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# Bioinformatics Study and the Role of Medicinal Plants on UMOD Gene Expression to Prevent Kidney Stones and Infections

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## ABSTRACT

Kidney stones, caused by mineral deposits, lead to severe pain and infections. Genetic factors, including the UMOD gene, influence stone formation, while medicinal plants like Silybum marianum and Zingiber officinale may offer protective effects. This study investigates how plant extracts modulate UMOD gene expression to prevent kidney stones and infections, exploring their therapeutic potential in renal health. For this purpose, 100 microliters of extracts of the medicinal plants *Zingiber officinale*, *Silybum marianum*, Alhagi, Urtica, and Brassica napus were used as samples, and the expression level of the UMOD gene was examined using the real-time PCR technique. Real-time PCR analysis revealed a significant increase in UMOD expression compared to the control, suggesting a protective role against kidney damage. Bioinformatics analysis used NCBI, ProtScale, UCSC, MBC, and OMIM databases. Bioinformatics analysis identified 23 miRNAs targeting UMOD, potentially influencing kidney disease progression. Additionally, 3D protein modeling confirmed UMOD's structural stability (GMQE = 0.83, 92.79% stability via Ramachandran plot). Network analysis highlighted UMOD's interaction with kidney stone-related genes, while domain analysis revealed functional ZP and EGF domains involved in infection resistance. Tissue-specific expression was highest in kidneys and liver, supporting its renal protective role. The results of this study provide a promising perspective, indicating that the medicinal plants examined possess antioxidant and anti-inflammatory properties. These properties help alleviate symptoms, prevent the reformation of kidney stones, and assist in expelling existing stones.

**Keywords:** UMOD, Kidney, *Zingiber officinale*, *Silybum marianum*, *Alhagi*, *Urtica*



## INTRODUCTION

Kidney stones are a prevalent urological disorder affecting approximately 12% of the global population. The primary cause of this condition is the accumulation of minerals, particularly calcium oxalate, on the papillary surfaces of the kidneys. The formation of kidney stones is a complex chemical and physical process that occurs due to the buildup of stone-forming compounds in the urinary tract. During this process, factors that typically inhibit stone formation are either rendered ineffective or have minimal impact, allowing stone production to dominate. In older individuals, increased cellular damage over time can lead to the retention of harmful mineral particles on the kidney's papillary surfaces. Generally, the accumulation of substances such as calcium, phosphorus, uric acid, and oxalate, combined with low urine volume, significantly contributes to stone formation. Uric acid, in particular, reduces the solubility of various substances and greatly influences the formation of calcium oxalate (CaOx) stones [1].

In general, the following factors have the greatest impact on kidney failure: Lifestyle and food consumption such as animal proteins and salt intake [2, 3]. Deficiency in the use of vegetables, substances such as fiber and citrate [4]. Urinary tract infections and urine pH and alkalinization of urine [5]. Genetic disorders, especially in autosomal genes [6]. Obesity and high blood pressure [7]. Climate change and water pollution [8]. Intestinal inflammation and infections and lack of intestinal oxalate-degrading bacteria [9]. Lithogenic drugs such as Indinavir and sulfonamides [10].

The human body operates as a complex network of interconnected processes that occur daily in various parts. One such process is detoxification, which is vital for the proper functioning of the kidneys. Effective detoxification can enhance kidney function and reduce the formation of kidney stones. In this context, medicinal plants and their extracts serve as significant resources for mitigating harmful changes and supporting kidney health. These plants have a long-standing role in traditional medicine, offering remedies for kidney diseases and addressing damage caused by toxic substances. This study will explore the roles and properties of several key medicinal plants associated with kidney stones [11].

*S. marianum* plant is native to the Mediterranean region but is currently cultivated all over the world. The milk thistle plant has effective compounds that, in addition to affecting the health of various organs, especially in the kidneys, gallbladder, and urinary tract, lead to detoxification. These compounds include silymarin, isosilybin, isoscelchristine, and taxifolin. This plant also strengthens the immune system due to its strong antioxidants and anti-inflammatory properties and prevents the formation of kidney stones [12].

*Z. officinale is* one of the most useful plants in traditional medicine is ginger. This plant has proven its anti-pathogenic effects in a wide range of diseases. In this section, we will focus on the medicinal properties of ginger in relation to kidney failure. Ginger helps prevent kidney stones through its antioxidant and anti-inflammatory compounds. First, it dissolves existing stones due to the presence of vitamin

C and magnesium. Additionally, these compounds inhibit the binding of stone-forming substances, thereby reducing the likelihood of large stone formation. Furthermore, the active antioxidants in ginger increase urine volume, which enhances the excretion of waste. Research also indicates that the phenolic and flavonoid compounds in ginger provide protection against kidney damage [13].

