.966	11.40±1.264	16.10±0.737	9.27±5.991
Alcoholic extract		0.00±0.000	11.40±1.264	12.10±3.665	17.00±1.885	10.12±6.461
L.S.D. 0.7272 P-Value: 0.001						L.S.D. 0.3636 P-Value:0.002
Average extract concentration effect						
		Control	**100**	**200**	**400**	
		0.00±0.000	7.56±4.500	8.83±3.763	12.93±5.375	
		L.S.D. 0.5142 P. Value: 0.001				

Table (2) Diameters in mm of inhibition zone caused by diverse concentrations of plant extract type (mg/ml) of plants against *E. coli* (Mean ± SD).
*** p≤ 0.05**

Plant type	**Extract type**	**Concentration of the extract (mg / ml)**				**plant type * Extract type**
		Control	**100**	**200**	**400**	
S. indicum	**Aqueous extract**	0.00±0.000	3.20±1.64	7.40±0.547	8.80±1.303	4.85±3.703
	Alcoholic extract	0.00±0.000	6.60±0.894	4.60±0.899	12.00±2.000	5.80±4.549
P. anisum	**Aqueous extract**	0.00±0.000	10.80±0.447	14.20±0.836	17.80±0.447	10.70±6.84
	Alcoholic extract	0.00±0.000	12.00±1.000	17.40±0.894	19.20±1.095	12.15±7.734
L.S.D. 1.199 P-Value:0.003						L.S.D. 0.599 P-Value:0.001
Plants type * Con.		**Control**	**100**	**200**	**400**	**Average Plant type**
S. indicum		0.00±0.000	4.33±1.988	4.86±2.1668	8.933±2.939	4.53±3.779
P. anisum		0.00±0.000	7.60±5.616	12.06±5.687	14.00±6.665	8.41±7.429
L.S.D. 0.848 P-Value:0.005						L.S.D. 0.424 P-Value:0.002
Extract type * Con.		**Control**	**100**	**200**	**400**	**Average Extract type**
Aqueous extract		0.00±0.000	7.00±4.163	10.80±3.645	13.30±4.831	7.77±6.187
Alcoholic extract		0.00±0.000	9.30±2.983	11.00±6.798	15.60±4.087	8.97±7.040
L.S.D. 0.848 P-Value:0.003						L.S.D. 0.424 P-Value:0.001
Average extract concentration effect						
		Control	**100**	**200**	**400**	
		0.00±0.000	5.96±4.460	8.46±5.593	11.46±5.679	
		L.S.D. 0.599 P. Value:0.001				

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Table (3) Diameters in mm of inhibition zone caused by diverse concentrations of plant extract type (mg/ml) of plants against *S. aureus* (Mean ± SD).
*** p≤ 0.05**

Plant type	Extract type	Concentration of the extract (mg / ml)				plant type * Extract type
		Control	100	200	400	
S. indicum	Aqueous extract	0.00±0.000	7.40±0.894	9.20±0.447	12.00±1.414	7.15±4.625
	Alcoholic extract	0.00±0.000	5.80±1.091	2.80±1.095	8.00±0.705	4.15±3.199
P. anisum	Aqueous extract	0.00±0.000	12.80±0.417	15.40±0.547	16.40±1.140	11.15±6.768
	Alcoholic extract	0.00±0.000	9.60±0.892	14.00±0.001	17.80±1.095	10.35±6.846
L.S.D. 0.9838 P-Value:0.001						L.S.D. 0.4919 P-Value:0.001
Plant type * Con.		**Control**	**100**	**200**	**400**	**Average plant type**
S. indicum		0.00±0.000	5.13±2.386	4.00±4.035	7.80±3.764	4.233±4.072
P. anisum		0.00±0.000	7.46±5.655	10.86±5.692	12.60±6.684	7.73±7.044
L.S.D. 0.6956 P-Value:0.001						L.S.D. 0.3478 P-Value:0.001
Extract type * Con.		**Control**	**100**	**200**	**400**	**Average Extract type**
Aqueous extract		0.00±0.000	10.10±2,923	12.30±3.301	14.20±2.616	9.15±6.070
Alcoholic extract		0.00±0.000	7.70±2.213	8.40±5.947	12.90±5.237	7.25±6.138
L.S.D. 0.6956 P-Value:0.001						L.S.D. 0.3478 P-Value:0.001
Average extract concentration effect						
		Control	**100**	**200**	**400**	
		0.00±0.000	6.30±4.426	7.43±5.975	10.20±5.862	
		L.S.D. 0.4919 P. Value:0.001				

