

Article

## The Inhibitory Effect Of Pomegranate Peel And Mint Ethanolic Extracts And The Synergy Between Their Active Components On Escherichia Coli And Pseudomonas Aeruginosa Bacteria Isolated From Urinary Tract Infection

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**Abstract:** Many people rely on medicinal plants to treat illnesses, enhance health, and support a variety of sectors like food and pharmaceuticals. As a result, they are an ancient source of therapy and healthcare. This is as a result of their potent chemicals. This study examined the inhibitory impact of various doses of pomegranate and mint plant alcoholic extracts against *Pseudomonas aeruginosa* and *Escherichia coli*, two types of bacterial pathogens that cause urinary tract infections. The studied extracts elicited different responses from the bacteria. The bacteria that responded to the pomegranate peel alcoholic extract the most was *Pseudomonas aeruginosa*, then *Escherichia coli*. *Pseudomonas aeruginosa* was significantly impacted by the pomegranate peel extract, but less so by the mint extract. However, *Pseudomonas aeruginosa* growth was less affected by the alcoholic extract of mint than *Escherichia coli*. The combined inhibitory impact of both extracts, at varying doses, was shown to be more effective against *Escherichia coli* than it was against *Pseudomonas aeruginosa*.

**Keywords:** Medicinal Plants, Pomegranate Extract, Bacterial Pathogens Inhibition

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### 1. Introduction

Many people still use medical plants today, just as they did thousands of years ago. Humanity has known about medicinal plants for a very long time, and ancient civilizations like the Egyptian, Indian, and Chinese civilizations recorded a great deal of information about them.

Drawings of therapeutic plants discovered in prehistoric caves provide evidence of their use dating back more than 60,000 years, and the earliest written record of this kind of plant dates to Mesopotamia around 2600 BC. According to (Darwish Mustafa Al-Shafei 2014), medicinal plants are still used today to cure a variety of illnesses, including as colds, coughs, and mild infections. As stated, medicinal plants are those that are used to treat illnesses and pains and have one or more chemical substances in them at low or high concentrations that have a physiological effect and are known as active substances. These compounds are also used in the pharmaceutical industry to prepare medicines in various forms and are a key component of medicine production.

Their efficacy and lack of adverse effects set them apart from chemical medications. Put another way, a medicinal plant is any plant that possesses an organ, such a leaf or bark, that, when utilized in a certain method and at a given dose, has the ability to heal. In

underdeveloped nations without access to a modern healthcare system, medicinal plants continue to be used as a source of medical care (Salhi et al., 2010). The Lamiaceae family (Labiatae), which includes 250 genera and 7000 species and represents at least 2% of all plant species as well as 25% of aromatic herbs (such as lemongrass, basil, mint of all kinds, thyme, rosemary, etc.), is considered to be one of the most significant groups of medicinal plants. Due to its global distribution, green mint was the subject of our investigation (Yaziji et al., 2015). Since they can be used as main sources for making pharmaceuticals or as a source of active ingredients for finished products, medicinal plants and herbs have attracted more attention in recent years. They are also utilized as raw materials in the synthesis of a few chemical compounds and a few medicinal products.

Numerous herbs have been utilized to treat ailments like inflammation, discomfort, fever, and cough (Boubakhti, 2010). Numerous research have examined how plant extracts affect microorganism growth and, consequently, the potential use of plant extracts in the treatment of certain diseases caused by different microbial infections. Numerous investigations on the impact of plant extracts on microorganisms have been carried out locally (Suleiman, 2007; Al-Quraishi, 2011; Khalaf 2020). We chose to investigate the impact of pomegranate peel and mint alcoholic extracts on the development of several bacterial species in this study. These plants were chosen for their ability to effectively suppress the growth of microorganisms and for their abundance in the surrounding habitat. The objective of this research is to determine the antagonistic effect of extracts from the peels of mint and pomegranate on pathogenic microorganisms. This will help in the search for substitutes for compounds that inhibit microorganisms that cause urinary tract infections, as these microorganisms have developed resistance to antibiotics as a result of improper and widespread use of these drugs.