*Alhagi* plant contains antioxidant compounds and substances that act in many diseases, especially kidney and liver failure, and improve the symptoms of the disease. Compounds such as magnesium, potassium, tannins, phenols, flavone glycosides, and flavonoids are considered anti-inflammatory compounds of this plant. In general, this plant cleanses the kidneys and bladder, increases urine volume, affects the cells of the urinary tract and tubes, and facilitates the excretion of kidney stones. Also, the antioxidant compounds of this plant dissolve calcium molecules by binding to them and preventing the formation of calcium stones [14].

*Urtica* is an annual herbaceous plant that contains many anti-inflammatory compounds. This plant, rich in mineral compounds and vitamins, is effective in treating various diseases, including stomach, lung, and urinary tract infections, and alleviating their symptoms. Additionally, it is renowned for its exceptional antioxidant properties, which help expel small stones from the kidneys and urinary tract, earning it the nickname "kidney stone-busting plant." Its active ingredients include carbohydrates, sodium, potassium, tannin, iron, manganese, magnesium, phosphorus, and iodine. Furthermore, it contains vitamins A and E, crucial for preventing kidney stone formation. Recent studies indicate that oxalate exposure can damage kidney epithelial cells, while Urtica helps reduce the formation of calcium oxalate crystals and promotes the excretion of toxins, particularly uric acid, the primary cause of kidney stones. Overall, this plant is highly regarded for relieving prostate and urinary tract disorders [15].

*B. napus* plant is a rich source of antioxidants. The roots of this plant contain phenols and flavonoids. Rapeseed root is also a solubilizer of urinary salts. These roots are also antiscorbutic and emollient, which cause the dissolution of kidney stones [16].

In recent years, the recognition and understanding of molecular and genetic processes have provided extensive insight into the mechanisms of the disease. Also, genomic associations and structural studies of these genes are very important. One of the important genes associated with renal failure is the glycoprotein UMOD. This protein is synthesized in the kidney and is the most abundant protein in urine. This gene is located on chromosome 16 and has 11 exons and 640 amino acids (Table 1). UMOD acts as a receptor for the binding and endocytosis of cytokines and TNF factor and facilitates the migration of neutrophils from the renal epithelium.

This study enhances our understanding of kidney stone research by merging bioinformatics with experimental validation to investigate the molecular mechanisms behind kidney stone formation and the therapeutic potential of medicinal plants. While earlier research has identified various lifestyle, genetic, and environmental factors contributing to kidney stones, this study stands out by integrating genomic analysis of critical genes like *UMOD*, which is essential for renal function and inflammation, with the assessment of bioactive compounds from plants such as *S. marianum*, *Z. officinale*, and *Urtica*. These plants are known for their antioxidant, anti-inflammatory, and stone-dissolving properties, providing new insights into their mechanisms of action, particularly in inhibiting calcium oxalate crystallization and enhancing detoxification pathways. By combining computational genomics with experimental validation of plant-based therapies, this research not only identifies new molecular targets but also offers evidence-based validation for traditional remedies, presenting a more holistic approach to preventing and treating kidney stones than previous studies that focused on isolated aspects of the disease.

**Table 1**Gene sequence results of UMOD

| Name | *UMOD* |
|---|---|
| ORGANISM | Homo sapiens (Human) |
| Accession number nucleotide | NM_003361.4 |
| Accession number protein | NP_003352.2 |
| Gene ID | 7369 |
| Chromosome | 16 |
| Cytogenetic location | 16p12.3 |
| Chromosome location bp | 20333051-20356301 |
| nucleotide length | 2315 bp |
| protein length | 640 aa |
| Molecular weight (Da) | 69760.86 |
| Isoelectric point | 5.05 |
| Total Exon | 11 |



## MATERIAL AND METHODS

### Preparation of Plant Materials

This study was conducted in a completely randomized design with three replications. In this study, seeds of specified varieties were first obtained from the Agricultural Jihad Organization and the Directorate General of Strategic and Oily Products. For cultivation, seeds were initially surface-sterilized by immersion in 70% ethanol for 60 seconds, followed by multiple rinses with sterile distilled water under aseptic conditions. Subsequently, the seeds were treated with a 3% sodium hypochlorite solution for one minute and again subjected to repeated washes with autoclaved distilled water to ensure complete decontamination. Following sterilization, the disinfected seeds were placed in a sterile mason jar and moistened with autoclaved water to facilitate germination. Upon sprouting, the germinated seedlings were transplanted into a light-textured growth substrate to promote further development. The seedlings were then transferred to individual pots containing sterilized soil and maintained in the controlled environment of Research Institute of Zabol greenhouse. Growth conditions were standardized at 25°C with a photoperiod of 16 hours light and 8 hours darkness. Regular irrigation was administered throughout the growth phases until the plants attained the 4-5 leaf developmental stage. In this study, leaf samples of the medicinal plants *Zingiber officinale*, *Silybum marianum*, *Alhagi*, *Urtica*, and *Brassica napus* were used. After that, 100 µl of each plant extract was used as a treatment. In this study, the soaking method was used to extract plant extracts. First, the leaves of these plants were completely powdered, and then 50 microliters of ethanol was added to them as a solvent. The resulting mixture was placed in special glass containers and stored

for three days. During this time, the mixture was placed on a shaker. Finally, the plant extracts were separated from the solvent by filtration and a water bath and used for the treatment steps.