Table (4) Diameters in mm of inhibition zone caused by diverse concentrations of plant extract type (mg/ml) of plants against *A. baumannii* (Mean ± SD).
*** p≤ 0.05**

Plant type	Extract type	Concentration of the extract (mg / ml)				plant type * Extract type
		Control	100	200	400	
S. indicum	Aqueous extract	0.00±0.000	6.80±1.095	10.80±1.643	10.80±1.097	7.10±4.644
	Alcoholic extract	0.00±0.000	8.00±0.001	2.60±0.894	8.00±0.700	4.65±3.603
P. anisum	Aqueous extract	0.00±0.000	9.80±1.303	10.40±0.890	13.00±0.100	8.30±5.140
	Alcoholic extract	0.00±0.000	8.80±1.642	9.80±0.836	15.60±1.516	8.55±5.826
L.S.D. 1.248 P-Value:0.009						L.S.D. 0.312 P-Value:0.001
Plant type * Con.		**Control**	**100**	**200**	**400**	**Average p. type**
S. indicum		0.00±0.000	5.80±2.512	4.46±4.866	7.06±3.692	4.33±4.193
P. anisum		0.00±0.000	2.20±4.693	7.53±3.934	10.86±5.289	6.15±5.596
L.S.D. 0.882 P-Value:0.017						L.S.D. 0.441 P-Value:0.002
Extract type * Con.		**Control**	**100**	**200**	**400**	**Average Extract type**
Aqueous extract		0.00±0.000	8.30±1.946	10.60±1.264	11.90±1.523	7.70±4.873

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Alcoholic extract	0.00±0.000	8.40±1.173	6.20±3.881	11.80±4.157	6.60±5.172
L.S.D. 0.882 P-Value:0.007					L.S.D. 0.441 P-Value:0.001
Average extract concentration effect					
	Control	**100**	**200**	**400**	
	0.00±0.000	6.00±3.704	6.00±4.623	8.96±4.881	
	L.S.D. 0.624 P. Value:0.003				

Water-Soluble Vitamins

Vitamins which soluble in water were (C, B1, B2) The results indicated the higher concentration of vitamins B1(1.518 µg/ml), (4.693µg/ml), of *S. indicum*, and *P. anisum* respectively, while Vitamins C (0.226 µg/ml), (0.447µg/ml) the lower concentration of two plants, respectively. Result showed the higher total concentration of vitamins which soluble in water in *P. anisum* was (6.729 µg/ml), while low total concentration in *S. indicum* was (2.934 µg/ml), Table (5), Figure (2), (3), (4), (5), and (6).

Table (5) concentration vitamins which soluble in water

Vitamins (µg/ml)	**Plant species**	
	S. indicum	***P. anisum***
Vitamins C	0.226	0.447
Vitamins B1	1.518	4.693
VitaminsB2	1.190	1.589
Total concentration (µg/ml)	**2.934**	**6.729**

