**PHYTOTHERAPY OF URINARY CALCULI: THE MASS REDUCTION OF CALCIUM OXALATE STONES IN VITRO BY THE AQUEOUS EXTRACT OF URTICA DIOICA L.**

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**ABSTRACT**

The purpose of this study is to evaluate in vitro the effect of an aqueous extract of Urtica dioica on the dissolution of oxalocalcic type kidney stones at the mesoscopic scale. The weight of the stones used in our experiment varied from: 0.0625g to 1.1049g. Type identification of kidney stone samples is performed by Infrared spectroscopic analysis. The presence of carboxylate ion of calcium oxalate is highlighted by absorption bands in the 1312.41 cm-1 and 1606.36 cm-1 areas. The aqueous extract of the aerial part of the plant Urtica dioica was prepared by infusion for 30 min of 5g of powder in 100 ml of saline solution (9 g/L of NaCl), previously brought to the boiling point, and there was then filtered. The stones were left in contact with the extract for 6 weeks, under constant magnetic stirring in 50 ml of aqueous extract. Kinetic evolution of the pH and the evaluation of the dissolution capacity of the extracts were carried out every week. The results obtained are very satisfactory where we observe a loss of mass which increases with time in order to reach a rate of 63%. This confirms the dissolution of stones and the increase of pH by the effect of the presence of the base of calcium oxalate in the aqueous medium. According to this study, we emphasize the need to suggest Urtica dioica as a means to reduce the occurrence of this urological disease and to establish less expensive tests and treatments.

**Keywords**:Kidney stones, Calcium oxalate, Urticadioica, Dissolution rate.

**INTRODUCTION**

Renal lithiasis is a disease that affects from 4 to 20% of the population in different countries, characterized by the formation of crystals in the kidneys**(El Habbani et *al*., 2021**). It is a multifactorial disease due to a sequence of physicochemical steps, in particular supersaturation, nucleation, growth, aggregation, and retention in the renal tubules**(Ammork et *al*., 2020).**The recurrence rate of this pathology is 70-81% in men compared to 47-60% in women **(Annand et *al*., 2021).**Extracorporeal shock wave lithotripsy (ESWL) is the treatment of choice for thisdisease, but with sequelae such as acute kidney injury and

non-removal of fragmentation debris (**Parveen et *al*., 2021).** In Algeria, alternative medicine is still widely used by the population with the use of medicinal plants based on recommendations made here and there. Therefore, we proposed to evaluate in vitro the effect of an aqueous extract of Urtica dioica on the dissolution of oxalocalcic type kidneystones.

**METHODS**

**Urinary stones**

Samples of kidney stones were eliminated spontaneously in patients suffering from urinary lithiasis, after shock wave treatment at the urology department of the University Hospital of Sidi-Bel-Abbès. These stone samples were washed with distilled water, air-dried on filter paper, and stored in sterile containers. The weight of the stones used in our experiment varied from: 0.0625g to 1.1049g. Type identification of kidney stone samples is performed by Infrared spectroscopic analysis on a Mattson Genesis II FTIR instrument. The samples were processed as KBr pellets**(Singh ,2008).**

**Plant material**

The plant studied belongs to the Urticaceae family under the scientific name: Urtica dioica. We are interested in this study in the aerial part of the plant. The plant is harvested at the level of the forest of the Ex-ITMA, wilaya of Sidi-Bel- Abbés, during the flowering period: February-April 2019. The aerial part (leaves) was dried at room temperature and protected from light for a period of 4 months; then reduced to powder and sieved. The powder is stored in an airtight glass bottle protected from light. The identification of the plant Urtica dioica was done with the help of a specialist in Botany of the laboratory of Water Resources and Environment at the University of SAIDA.

**Extraction process**

Our experimental work was carried out at the laboratory of Agronomic Sciences, Faculty of Natural Sciences and Life, and laboratory organic physical chemistry and Macromolecular LCPOM of the University Djillali Liabés of Sidi-Bel-Abbes.The extract of Urtica dioica leaves was prepared by infusion for 30 min of 5g of powder in 100 ml of a physiological aqueous solution of sodium chloride (NaCl) at 9g /L, previously brought to boiling point **(Hannache et *al.*, 2012).** The extract was then filtered.