### Examination of UMOD Gene Expression

In this study, the UMOD gene was focused on as one of the most important genes associated with kidney stone excretion to investigate the genes associated with kidney failure. Real-time PCR was used to examine the expression level of the UMOD gene. First, total RNA was extracted from cells treated with leaf extracts of S. marianum, Z. officinale, Alhagi, Urtica, and B. napus. Then, an untreated RNA sample was extracted as a control using the DNAzist RNA extraction kit according to the instructions. The concentration of extracted RNAs was measured using the NanoDrop device, and then cDNA was extracted using the Fermentas kit. Finally, a real-time PCR reaction was performed using the Taligene kit, and the expression results were evaluated using LineGeneK software. Finally, these data were analyzed by SAS software, and the expression profile of the desired gene was obtained.

### Bioinformatics Analysis

Initially, the nucleotide sequences of all target genes were retrieved from the NCBI genomic repository. Subsequently, computational analyses of structural modifications and proteomic variations associated with the UMOD gene were performed utilizing bioinformatics platforms. The physicochemical properties of the UMOD protein, including molecular mass and isoelectric point, were evaluated using ProtScale and Expasy computational tools (Table 1). Furthermore, the tertiary conformation and thermodynamic stability of the protein were assessed through structural data obtained from the Protein Data Bank (PDB) and the MBC structural database. Statistical interpretation of experimental data was conducted via SAS analytical software, while phylogenetic reconstruction was executed using MEGA5. Finally, following a BLAST alignment of the UMOD protein, homologous sequences in model sequence with sequence identity exceeding 50% were identified, after which the co-expression network of the target protein was visualized using TBtools.

## RESULTS

### Changes in the Expression Level of the UMOD Gene under the Influence of Medicinal Plant Extracts

As mentioned in the introduction to this study, the UMOD gene plays a crucial role in the elimination of kidney stones. Generally, genetic changes are associated with increased stone production in the kidneys. For instance, the HNF1B and SLC7A9 genes contribute to heightened stone formation as a result of biochemical and genetic alterations. In contrast, the UMOD gene provides physiological protection to the kidneys and helps prevent microbial infections. Research indicates that a decrease in the expression level of the UMOD gene is linked to reduced kidney function and increased kidney damage. Therefore, understanding the changes in the expression levels of the UMOD gene and its protein effects is vital for diagnosing kidney failure. Therefore, in this study, we investigated the effects of the medicinal plants *S. marianum, Z. officinale, Alhagi, Urtica,* and *B. napus* root on changes in UMOD gene expression by Real-time PCR. As can be seen in Figure 1, the effect of plant extracts used as treatments in this study was significant in all replicates compared to the control condition and showed a significant difference at the five percent level. On the other hand, as can be seen, the effect of Silybum marianum treatment was greater than that of other treatments and showed a significant difference from other treatments studied. Overall, these findings indicated an increase in the expression of the UMOD gene as a result of treatment with medicinal plant extracts in this study.

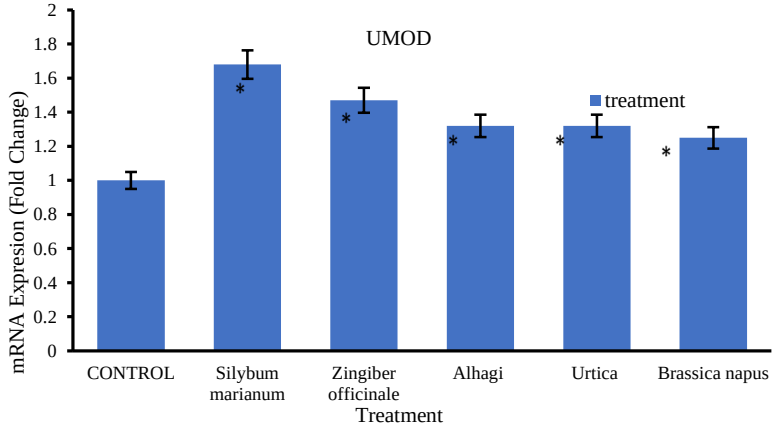


**Fig. 1** Changes in UMOD gene expression levels in response to treatment with extracts of medicinal plants *S. marianum, Z. officinale*, Alhagi, Urtica, and *B. napus* root. * Significant at 1 percent level probability.