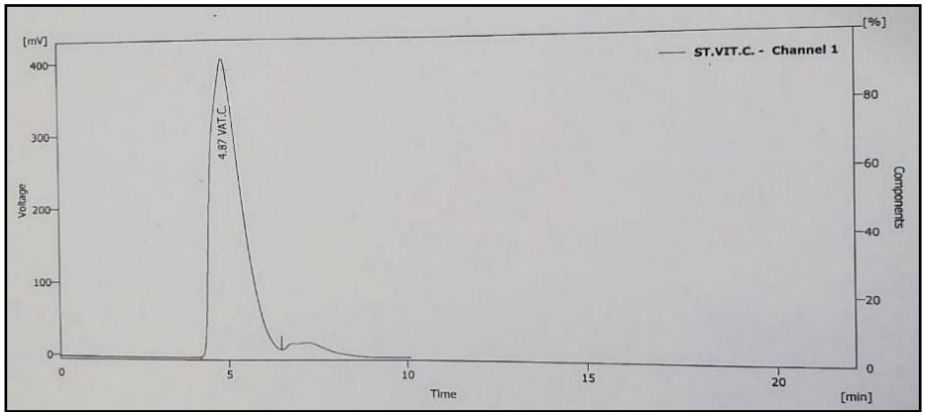

Figure (2) HPLC profile of Vitamins C standard

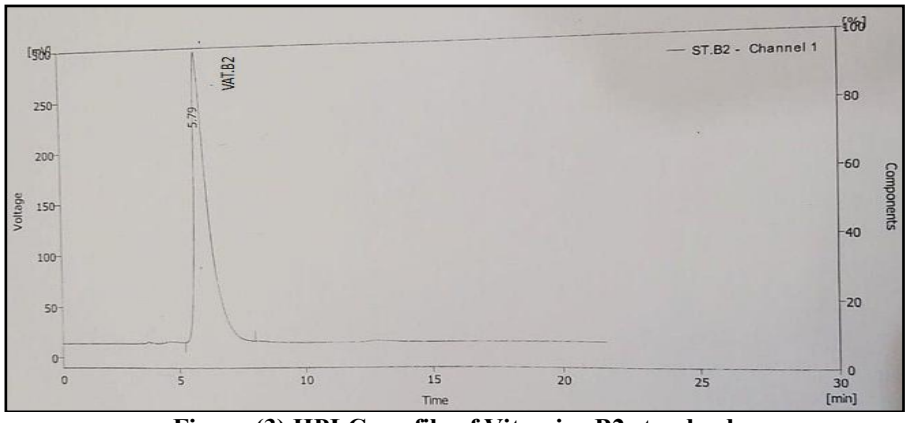

Figure (3) HPLC profile of Vitamins B2 standard

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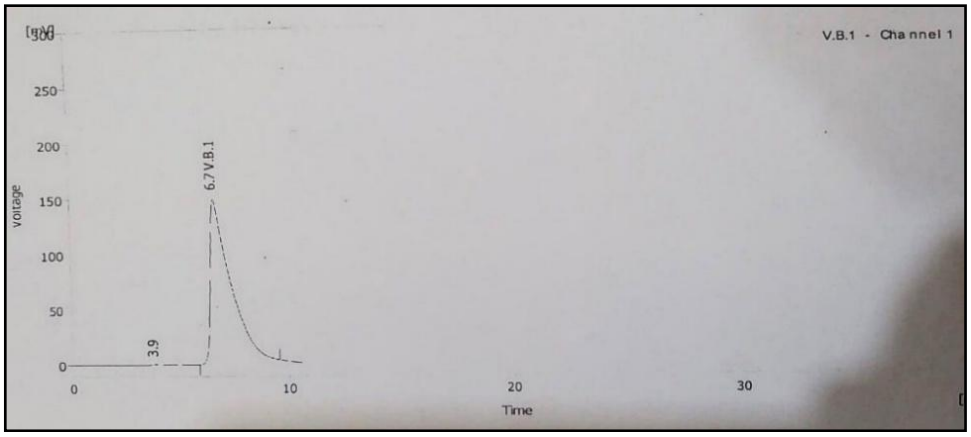

Figure (4) HPLC profile of Vitamins B1 standard

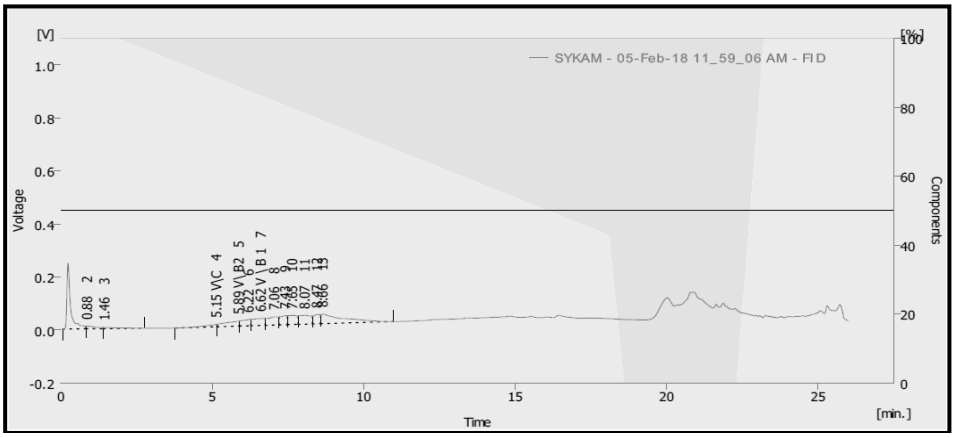

Figure (5) HPLC profile of water- soluble Vitamins of *S. indicum* (Vitamins C, B2, B1)