**Experimental device**

The aqueous extract of the plant (Urtica dioica) is used to demonstrate, in vitro, the dissolving power of urinary stones at the mesoscopic scale, by putting the stones in the presence of 50 ml of each sample at room temperature under constant magnetic stirring (130 rpm). The stones were left in contact with the extract for 6 weeks, which is the recommended treatment period in traditional medicine **(Meiouet et *al*., 2011)**.Each week, the stones are removed from the different solutions, washed with distilled water, dried at 40°C for 18 h in an oven, and then weighed with a 10-4 g precision balance to evaluate the mass loss. The sample is put back into the extract with the same conditions to count the second week, until the sixth week of the experiment. The study is performed on three samples of the same type of kidney stones. In parallel, the same experiment was performed, where physiological saline water (NaCl 9g/l) was used instead of Urtica dioica extracts. Furthermore, the dissolution of the urinary calculi in the extract is monitored by evaluating the pH values during six weeks of immersion with agitation and at room temperature. The pH ismeasured weekly using a pH meter with a 10-4g precision scale.

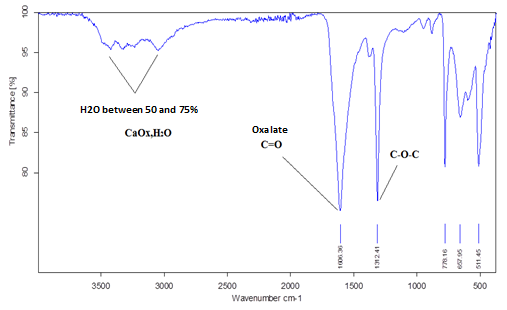
The Ca+2 and Mg+2 ions were determined according to the method described by **(Rodier et *al*., 2009)**, before and after the six weeks contact of calcium oxalate stones with the aqueous extract, by an EDTA solution containing ethylene diamine tetraacetate ion in the basic medium of ph=10.

**RESULTS**

**Analysis of kidney stones**

The presence of oxalate is highlighted by absorption bands in the 1600 cm-1 and 1300 cm-1 areas (Figure 1). The oxalocalcic dependent species is hyperoxaluria represents the major cause of urinary lithiasis, among its causes,is the excessive consumption of food rich in oxalate as tea.

The spectrum below shows two characteristic bounds, the first one around 1312.41 cm-1 of the C-O-C bond due to the presence of the carboxylate ions and the second one around 1606.36cm-1 of the carbonyl function C=O which confirms the presence of the carboxylate ion of calcium oxalate. The large bung presented between 3000 and 3500cm-1 is due to the presence of humidity from 50 to 75%. The IR spectrum data confirms that our urinary stone samples used in this study are of the oxalocalcic type.

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**Figure 1*FT-IR*** analysis of urinary stones

**Kinetic evolution of ph**

The pH values are obtained at the beginning and at the end of the experiment for each week during the whole duration of our study(Figure 2).The urinary stone samples used in this study are of the calcium oxalate type.

**Figure 2p**H evaluation

We observe a very important increase in the pH values and the highest value of 9,31 where we find the greatest efficiency. The pH in physiological water remains almost constant where we can say that the properties do not change during the experiment (no dissolution of kidney stones in physiological water).

**Evaluation of the dissolution capacity of extracts**

The dissolution capacity of the extracts (A%) was evaluated by the mass lost from the samples of the kidney stones by the effect of the tested extracts in a period of one week. The formula used to calculate the dissolution capacity in our extract (A%) is:

: The dissolution rate of the kidney stones

: The lost in a week

: The mass of the initial sample0

The different results of the dissolution rates in the experimental medium with the sample masses of the kidney stonesare shown in the figure 3.

**Figure 3Dissolution capacity of extracts**

The results show a rapid evaluation for the C2 stone sample, a rate of 50% is obtained in the third week and the maximum in the fourth week. The sample C1 has a good dissociation but the dissolution takes five weeks with a rate of 63%. Sample C3 does not give good results because it is very bulky.

The results of the measurements of the concentration of calcium Ca2+ and magnesium Mg2+ ions, in the extract solution before and after the emersion of the stones obtained are presented in the table 1:

**Table 1**Concentration of Ca2+ and Mg2+ ions

|  |  |  |
| --- | --- | --- |
|  | [Ca2+] + [Mg2+] mmol/l | |
| Before | After |
| Aqueous extract of Urtica dioica | 15 | 900 |