### MicroRNAs Associated with the UMOD Gene

MicroRNAs are a type of non-coding RNA that plays a critical role in regulating signals related to gene and protein expression. These small molecules show abnormal expression changes in many diseases, such as cancer and infectious diseases, which can affect cell function. On the other hand, microRNAs have the potential to be used as biomarkers for the diagnosis and prognosis of kidney infectious diseases. For this reason, their detailed study of infectious diseases related to the urinary tract and kidneys is of particular importance [17-19]. In this study, microRNAs associated with kidney infections were extracted from the miRDB database. Studies conducted in this database showed that 23 miRNAs are directly involved in kidney infections and affect the expression level of the UMOD gene. The

identification of these microRNAs will play a significant role in future research, providing valuable insights into cellular biological processes. Table 2 shows the list of miRNAs associated with the UMOD gene.

**Table 2** microRNA associated with UMOD gene.

| Gene | miRNAs | miRNA Sequence | length |
|---|---|---|---|
| UMOD | hsa-miR-6760-5p | 5'- CAGGGAGAAGGUGGAAGUGCAGA- 3' | 23 |
| | hsa-miR-3064-3p | 5' - UUGCCACACUGCAACACCUUACA- 3' | 23 |
| | hsa-miR-548c-3p | 5' - CAAAAAUCUCAAUUACUUUUGC- 3' | 22 |
| | hsa-miR-196b-3p | 5' - UCGACAGCACGACACUGCCUUC- 3' | 22 |
| | hsa-miR-6838-5p | 5' - AAGCAGCAGUGGCAAGACUCCU- 3' | 22 |
| | hsa-miR-627-3p | 5' - UCUUUUCUUUGAGACUCACU- 3' | 20 |
| | hsa-miR-497-5p | 5' - CAGCAGCACACUGUGGUUUGU- 3' | 21 |
| | hsa-miR-15b-5p | 5' - UAGCAGCACAUCAUGGUUUACA- 3' | 22 |
| | hsa-miR-195-5p | 5' - UAGCAGCACAGAAAUAUUGGC- 3' | 21 |
| | hsa-miR-16-5p | 5' - UAGCAGCACGUAAAUAUUGGCG- 3' | 22 |
| | hsa-miR-15a-5p | 5' - UAGCAGCACAUAAUGGUUUGUG- 3' | 22 |
| | hsa-miR-424-5p | 5' - CAGCAGCAAUUCAUGUUUUGAA- 3' | 22 |
| | hsa-miR-6878-5p | 5' - AGGGAGAAAGCUAGAAGCUGAAG- 3' | 23 |
| | hsa-miR-4428 | 5' - CAAGGAGACGGGAACAUGGAGC- 3' | 22 |
| | hsa-miR-8055 | 5' - CUUUGAGCACAUGAGCAGACGGA- 3' | 23 |
| | hsa-miR-761 | 5' - GCAGCAGGGUGAAACUGACACA- 3' | 22 |
| | hsa-miR-214-3p | 5' - ACAGCAGGCACAGACAGGCAGU- 3' | 23 |
| | hsa-miR-3619-5p | 5' - UCAGCAGGCAGGCUGGUGCAGC- 3' | 22 |
| | hsa-miR-103a-3p | 5' - AGCAGCAUUGUACAGGGCUAUGA- 3' | 22 |
| | hsa-miR-107 | 5' - AGCAGCAUUGUACAGGGCUAUCA- 3' | 23 |
| | hsa-miR-4477b | 5' - AUUAAGGACAUUUGUGAUUGAU- 3' | 22 |
| | hsa-miR-4478 | 5' - GAGGCUGAGCUGAGGAG- 3' | 17 |
| | hsa-miR-4310 | 5' - GCAGCAUUCAUGUCCC- 3' | 16 |

### Changes in UMOD protein concentration in infectious diseases and pediatrics

In this study, a series of infectious diseases and diseases related to children were evaluated. The results of the study, depicted in Figure 2, showed that the concentration of UMOD protein was lower in infectious diseases compared to diseases related to children. These findings indicate that the level of this protein is observed more in children than in middle-aged people. In addition, by examining and comparing diseases specific to children, it was found that the level of UMOD protein was higher in renal tumors of children than in other diseases studied.

### Three-dimensional Structure and Energy Level Analysis of the UMOD Protein

The UMOD protein 3D structure was predicted by the GMQE criterion. In this model, the predicted structure is in the range of zero to one, so the closer this value is to one, the more accurate the prediction of the 3D structure of the protein in question. Considering that in the estimation of the 3D structure of the UMOD protein, the GMQE index is equal to 0.83, this model provides a relatively strong estimate of the 3D structure. Figure 3 shows the 3D structure of the UMOD protein. The UMOD protein stability was determined by examining the Ramachandran plot. Thus, to determine the energy level and stability, the two angles φ and ψ in the protein were used. According to the above diagram, it was found that the stability of UMOD protein is equal to 92.79%. This estimate also showed that the UMOD protein is in a stable state. Figure 4 shows the Ramachandran diagram of the UMOD protein.