#### **1-1: *Punica granatum***

It is among the most significant and appetizing fruit varieties that have been known to humans since antiquity. Given that it is an antioxidant, essential, and ready-to-eat, it is regarded as the perfect, healthful, and protective food. Because it is both food and medicine at the same time, God prepared it by making it a food with a high nutritional value. It was described in numerous books and inscribed on the walls of old temples and palaces by the Greeks and Egyptians, who discovered it before to the Romans. When it came to describing the pomegranate, the great Arab poets competed. It is one of the fruits of Paradise and was referenced in Surat Ar-Rahman and Surat Al-An'am of the Holy Quran. Pomegranates are summer fruits belonging to the Asian family. They originated in Iran and migrated to the Arabian Peninsula, the Levant, India, and other places like Spain and California (Kamel, 1991). It was brought to other hot areas in Europe and the Arab world, where it gained notoriety (Ahmed et al., 2005). Pomegranates are members of the family Punicaceae. Its trees are not planted for medical purposes, but rather to yield fruit. It has been discovered to offer numerous medical advantages, nevertheless.

The medicinal qualities of pomegranate plants vary depending on their parts. Because its peels contain a stomach-tanning ingredient, they are used to cure diarrhea and other stomach disorders. The seeds are good for the stomach, while the fruit body strengthens the heart and stomach. Fruit juice has cooling and moisturizing properties. Its active constituents include tanning agents and alkaloids, of which Pelletierine, Granatin, and Gallotannin are the most significant. It also contains a bitter compound known as Punicine. In addition to the above listed benefits, pomegranate peels have numerous additional medicinal uses. It is regarded as one of the medications that kills tapeworms the most effectively. It is also utilized in the treatment of dysentery and other disorders. Recent research have indicated that traditional Chinese medicine has used preparations from the pomegranate fruit, which include its roots, tree bark, and fruit juice, especially the dried skin of the fruit. these are all used to treat infections brought on by worms and microorganisms, blood alkalinity, and diarrhea (Ajaikumar et al. 1996).

### 1-1-1: Therapeutic uses of pomegranate:

Studies have shown that pomegranate plants have a variety of biological interactions and activities, including anti-tumor, anti-bacterial, anti-diarrheal, and anti-ulcer properties. These plants are highly significant due to their strong antioxidant activity, and certain pomegranate fruit oxidants have been isolated or separated and have been found to have a significant biological impact. According to (Ismail et al., 2009), pomegranate fruits are significant because of their potent antioxidant properties, which allow for the isolation or separation of some of the fruit's compounds for biological purposes. Additionally, it was demonstrated that pomegranate extracts, fruit juice, leaf and peel extracts, and seed oils all exhibited potent and significant antioxidant activity. Additionally, pomegranate juice alters the strain on oxidation-sensitive genes found inside agricultural cells. and regions where atherosclerosis is induced and contact occurs in mice with elevated blood cholesterol. The entire pomegranate fruit—leaves, pulp, skin, and juice—has a high concentration of components and chemicals that are antioxidants. Additionally, anti-cancer substances such dietary fiber, polyphenols, flavones, and isoflavones are present in the diverse diets that people consume (Silvia et al., 2005). Consuming pomegranate leaf extract improves the poor functional performance of blood lipids in cases of obesity and cardiovascular disease risk factors. It has been demonstrated that pomegranate leaf extract reduces the rise in triglyceride levels after taking the fat emulsion for more than 6 hours in obese mice, with a significant decrease in visceral fat filling and weight percentage (Lei et al., 2007). Phenolic compounds from the peel, seeds, and pulp of pomegranates have been isolated in some recent studies on processing, and research has shown that these compounds are employed as food preservatives and antioxidants (Singh et al., 2002). In a study (Lansky et al., 2007) Data gathered from contemporary scientific study indicates that pomegranate trees and their fruits are utilized extensively in folk medicine in many countries, where their significance stems from their status as medicinal plants. Pomegranate peel extract, which is more advantageous than pomegranate pulp extract alone, can be prepared from the peels, which most people toss away. Pomegranate peels contain far more antioxidants than the pulp.