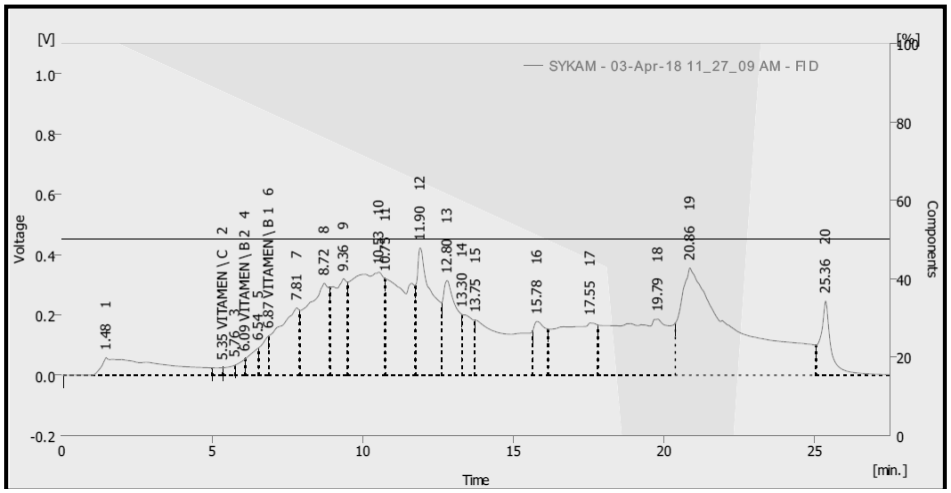

Figure (6) HPLC profile of water- soluble Vitamins of *P. anisum* (Vitamins C, B2, B1)

Fat-Soluble Vitamins

Vitamins which soluble in fat were (E, D3, A, K). The results indicated the higher concentration of vitamins A (27.198 µg/ml), vitamins K (20.839µg/ml), of *S. indicum,* and *P. anisum* respectively, while Vitamins D3 (1.792µg/ml), (0.777µg/ml) the lower concentration of two plants, respectively. Result showed the higher total concentration of vitamins which soluble in Fat in *P. anisum* was (41.21µg/ml), while low total concentration in *S. indicum* was (35.96µg/ml), Table (6), Figure (7), (8), (9), (10), (11) and (12).

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Table (6) concentration vitamins which soluble in fat

Vitamins (µg/ml)	Plant species	
	S. indicum	***P. anisum***
Vitamins E	3.085	-
Vitamins D3	1.792	0.777
Vitamins A	27.198	19.594
Vitamins K	3.885	20.839
Total concentration (µg/ml)	**35.96**	**41.21**