**DISCUSSION**

Urinary lithiasis ranks third among the most common urologic diseases **(Wigner et *al*., 2022).** With a wide range of sizes, kidney stones can have a diameter ranging from a few millimeters to several centimeters **(Idm’hand et *al*., 2019).**These require other treatments and techniques such as ESWL **(Kim et *al*., 2021).** On the other hand, **SALAN *et al.*(2018)** stated that ESWL is less effective for calcium oxalate monohydrate (COM) stones. Herbal medicine is an integral part of the cultural practices of our local communities, which constitute an important heritage for the management of urological diseases **(Bencheikh *et al.,*2021;El Guerrouj *et al.,* 2021).** According to the WHO (World Health Organization), 80% of the world's population uses herbal medicine **(D Waghmare, 2020).** Given that health services are generally inaccessible to rural populations living far from major cities. In recent years, various plants and traditional medicines have been proposed to reduce calcium oxalate kidney stones, which can be useful in its prevention and treatment **(Afkari *et al.,* 2019).** According to recent ethnobotanical studies in Algeria, the infusion of leaves is the most used practice **(Benarba *et al.,*2021;Zatout *et al.,* 2021).** As well, pharmacological research on medicinal plants used in anti-lithiasis therapy has revealed their therapeutic potential in vitro models **(Manasa Reddy *et al.,* 2018)**. The complete mechanisms of actions of medicinal plants are not well known, but herbal medicine is more effective in the treatment of urolithiasis **(Chandel *et al.,* 2019).**The possible mechanism by which Urtica dioica affects calcium oxalate could be the result of several valuable chemical compounds, such as phenolic compounds (such as chlorogenic acid, ferulic acid, ellagic acid, naringin, myricetin, rutin), flavonoids ( such as kaempferol), tannins, coumarins (e.g., scopoletin), lignans (secoisolariciresinol, 9,9-bisacetyl-neo-olivil and their glucosides), phytosterols (e.g., 𝛽-sitosterol), fatty acids, polysaccharides, isolectins, triterpenic acids and monoterpendiols**(Taibi *et al.,* 2021).** Studies have shown that the main bioactive of Urtica dioica are flavonoids, anthocyanins, and saponins **(Nirumand*et al.,* 2018)**, which could inhibit calcium and oxalate deposition and crystal growth by disintegrating mucoproteins **(Al-Assaf et *al*., 2020).**In our study, the dissolution or degradation of the stones in the medium leads to the release of calcium oxalate ions of basic character. The presence of oxalate will increase the pH of the medium. The experimental data show a positive evaluation of pH with the loss of mass of the studied urinary stones. Tannins and polyphenols inhibit CaOx crystal formation and dissolve preformed CaOx crystals by promoting calcium complexation **(Sweta *et al.,* 2018).** The results obtained justify well the evaluation of the dissolution of the stones in the extract of our plant. We observe a very important increase in the concentration of Ca2+ and Mg2+ ions in the solution of the extract after emersion of the stones during the six weeks. Flavonoids could effectively inhibit CaOx stone formation in vitro, correlating with their diuretic, antioxidant, and anti-inflammatory properties **(Zeng *et al.,* 2019).** According to the study of **Khaled Taïbi *et al.* (2021)** in the Tiaret region of Algeria, the medicinal benefits of Urtica dioica are related to its nutritive, depurative, diuretic, antioxidant, anti-inflammatory, and stimulating effects. Antioxidant therapy could be one of the effective methods to prevent the nucleation and fixation and growth of calcium oxalate crystals **(Keles *et al.,* 2020).** The process of calcium oxalate crystallization is of great interest in medicine, it is the main component of 75-80% of kidney stones **(Khan *et al.,* 2021).** A more negative crystallite surface inhibits the growth and agglomeration of urinary crystals (Sun *et al.,* 2017). The study of **Polat (2019)** shows that Urtica dioica extracts can reduce the size of calcium oxalate crystals leading to the formation of COD (calcium oxalate dihydrate: Ca-C2O4-2H2O, weddellite) and inhibiting the growth and aggregation of COM (calcium oxalate monohydrate: CaC2O4-H2O, whewellite) crystals. Furthermore,**Polat (2019)** indicates that the surface of the crystals becomes negative due to the coverage of the crystal surface by the negatively charged Urtica dioica ions, which induces the increase of the zeta potential over time.

**CONCLUSION**

The present study shows the efficacy of the aqueous extract of Urtica dioica in dissolving oxalocalcic type urinary stones in vitro. Therefore, we emphasize the need to suggest Urtica dioica as a means to reduce the occurrence of this disease and to establish less expensive tests and treatments. However, further studies are needed to determine the mechanism of action of this plant in preventing kidney stone formation in vivo.