Image (1): Pomegranate plant and peel powder

### 1-2: *Mentha spicata*

Since mint leaves have been utilized in medicine for thousands of years, it is one of the most significant aromatic and therapeutic plants economically. Approximately 8,000 tons of mint oil are produced worldwide and in the United States of America (Muhammad et al., 2015). The leaves of the mint plant are used because they contain compounds that are useful. There exist multiple varieties of mint, such as peppermint, lemon mint, local mint, and Japanese mint.



Image (2): The mint plant (Ahmed et al., 2014)

### 1-2-1: The most important uses of mint

Some drugs, including those for rheumatism, arteriosclerosis, high blood pressure, and joint discomfort, are prepared with it (Abu Zaid, 1992). 1-Peppermint is used to ease sore throats, coughs, sinus infections, and asthma and it is used to treat conditions of the digestive system, including as acidity, colic, diarrhea, and loss of appetite. Patients with cholera often utilize it. 2- Four human cancer cell lines are impacted by peppermint leaf extract: bladder, colon, and cervical cancer cells (Mohammed et al. 2015). 3- Heart palpitations can be treated with peppermint tea and Mint helps with sleep and combats headaches and migraines (Abbas, 2003). 4- For bloating and colic, peppermint leaf extract is used as a carminative and In addition to being utilized in the food and cosmetic industries, peppermint oil is used in toothpaste production as an antibacterial and flavoring for mouthwashes and gums. Additionally, a lot of pharmaceutical treatments employ it as a fragrance (Hussein, 1979).

### 1-3-: Causes of urinary tract infection

One of the most prevalent bacterial diseases are urinary tract infections, which can have serious consequences for both the person and the community as a whole ( Kim *et al.*, 2023). Urinary tract infections (UTIs) encompass a broad spectrum of illnesses, from simple cystitis to potentially fatal UTIs. UTIs are among the most prevalent bacterial infections globally (Öztürk & Murt, 2020). While other bacteria, including Gram-positive species, have occasionally been discovered, *Pseudomonas aeruginosa*, *Escherichia coli*, and *Klebsiella spp.* are the primary culprits behind urinary tract infections (Flores et al., 2015). Antimicrobial-resistant bacteria are a serious public health problem since they are predicted to become the primary cause of death worldwide by 2050, incur higher healthcare costs, and result in worse patient outcomes (Harris et al., 2023).

## 2. Materials and Methods

**Culture media:** The following culture media were used: Nutrient Agar, Nutrient Broth, and Muller-Hinton Agar, which were sterilized in an autoclave at 121°C and 1.5 atmospheres for 15 minutes. *Pseudomonas aeruginosa* and *Escherichia coli* were obtained from the College of Science/Department of biology/University of Thi Qar.

### 2-1 Preparation of ethanolic plant Extracts

By combining 20 g of the plant model mint and pomegranate peels separately, the researcher Grand et al.'s method—which was modified from the basic method of the researcher Verporte et al.—is followed to obtain an alcoholic extract in which the soluble plant components are extracted from the plant by alcohol or other solvents. Following the addition of 200 ml of ethanol alcohol and twelve hours of stirring with an electric stirrer, the mixture was refrigerated for five days to allow it to soak. It was then filtered through filter papers and allowed to dry at room temperature. Finally, it was dissolved in dimethyl sulfoxide (DMSO) and concentrations were made for both extracts.

### 2-2 Estimating the inhibitory effect of ethanolic extract against bacterial isolates

A volume of 0.1 ml of the bacterial suspension was spread out on the solid Muller-Hinton Agar medium, and the plates were then allowed to sit at room temperature for 15 minutes in order to allow the inoculum to absorb. Then, using a sterile cork punch with a 7 mm diameter, wells were made in the nutrient medium that had been infected with

bacteria. Next, 100 microliters of each concentration (25%, 50%, 75%, and 100%) of the concentrations of the plant extracts under study were transferred and put inside the wells using a fine pipette and The alcoholic extract was replaced with 100 microliters of DMSO in the hole of the control plates, which were then incubated at 37°C for 18 to 24 hours. The diameter of the bacterial growth inhibition zone surrounding the hole was measured with a ruler to determine the outcome. The result appeared as shown in pictures (3,4).



Figure (3): Inhibitory activity of mint extract against *Pseudomonas aeruginosa* (A) and *Escherichia coli* (B).