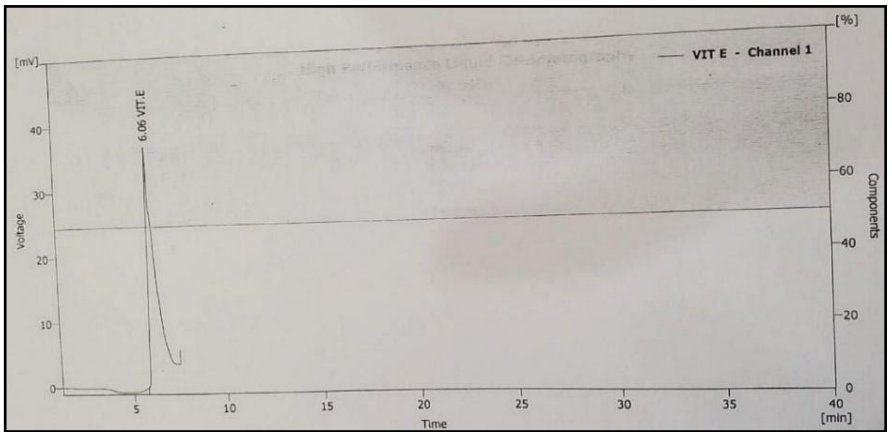

Figure (7) HPLC profile of Vitamins E standard

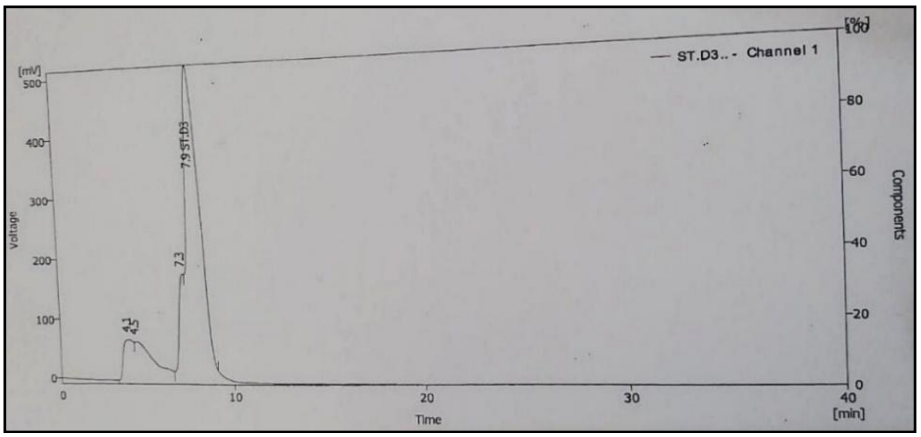

Figure (8) HPLC profile of Vitamins D3 standard

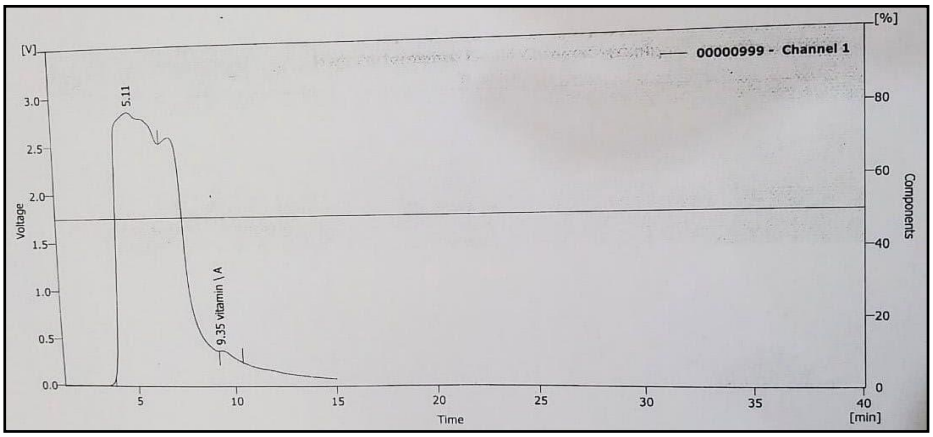

Figure (9) HPLC profile of Vitamins A standard

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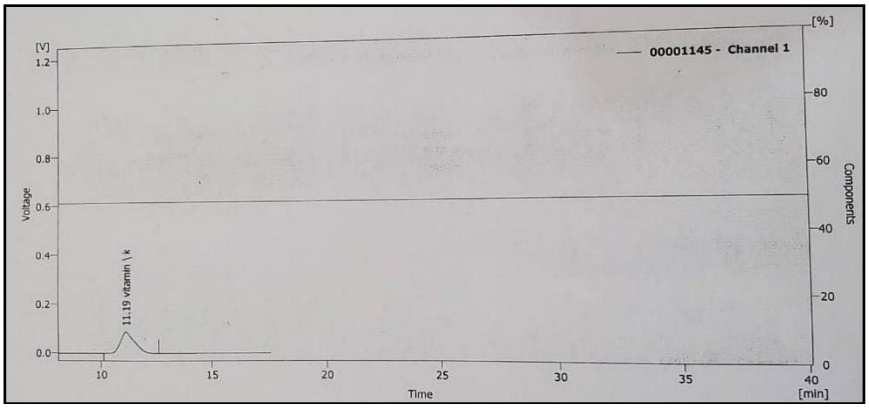