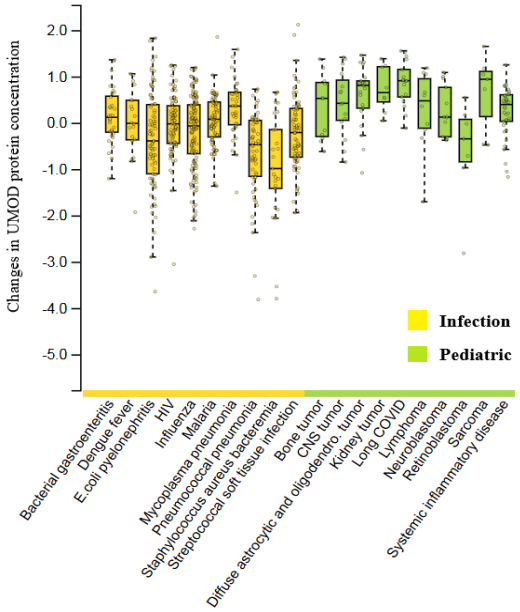


**Fig. 2** Changes in UMOD protein concentration in infectious diseases and pediatrics

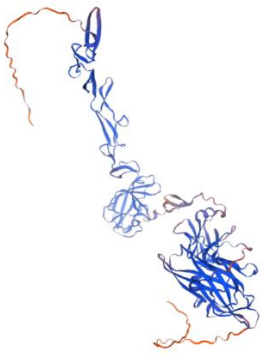

**Fig. 3** 3D structure of UMOD protein.

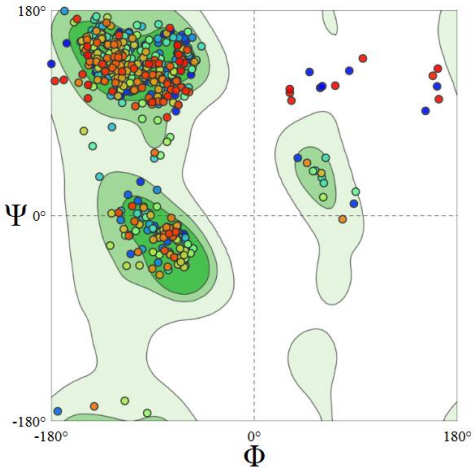


**Fig. 4** Ramachandran diagrams of UMOD protein.

### UMOD Gene Network Analysis

The UMOD gene network analysis showed that this gene is associated with an important network of transcription factors and proteins. A number of these proteins, as previously mentioned, lead to the stimulation of kidney stones. However, the UMOD gene helps to reduce kidney infection by stimulating signals activating transcription factors and preventing its effects on kidney stones. Figure 5 shows the network of genes associated with the UMOD gene. In the observed structure, the PKHD1 gene, as one of the UMOD-related genes, encodes fibrocystin and plays a key role in cell division and mitotic spindle assembly. Additionally, the ALB gene, which encodes serum albumin, is one of the primary proteins in blood plasma and plays a crucial role in regulating blood osmotic pressure. This gene acts as the main transporter of calcium and magnesium in plasma and performs about 45% of the exchanges of these elements. In addition, the AQP2 gene, which is closely related to the UMOD gene, plays an important role in regulating renal water homeostasis.

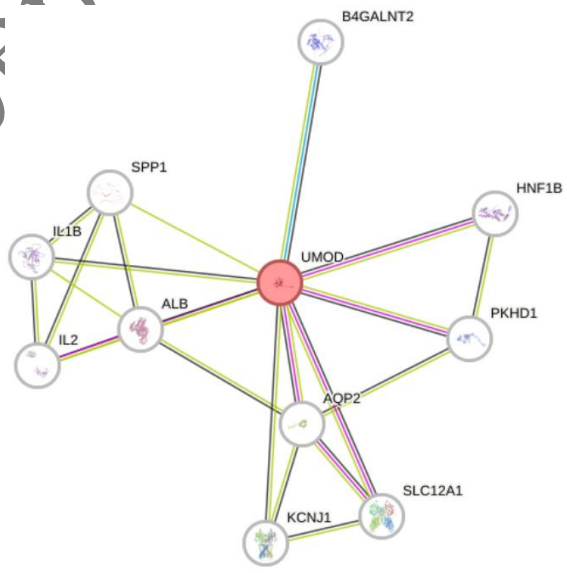


**Fig. 5** UMOD gene network.

### Analysis of Domains Associated with the UMOD Protein

As can be seen in Figure 6, this protein contains a ZP domain and several EGF domains. First, it should be said that the ZP domain is involved in the polymerization process and causes the production of long strands. This domain consists of a core and the N-terminal and C-terminal parts that are connected by a strong bond. The UMOD protein also contains several EGF domains, which are involved in pathogen uptake and lead to the suppression of infection.