Figure (4): Inhibitory activity of pomegranate peel extract against *Pseudomonas aeruginosa* (A) and *Escherichia coli* (B).

### 3. Results

The bacteria showed a response to the extracts under study in varying proportions. The results showed that *Pseudomonas aeruginosa* had the highest response to the alcoholic extract of pomegranate peels, followed by *Escherichia coli*. The pomegranate peel extract had a significant effect on *Pseudomonas aeruginosa*, while the effect of the mint extract was less effective. While the alcoholic extract of mint had a greater effect on *Escherichia coli* and less effect on the growth of *Pseudomonas aeruginosa* as shown in Table (1) and Table (2). The results also showed the synergistic effect between the plant extracts against *E. coli* bacteria at concentrations (100%, 75%, 50%) as shown in Table (3).

Table (1) - The effect of the alcoholic extract of pomegranate peels and its concentrations on bacterial isolates.

Effect of ethanolic extract of pomegranate peels and concentrations on bacterial isolates		Pomegranate peel ethanolic extract concentration (ml)
<i>E.coli</i>	<i>Pseudomonas</i>	
Inhibition zone diameter (ml)		
15	20	100%
13	18	75%

11	18	50%
10	15	25%

Table (2) - The effect of the alcoholic extract of mint and its concentrations on bacterial isolates

Effect of ethanolic extract of mint at different concentrations on bacterial isolates		Concentration of ethanolic extract of mint (ml)
<i>E.coli</i>	<i>Pseudomonas</i>	
Inhibition zone diameter (ml)		
15	14	100%
15	12	75%
15	11	50%
15	10	25%

Table (3): The synergistic effect of the alcoholic extract of pomegranate peels and mint at different concentrations towards the bacterial isolates studied.

The effect of alcoholic extract of pomegranate and mint peels at different concentrations on bacterial isolates		Concentration of tartaric alcoholic extract of pomegranate and mint peels (ml)
<i>E.coli</i>	<i>Pseudomonas</i>	
Inhibition zone diameter (ml)		
20	17	100%
18	16	75%
17	14	50%
14	12	25%

#### 4. Discussion

Results showed that the pomegranate peel alcoholic extract has antibacterial properties against the investigated microorganisms. The presence of various active components, including flavonoids, tannins, glycosides, and resins, may explain the pomegranate peel alcoholic extract's ability to inhibit and kill microbes. Numerous microorganisms, such as fungus and bacteria, are inhibited by these substances (Altuner,2011; Foss et al.,2014). Active substances, particularly tannins, have the ability to alter the structure of proteins in bacteria, which can kill them, or alter the plasma membrane's functional characteristics, which can restrict the growth of germs (Dahham *et al.*,2010; Janani& Estherlydia,2013). The alcoholic extract of pomegranate peels contains flavonoids, gallic acid, elgic acid, polyphenols, and glycosides that are all highly toxic to bacteria (Dahham *et al.*, 2010; Barathikannan *et al.*, 2016).

Additionally, it was discovered that the inhibitory capacity rises as the plant extract concentration does, and the current study's findings concurred with the researcher's conclusions (Gosset et al., 2021). Mint contains flavonoids, tannins, saponins, volatile oils,

and fucoumarins, among other active chemicals that are thought to be responsible for the plant's inhibitory impact. Our study's findings concurred with those of (Abdul Qadir et al., 2017; El-Said, 2021). Because mint plants have a high concentration of physiologically active chemicals, such as polyphenols and carotenoids, which have antibacterial and antioxidant activity, aqueous plant extracts have been demonstrated to be helpful in decreasing microorganisms. The study's findings allow us to draw the important conclusion that plant extracts can provide products that are useful in the production of safe, affordable, and effective medications and therapies by inhibiting the growth of bacteria resistant to antibiotics.