Figure (10) HPLC profile of Vitamins K standard

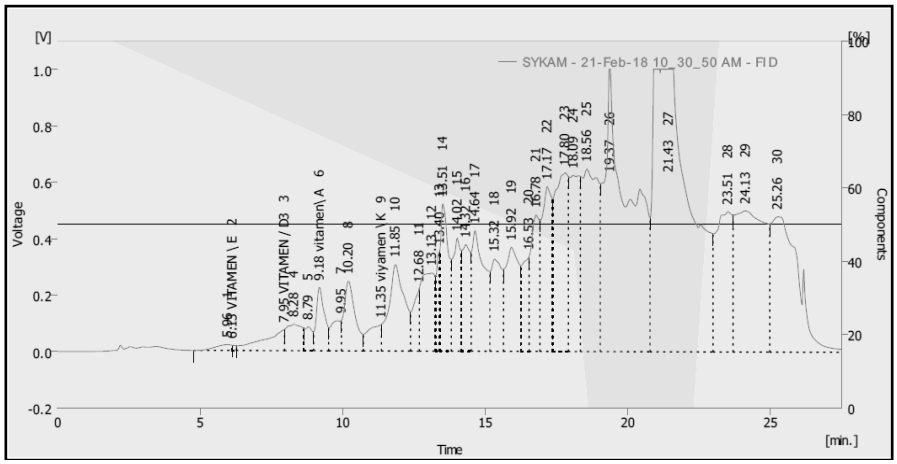

Figure (11) HPLC profile of fat- soluble Vitamins of *S. indicum* (Vitamins E, D3, A, K)

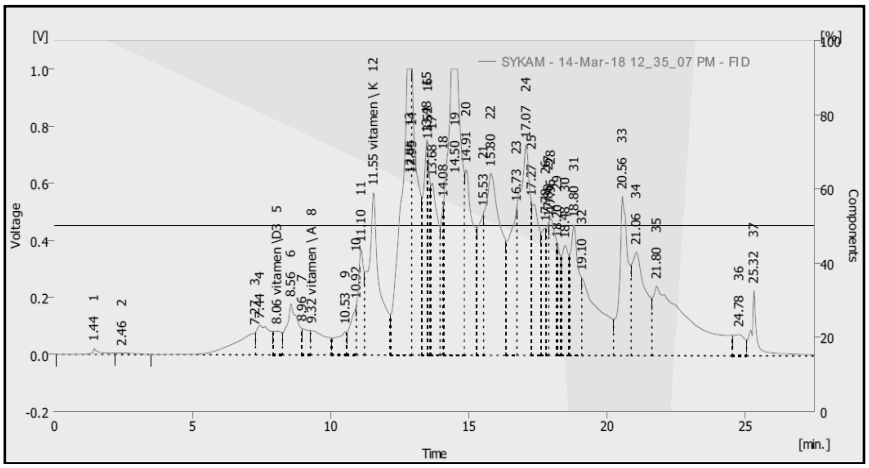

Figure (12) HPLC profile of fat- soluble Vitamins of *P. anisum* (Vitamins D3, A, K)

IV. DISCUSSION

The results of bacterial identification from the urinary tract infection (UTI) samples are consistent with the findings reported by Raheema *et al.* (2024) that observed resistance patterns align with previous studies, emphasizing the growing challenge of antimicrobial resistance among uropathogens. The high sensitivity of *E. coli* to Imipenem and Amikacin supports their continued use in empirical therapy, while resistance to commonly prescribed agents like Ciprofloxacin is concerning. The resistance profile of *K. pneumoniae* and the multidrug-resistant nature of *A. baumannii*

underscore the need for careful antibiotic stewardship. The susceptibility of *S. aureus* to Linezolid and Tigecycline indicates potential treatment options. These findings are consistent with those reported by Raheema *et al.* (2024) and Hussein *et al.* (2023), confirming similar resistance trends in related studies. The results of this study contributed to importance the uses of medicinal plants constituents for developing natural drugs particularly UTIs infections. High level of bacterial isolates which multi drug-resistance were improved from UTI and determine the active antimicrobial compounds from medicinal plants to be increased and that lead to reduction the spread and appearance the drug-resistant pathogens in order to save human health, and developing natural drugs from medicinal plants (Shoker *et al.*, 2021).