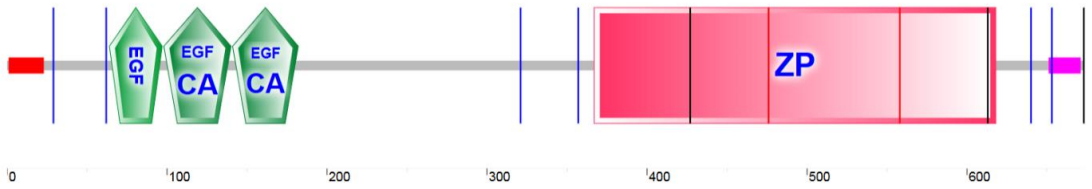


**Fig. 6** Domains related to UMOD gene.

### Expression Analysis of the UMOD Gene in Different Organs of the Body

The expression analysis of the UMOD gene across various organs revealed that this gene is primarily expressed in the kidney and urinary tract tissues, as well as in the liver and gallbladder, with minimal expression in most other organs (Figure 7). Additionally, the analysis showed that gene expression levels are relatively similar in both men and women. Notably, UMOD expression is higher in kidney tissues compared to the liver and gallbladder. This selective expression in the liver and kidneys suggests a significant connection between these two organs, potentially serving to mitigate damage from kidney stones.

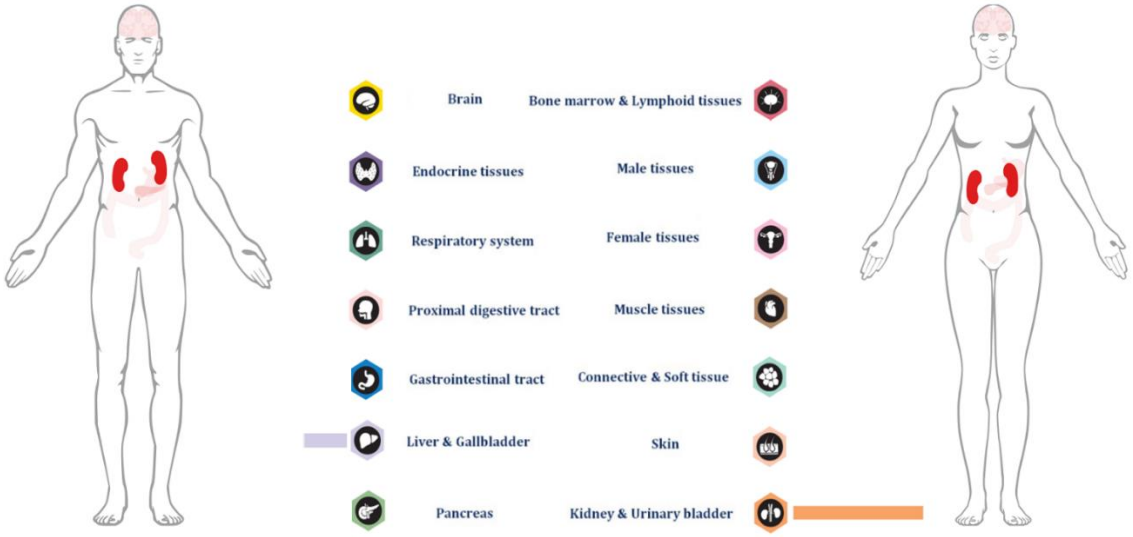


**Fig. 7** Changes in UMOD gene expression in different body organs.

### DISCUSSION

Kidney diseases and failures are among the silent diseases that, if not treated, may lead to long-term disability or even death. Many of these diseases, such as kidney and urinary tract infections, polycystic kidney disease, and kidney stones, have a hereditary and genetic background. Therefore, it is very vital to examine the genes related to this process [20]. We should note that many genes increase the risk of kidney diseases. These genes are often associated with blood pressure and kidney and bladder failure. On the other hand, plants such as *S. marianum, Z. officinale,* and Urtica have anti-inflammatory properties and can reduce the damage caused by these negative effects of genes through active antioxidants and help improve infection and prevent kidney stone formation. In addition, these plants make it easier to expel kidney stones by creating lubricants and increasing urine volume.