From this study it can be concluded that both alcoholic extracts of natural herbs (pomegranate peels and mint) have antimicrobial activity against a range of microorganisms but the peel extract is superior to the mint extract as it shows more antimicrobial activity against some species and The synergistic effect between the two plant extracts under study is synergism. It was shown through conducting this experiment that the synergism between them sometimes increases the inhibitory effect against germs

## 5. Conclusion

Reducing the use of antibiotics to which bacterial isolates have shown high resistance. We recommend conducting more studies on pomegranate and mint peels and extracting active ingredients from them and isolating them to increase their effect on microorganisms. Extracting active compounds using GC-mass for pomegranate and mint plants and studying their biological effectiveness inside and outside the body of the living organism. Molecular investigation of virulence factors of isolates resistant to antibiotics used in this study.

## REFERENCES

- [1] Abdul Qadir, M., Shahzadi, S. K., Bashir, A., Munir, A., & Shahzad, S. (2017). Evaluation of phenolic compounds and antioxidant and antimicrobial activities of some common herbs. *International journal of analytical chemistry*, 2017.
- [2] Abbas, Fatima Hussein (2003). Mint is an aromatic plant - Isa Town Commercial Secondary School for Girls - Bahrain.
- [3] Abu Zaid, Shahat Nasr (1992). Medicinal plants and their agricultural and medicinal products - second edition - Dar Al Arabiya for Publishing and Distribution.
- [4] Ahmed ,S; Wang N.; Hafeez ,BB and Cheruvu, VK. (2005). Haqqi TM: Punica granatum L extract inhibits IL-t beta-induced expression of matrix metalloproteinases by inhibiting the activation of MAP kinases and NF-kappa B in human chondrocytes in vitro. *J Nutr*, 135:2096-2102.
- [5] Ahmed, Minya; Sheikh Idris, civilian; Israa, Abdullah (2014). Extracting volatile oil from the lemon mint plant and applying it in the manufacture of a mosquito-killing cream - Department of Scientific Laboratories - College of Science - University of Sudan.
- [6] AJaikumar, KB. ;Asheef\_I, Babu BHA , Padikkafa J.(1996 ).The inhibition of gastric mucosaL infuryby. Punicagrana ` - :L»(Pomegranate) methanolic extract. *J.Ethnopharmacol* 00 96:171-176.
- [7] Al-Quraishi, Manar Karim Fadel (2011). Evaluation of some effectiveness of some plant extracts in the growth of some pathogenic fungi. Master's thesis/College of Science - University of Karbala.
- [8] Al-Shafi'i, Darwish Mustafa (2014). Medicinal plants and healthy food, Dar Al-Khatib for Publishing and Distribution, Amman - Jordan.
- [9] Altuner, E. M. (2011). Investigation of antimicrobial activity of Punica granatum L. fruit peel ash used for protective against skin infections as folk remedies especially after male circumcision. *African Journal of Microbiology Research*, 5(20), 3339-3342.