**REFERENCES**

Afkari, R., Feizabadi, M. M., Ansari-Moghadam, A., Safari, T., & Bokaeian, M. (2019). Simultaneous use of oxalate-degrading bacteria and herbal extract to reduce the urinary oxalate in a rat model: A new strategy. International Braz j Urol, 45(6), 1249–1259. http://dx.doi.org/ 10.1590/s1677-5538.ibju.2019.0167

Ahmed, S., Hasan, M. M., Khan, H., Mahmood, Z. A., & Patel, S. (2018). The mechanistic insight of polyphenols in calcium oxalate urolithiasis mitigation. Biomedicine & Pharmacotherapy, 106, 1292–1299. http://dx.doi.org/ 10.1016/j.biopha.2018.07.080

Al-assaf, I. N., Al-Dabbagh, A. G., Al-Abachi, R. Y., & Al-Bajari, S. A. (2020). Protective role of Urtiea dicica on the pathological alteration induced by ethylene glycol in male rabbits. Systematic Reviews in Pharmacy, 11(12), 1180-1183.

Ammor, K., Mahjoubi, F., Bousta, D., Elhabbani, R., & Chaqroune, A. (2020). In vitro litholytic activity of extracts and phenolic fractions of some medicinal plants on urinary stones. Mediterranean Journal of Chemistry, 9(6), 468–477. http://dx.doi.org/ 10.13171/mjc9602001101135ka

Anand, D., Chandrasekar, R., & Sivagami, B. (2021). A critical review on Antiurolithiatic activity of Bioactive Phytoconstituents. Research Journal of Pharmacognosy and Phytochemistry, 13(2), 95-100. http://dx.doi.org/ 10.52711/0975-4385.2021.00015

Bawari, S., Negi Sah, A., & Tewari, D. (2018). Antiurolithiatic Activity of Daucus carota: An In vitro Study. Pharmacognosy Journal, 10(5), 880–884. http://dx.doi.org/ 10.5530/pj.2018.5.148

Belhouala, K., & Benarba, B. (2021). Medicinal Plants Used by Traditional Healers in Algeria: A Multiregional Ethnobotanical Study. Frontiers in Pharmacology, 12. http://dx.doi.org/ 10.3389/fphar.2021.760492

Bencheikh, N., Elbouzidi, A., Kharchoufa, L., Ouassou, H., Alami Merrouni, I., Mechchate, H., … Elachouri, M. (2021). Inventory of Medicinal Plants Used Traditionally to Manage Kidney Diseases in North-Eastern Morocco: Ethnobotanical Fieldwork and Pharmacological Evidence. Plants, 10(9), 1966. http://dx.doi.org/ 10.3390/plants10091966

Chandel, V. K., Jain, S., & Choubey, A. (2019). An Overview on Phyto-molecules and Screening Method of Antiurolithiatic Activity. Journal of Drug Delivery and Therapeutics, 9(4-A), 848-857. http://dx.doi.org/ 10.22270/jddt. v9i4-A.3709

D. Waghmare, S. (2020). Ethnobotanical Survey on Antiurolithiatic Activity of Some Medicinal Plants. International Research Journal on Advanced Science Hub, 2(Special Issue ICARD), 268–275. http://dx.doi.org/ 10.47392/irjash.2020.131

Guerrouj, B. E., Bencheikh, N., Bouhrim, M., Kharchoufa, L., Ouassou, H., & Imtara, H. (2021). Attitude and awareness of medicinal plants in treatment of kidney lithiasis in eastern Morocco: a retrospective study. Herba Polonica, 67(2), 17–28. http://dx.doi.org/ 10.2478/hepo-2021-0011

El Habbani, R., Lahrichi, A., Sqalli Houssaini, T., Kachkoul, R., Mohim, M., Chouhani, B. A., & Chaqroune, A. (2021). In vitro mass reduction of calcium oxalate urinary calculi by some medicinal plants. African Journal of Urology, 27(1). http://dx.doi.org/ 10.1186/s12301-021-00132-2

Hannache, B., Bazin, D., Boutefnouchet, A., & Daudon, M. (2012). Effet des extraits de plantes médicinales sur la dissolution des calculs rénaux de cystine in vitro : étude à l’échelle mésoscopique. Progrès En Urologie, 22(10), 577–582. http://dx.doi.org/ 10.1016/j.purol.2012.06.001

Idm'hand, E., Msanda, F., & Cherifi, K. (2019). Étude ethnobotanique des plantes médicinales utilisées dans le traitement de la lithiase urinaire dans la province de Tarfaya (Maroc). International Journal of Innovation and Applied Studies, 26(3), 711-719.