Research has demonstrated that the ethanol extract of Urtica is effective in both preventing and treating kidney stones, along with its underlying mechanisms. Additionally, the study found that Urtica extract significantly enhances the expression of the UMOD gene, which plays a crucial role in regulating kidney infections and the formation of kidney stones [21]. In 2019, Das et al. demonstrated that silymarin, a natural antioxidant derived from the milk thistle plant, is effective in treating kidney, liver, and biliary tract diseases. This study further supports the finding that milk thistle enhances the expression of the UMOD gene in the liver, kidneys, and bile ducts. Additionally, Das et al. found that milk thistle reduces tumor activity in the kidneys and slows calcium metabolism. These effects contribute to a decrease in stone formation and promote the excretion of kidney stones by increasing urine volume [22]. Also, Sharma in 2017 showed that ginger contains antioxidant compounds and enzymatic and probiotic activities that prevent the production of kidney stones [23].

The results of this study indicate that milk thistle is the most effective plant for eliminating kidney stones among those examined. However, all the plants studied demonstrated a positive effect in this regard. Additionally, the bioinformatics analysis revealed that the UMOD gene is linked to other genes that contribute to the formation of kidney stones. This suggests that the UMOD gene may mitigate the harmful

effects of these genes by interacting with those that promote kidney stone development. Consequently, the UMOD gene can be viewed as an agent that disrupts the mechanisms responsible for kidney stone formation. Furthermore, numerous studies have confirmed the direct role of the UMOD gene in combating kidney stones, aligning perfectly with the findings of this study [24].

## CONCLUSION

In general, the results of this study showed that medicinal plants and their active compounds act as antioxidants and destroy free radicals. Also, these plants can inhibit lipid peroxidation and protect the kidneys against gene damage through the production of secondary metabolites. On the other hand, plants such as *S. marianum, Z. officinale*, and *Urtica* can stimulate the transcriptional activity of genes that reduce kidney infections and thereby stop the mechanisms of kidney stone formation. Additionally, it is essential to identify other signals and microRNAs involved in kidney stone formation. Given the genetic basis of this condition, future research aims to leverage nanotechnology and molecular methods to gain a clearer understanding of the underlying mechanisms. This knowledge may lead to the design of specific antigens that can disrupt these processes and ultimately prevent kidney stone formation.

### Data Availability

All of the data in this investigation have been reported in the paper and are freely available on request.

### Authors' contributions

All authors gave final approval for publication.

### Competing Interests

The author declare that they have no known competing financial interests or personal relationships that could have appeared to influence the study reported in this paper.

### Ethical and Informed Consent for Data used

This article does not contain any studies with human participants or animals performed by any of the authors.