The antibacterial effect of *S. indicum* and *P. anisum* extracts against *K. pneumoniae* increased with higher concentrations, general *P. anisum* was more effective against bacterial isolated than *S. indicum*, statistical analysis confirmed that plant type, extract type, and concentration had significant effects at ($p \leq 0.05$). Shoker (2021) showed the therapeutic plants contain greatest secondary metabolites groups which are important for medicinal uses, one of them phenolic compounds, The phenolic extracts of *P. anisum* and *S. indicum* have antibacterial activity against Gram-negative, and Gram positive bacteria. Previous studies showed the secondary metabolism of medicinal plants such as flavonoids, phenolics, and essential oils, contain antimicrobial properties (Salim *etal.,*2016). Anise has been tested for antioxidant (Gulcin *et al.,* 2003), antimicrobial (Al-Kassie, 2008). The antibacterial effect of aqueous extracts of anise seed, bay leaf, coriander, and black pepper against 176 bacterial isolates from 12 different genera was evaluated utilizing the disc diffusion method (Chaudhry and Tariq, 2006).

The alcoholic extract of *P. anisum* exhibited the largest inhibition zone against *E. coli*, followed by its aqueous extract. These results are agreed with Mohamed *et al.* (2015), who also reported significant antibacterial effects of *P. anisum* extracts, suggested traditional use of anise seeds in herbal medicine and suggest potential for development into antimicrobial agents. Antibacterial activity of both aqueous and alcoholic extracts of *P. anisum*, particularly in higher concentrations, against several skin-related bacterial pathogens were effective, aqueous extracts generally showing slightly greater activity against *A. baumannii* (Hamedi *et al.,* 2018). The antibacterial effect of *S. indicum* and *P. anisum* extracts against *S.aureus* increased with higher extract concentrations, the strongest inhibition at ($p \leq 0.05$) was observed with the alcoholic extract of *P. anisum* against *S. aureus* followed by its aqueous extract. In general, this result came in agreement with Hamedi *et al.,* (2018).

The reported deficiency in eating of vitamins E and A is maybe associated to the lacking consumption of diets which the main sources for these vitamins (Tureck *et al.,* 2013). Antioxidant activity of *S. indicum* seeds has been credited to a synergistic activity of vitamin E with lignans which performance the hydroxyl radicals detoxify, lead to reduce in peroxidation of lipid and Malondialdehyde (MDA) level (Askari *et al.,* 2012). Result showed the higher total concentration of vitamins which soluble in water and Fat in *P. anisum*, while low total concentration in *S. indicum*. Previous study reported supplement with the sesame paste, which it contains these two antioxidant vitamins (E and A) increased in the athletes serum, and this supporting the described dietary benefits of sesame (Anilakumar *et al.,* 2010). Free radical might be in control of numerous pathophysiology sickness for human life threatening, and they are formed from exogenous and endogenous sources, which utilizing the balanced quantity of healthy food lead to a good health, may be scavenging or neutralizing free radicals by antioxidants constituents of plants as vitamin A, C and E, polyphenols, carotenoids, etc. as diet natural antioxidants (Shoker *et al.,* 2023).

V. CONCLUSION

This study demonstrated that both *S. indicum* and *P. anisum* seed extracts possess notable antibacterial activity against common urinary tract infection pathogens, including *E. coli, K. pneumoniae, S. aureus*, and *A. baumannii*. The alcoholic extracts, particularly from *P. anisum*, showed the highest antibacterial effectiveness, while *K. pneumoniae* was the most sensitive among the tested bacteria and *A. baumannii* the most resistant. In terms of nutritional content, *P. anisum* extracts contained higher levels of both water-soluble and fat-soluble vitamins compared to *S. indicum*. These results suggest that the extracts, especially from *P. anisum* could be promising natural alternatives for managing infections, particularly in light of increasing antibiotic resistance. Further research is needed to isolate active compounds and assess their clinical applicability.

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