- [10] Barathikannan, K., Venkatadri, B., Khusro, A., Al-Dhabi, N. A., Agastian, P., Arasu, M. V., ... & Kim, Y. O. (2016). Chemical analysis of *Punica granatum* fruit peel and its in vitro and in vivo biological properties. *BMC complementary and alternative medicine*, 16, 1-10.
- [11] Boukhalti, Habiba (2010). Medicinal plants traded in the northern region of Setif Province: An anatomical study of two species of the genus Mint and the anti-bacterial activity of their essential oils. Master's thesis. Farhat Abbas University of Setif - Algeria. 2010. p. 7.
- [12] Dahham, S. S., Ali, M. N., Tabassum, H., & Khan, M. (2010). Studies on antibacterial and antifungal activity of pomegranate (*Punica granatum* L.). *Am. Eurasian J. Agric. Environ. Sci*, 9(3), 273-281.
- [13] Egorove, N. S. (1985). Antibiotic asientific approach Mir publishers.
- [14] El-Said, M. A., & Hassan, R. G. (2021). Evaluation of the antimicrobial activity of aqueous extract of mint leaves and basil leaves for using in water purification. *Egypt J. Appl. Sci*, 36, 41-50. Fawole, O. A., Makunga, N. P., & Opara, U. L. (2012). Antibacterial, antioxidant and tyrosinase-inhibition activities of pomegranate fruit peel methanolic extract. *BMC complementary and alternative medicine*, 12, 1-11.
- [15] Flores-Mireles, A. L., Walker, J. N., Caparon, M., & Hultgren, S. J. (2015). Urinary tract infections: epidemiology, mechanisms of infection and treatment options. *Nature reviews microbiology*, 13(5), 269-284.
- [16] Foss, S. R., Nakamura, C. V., Ueda-Nakamura, T., Cortez, D. A., Endo, E. H., & Dias Filho, B. P. (2014). Antifungal activity of pomegranate peel extract and isolated compound punicalagin against dermatophytes. *Annals of clinical microbiology and antimicrobials*, 13, 1-6.
- [17] Gosset-Erard, C., Zhao, M., Lordel-Madeleine, S., & Ennahar, S. (2021). Identification of punicalagin as the bioactive compound behind the antimicrobial activity of pomegranate (*Punica granatum* L.) peels. *Food Chemistry*, 352, 129396.
- [18] Gupte, S. (2016). The short textbook of pediatrics. JP Medical Ltd.
- [19] Harris, M., Fasolino, T., Ivankovic, D., Davis, N. J., & Brownlee, N. (2023). Genetic factors that contribute to antibiotic resistance through intrinsic and acquired bacterial genes in urinary tract infections. *Microorganisms*, 11(6), 1407.
- [20] Hussein, F. T. (1979). Medicinal plants, their cultivation and components - second edition - Arab Book House.
- [21] Ismaeil ,C.; Atilla, T. and Ishak I.( 2009). Hepatoprotective role and antioxidant capacity of pomegranate. *Food and chemical toxicology* 47 1) 145-149.
- [22] Janani, J., & Estherlydia, D. (2013). Antimicrobial activities of *Punica granatum* extracts against oral microorganisms.
- [23] Kamel, Mukhtar Muhammad. (1991). The Comprehensive Scientific Encyclopedia of Aromatic Medicinal Plants, Modern Mosque Office, Alexandria, Arab Republic of Egypt.
- [24] Khalaf, Nagham Muhammad (2020). Evaluation of the effectiveness of some plant extracts on pathogenic bacteria that produce beta-lactamase enzymes and isolated from skin infections. Master's thesis / College of Science - University of Diyala
- [25] Kim, D. S., & Lee, J. W. (2023). Urinary tract infection and microbiome. *Diagnostics*, 13(11), 1921.
- [26] Lansky, EP. & Newman, RA.(2007) .*Punica granatum* pomegranate and its potential for prevention and treatment of infl animation and cancer. *J Ethnopharmacol* 2007; 109:177-206.
- [27] Lei, G.; Zhanf ,W.; Wang, DM. and Xie, H .(2007). Evi9dence of anti obesity effects of pomegranate leaf extract in high fat diet induced obese mice. 31: 1023-1029.
- [28] Muhammad, Marwa; Saeed, Rasheed; Marib, Nazih; Nader, Muhammad; Ibrahim, Hassan; Sarah, Faisal. (2015) Extracting volatile oils from mint plants and studying their toxic effect on some cancer cell lines - Department of Biotechnology - University of Baghdad.
- [29] Salhi et al., )2010( . Etudes floristique et ethnobotanique des plantes médicinales de la ville de Kénitra .Revue LAZA.31(9) p133.



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- [30] Silvia ,H.A; Sandra , A.A ; and Olga , M. F. (2005). Partial purification and characterization of pectin methylase from orange citrus sinensis CV. Pere RIO .journal of food biochemistry .page 367.
- [31] Suleiman, Khader Daoud; Al-Dulaimi, Fatima Ibrahim Sultan (2007). The inhibitory effect of elm and eucalyptus plant extracts and the synergy between their active components and antibiotics on *Salmonella typhimurium* and *Staphylococcus aureus* bacteria isolated from cases of food poisoning. College of Education - University of Mosul.
- [32] Öztürk, R., & Murt, A. (2020). Epidemiology of urological infections: a global burden. *World journal of urology*, 38, 2669-2679.
- [33] Yaziji, Maysaa; Al-Awad, Daniel. Grecos, Balsam (2015). Study of the inhibitory activity of *Mentha longifolia* extracts against an isolate of the fungus *Drechslera dematioidea*. *Tishreen University Journal for Scientific Studies and Research: Biological Sciences Series*. p. 113-.