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## REFERENCES


1. Alelign T., Petros B. Kidney stone disease: an update on current concepts. Advances in Urology. 2018; 2018(1): 3068365.
2. Łojewska J.N., Rosińska K., Bochenek O., Koper M., Janicka E.J., Perko A., Rosiński M., Niedźwiedzka M. The Impact of Nutrition and Exercise on Kidney Health: How to Prevent Kidney Stones? Quality in Sport. 2024; 22: 54268-54268.
3. Swapna B., Fathima K., Muwayyad H., Khanam M., Salma S., Harsha S., Gayas N. A study to assess the associated risk of developing cardiovascular diseases in chronic kidney disease. Cellular, Molecular and Biomedical Reports. 2024; 4(3): 150-158.
4. Balawender K., Łuszczki E., Mazur A., Wyszyńska J. The Multidisciplinary Approach in the management of patients with kidney Stone Disease—A State-of-the-art review. Nutrients. 2024; 16(12): 1932.
5. Segall M., Mousavi A., Eisner B.H., Scotland K. Pharmacologic treatment of kidney stones: Current medication and pH monitoring. Actas Urológicas Españolas (English Edition). 2024; 48(1): 11-18.
6. Liu M., Gao M., Wu J., Zhu Z., Hu J., Chen H., Chen Z., Chen J. Metabolic syndrome and the risk of kidney stones: evidence from 487 860 UK Biobank participants. The Journal of Clinical Endocrinology & Metabolism. 2025; 110(4): e1211-e1219.
7. Aiumtrakul N., Thongprayoon C., Suppadungsuk S., Krisanapan P., Pinthusopon P., Mao M.A., Arayangkool C., Vo K.B., Wannaphut C., Miao J. Global trends in kidney stone awareness: a Time Series Analysis from 2004–2023. Clinics and Practice. 2024; 14(3): 915-927.
8. Noonin C., Thongboonkerd V. Beneficial roles of gastrointestinal and urinary microbiomes in kidney stone prevention via their oxalate-degrading ability and beyond. Microbiological Research. 2024; 282: 127663.
9. Skolarikos A., Somani B., Neisius A., Jung H., Petřík A., Tailly T., Davis N., Tzelves L., Geraghty R., Lombardo R., Bezuidenhout C., Gambaro G. Metabolic Evaluation and Recurrence Prevention for Urinary Stone Patients: An EAU Guidelines Update. European Urology. 2024; 86(4): 343-363.
10. Elgendy A.M., Nafie M.S., Nabil Z.I., El-Shenawy N.S., Gad El-Hak H.N. Unveiling the antiurolithiatic potentiality of two benzene sulfonamide derivatives against ethylene glycol-induced renal calculi. Nefrología. 2025; 45(2): 167-181.
11. Nirumand M.C., Hajialyani M., Rahimi R., Farzaei M.H., Zingue S., Nabavi S.M., Bishayee A. Dietary plants for the prevention and management of kidney stones: preclinical and clinical evidence and molecular mechanisms. International Journal of Molecular Sciences. 2018; 19(3): 765.
12. Zubair M.H., De Ranieri A. Alternative and herbal medicines. In Abd-Elsayed A (Ed.), Basic Anesthesia Review (pp. 169 Pages): Oxford University Press. 2024
13. Zammel N., Jedli O., Rebai T., Hamadou W.S., Elkahoui S., Jamal A., Alam J.M., Adnan M., Siddiqui A.J., Alreshidi M.M., Naïli H., Badraoui R. Kidney injury and oxidative damage alleviation by Zingiber officinale: pharmacokinetics and protective approach in a combined murine model of osteoporosis. 3 Biotechnology. 2022; 12(5): 112.
14. Mehrabi S., Beigi P., Salehpour Z. Comparison of the effect of hydroalcholic extract of alhagi maurorum and hydrochlorothiazide on excretion of 4–10 mm kidney and ureteral stones in adults: a randomized prospective study. Advances in Pharmacological and Pharmaceutical Sciences. 2023; 2023(1): 6624981.
15. Ghanati K., Vahide O., Mohammad R.-G., Parisa S.-G., Ghazal M., and Sadighara P. Oxalate in plants, amount and methods to reduce exposure; a systematic review. Toxin Reviews. 2024; 43(3): 411-422.
16. Benaicha S., Aissa I., Subhasis P., Mahanty D.S., Bussmann R.W., Mostafa E. Brassica fruticulosa Cirillo Brassica napus L. Brassica nigra W.D.J. Koch Brassica oleracea L. Brassica rapa L. Coincya tournefortii (Gouan) Alcaraz, T.E. Díaz, Rivas Mart., & Sánchez-Gómez Brassicaceae. In Bussmann R W Elachouri M, Kikvidze Z (Eds.), Ethnobotany of Northern Africa and Levant (pp. 1-14). Cham: Springer International Publishing. 2023

17. Humadi S., Hassan S.M., Ahjel S.W. The Use and Perception of Herbal Remedies in the Management of Nephrolithiasis Among Diverse Iraqi Patients Residing in Karbala: A Cross-Sectional Survey Conducted in Southern Iraq. Azerbaijan Pharmaceutical and Pharmacotherapy Journal. 2023; 22: 135-140.
18. Hashemi M., Khosroshahi E.M., Daneii P., Hassanpoor A., Eslami M., Koohpar Z.K., Asadi S., Zabihi A., Jamali B., Ghorbani A., Nabavi N., Memarkashani M.R., Salimimoghadam S., Taheriazam A., Tan S.C., Entezari M., Farahani N., Hushmandi K. Emerging roles of CircRNA-miRNA networks in cancer development and therapeutic response. Non-coding RNA Research. 2025; 10: 98-115.
19. Yang Y., Wang Q., Xun Y., Li C., Wang S. The Preliminary Exploration of What Role miRNAs Derived From Urinary Exosomes Play in Kidney Stone Formation. Urology. 2022; 166: 104-110.
20. Kanwal N., Al Samarrai O.R., Al-Zaidi H.M.H., Mirzaei A.R., Heidari M.J. Comprehensive analysis of microRNA (miRNA) in cancer cells. Cellular, Molecular and Biomedical Reports. 2023; 3(2): 89-97.
21. Keleş R., Şen A., Ertaş B., Kayali D., Eker P., Şener T.E., Doğan A., Çetinel Ş., Şener G. The effects of Urtica dioica L. ethanolic extract against urinary calculi in rats. Journal of Research in Pharmacy. 2020; 24(2): 205-217.
22. Das S., Vasudeva N., Sharma S. Kidney disorders and management through herbs: A. The Journal of Phytopharmacology. 2019; 8(1): 21-27.
23. Sharma Y. Ginger (Zingiber officinale)-an elixir of life a review. The Pharma Innovation. 2017; 6(11): 22-27
24. Gudbjartsson D.F., Holm H., Indridason O.S., Thorleifsson G., Edvardsson V., Sulem P., de Vegt F., d'Ancona F.C., den Heijer M., Franzson L. Association of variants at UMOD with chronic kidney disease and kidney stones—role of age and comorbid diseases. PLoS Genetics. 2010; 6(7): e1001039.