KELEŞ, R., ŞEN, A., ERTAŞ, B., KAYALI, D., & EKER, P. (2020). The effects of Urtica dioica L. ethanolic extract against urinary calculi in rats. Journal of Research in Pharmacy, 24(2), 205–217. http://dx.doi.org/ 10.35333/jrp.2020.137

Khan, A., Bashir, S., & Khan, S. R. (2021). Antiurolithic effects of medicinal plants: results of in vivo studies in rat models of calcium oxalate nephrolithiasis—a systematic review. Urolithiasis, 49(2), 95–122. http://dx.doi.org/ 10.1007/s00240-020-01236-0

Kim, C. H., Chung, D. Y., Rha, K. H., Lee, J. Y., & Lee, S. H. (2020). Effectiveness of Percutaneous Nephrolithotomy, Retrograde Intrarenal Surgery, and Extracorporeal Shock Wave Lithotripsy for Treatment of Renal Stones: A Systematic Review and Meta-Analysis. Medicina, 57(1), 26. http://dx.doi.org/ 10.3390/medicina57010026

Manasa, R.J., Prathyusha, K., Himabindhu, J., & Ramanjaneyulu, K. (2018). Evaluation of in vitro antiurolithiatic activity of Mentha piperita. Journal of Pharmaceutical Sciences and Medicine , 3(8), 22-28.

Nirumand, M., Hajialyani, M., Rahimi, R., Farzaei, M., Zingue, S., Nabavi, S., & Bishayee, A. (2018). Dietary Plants for the Prevention and Management of Kidney Stones: Preclinical and Clinical Evidence and Molecular Mechanisms. International Journal of Molecular Sciences, 19(3), 765. http://dx.doi.org/ 10.3390/ijms19030765

Meiouet, F., El Kabbaj, S., & Daudon, M. (2011). Étude in vitro de l’activité litholytique de quatre plantes médicinales vis-à-vis des calculs urinaires de cystine. Progrès en urologie, 21(1), 40-47.http://dx.doi.org/ 10.1016/j.purol.2010.05.009

Parveen, R., Wadud, A., Shamsi, S., & Parveen, S. (2021). Antilithiatic activity of a non-pharmacopoeial Unani formulation in chemically induced urolithiasis in rats. Journal of Complementary and Integrative Medicine, 18(4), 685–694. http://dx.doi.org/ 10.1515/jcim-2020-0426

Polat, S. (2019). An in vitro evaluation of the effects of Urtica dioica and Fructus Urtica Piluliferae extracts on the crystallization of calcium oxalate. Journal of Crystal Growth, 522, 92–102. http://dx.doi.org/ 10.1016/j.jcrysgro.2019.06.019

Rodier, J., Legube, B. & Merlet, N. (2009) : L’analyse De L’eau (9 Edition). Ed Dunod. Paris. 249 pp.

Singh, I. (2008). Renal geology (quantitative renal stone analysis) by “Fourier transform infrared spectroscopy.” International Urology and Nephrology, 40(3), 595–602. http://dx.doi.org/ 10.1007/s11255-007-9327-2

Taïbi, K., Aït Abderrahim, L., Boussaid, M., Taibi, F., Achir, M., Souana, K., … Nait Said, K. (2021). Unraveling the ethnopharmacological potential of medicinal plants used in Algerian traditional medicine for urinary diseases. European Journal of Integrative Medicine, 44, 101339. http://dx.doi.org/ 10.1016/j.eujim.2021.101339

Wigner, P., Bijak, M., & Saluk-Bijak, J. (2022). Probiotics in the Prevention of the Calcium Oxalate Urolithiasis. Cells, 11(2), 284. https://doi.org/10.3390/cells11020284

Sun, X.-Y., Xu, M., & Ouyang, J.-M. (2017). Effect of Crystal Shape and Aggregation of Calcium Oxalate Monohydrate on Cellular Toxicity in Renal Epithelial Cells. ACS Omega, 2(9), 6039–6052. http://dx.doi.org/ 10.1021/acsomega.7b00510

Zatout, F., Benarba, B., Bouazza, A., Babali, B., Nacer Bey, N., & Morsli, A. (2021). Ethnobotanical investigation on medicinal plants used by local populations in Tlemcen National Park (extreme North West Algeria). Mediterranean Botany, 42, e69396. http://dx.doi.org/ 10.5209/mbot.69396

Zeng, X., Xi, Y., & Jiang, W. (2018). Protective roles of flavonoids and flavonoid-rich plant extracts against urolithiasis: A review. Critical Reviews in Food Science and Nutrition, 59(13), 2125–2135. http://dx.doi.org/ 10.1080/10408398.2018.1439880