Research Article

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ANTIUROLITHIATIC ACTIVITY OF AQUEOUS BARK EXTRACT OF *CRATEVA MAGNA* LOUR. (DC).

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ABSTRACT

The present work was aimed to investigate the In vivo antiurolithiatic activity of aqueous bark extract of *Crateva magna* Lour. (DC). The *In vivo* antiurolithiatic activity was carried out by Molybdate U.V., OCPC, Calmagite, Erba diagnostics Mannheim Gmbh methods. The antiurolithiatic activity of Aqueous extract of *Crateva magna* Lour. (DC) bark extract in 100 mg/kg b. wt and 200 mg/ kg/b wt at 28 days' administration was compared with standard drug cystone. Urine, Serum and the Histopathological examinations showed that the treatment with *Crateva magna* Lour. (DC) aqueous bark extract decreased the number and size of calcium oxalate deposits in different parts of the renal tubules and also prevented damages to the tubules and calyxes. This is the first study demonstrating the antiurolithiatic activity of aqueous bark extract of *C. magna.* This study also provides a significant basis for further isolation and characterization of bioactive compounds from *C. magna*.

Key words: *Crateva magna* Lour. (DC). calcium oxalate, antiurolithiatic

INTRODUCTION

Urolithiasis (from Greek *oûron*, "urine" and *lithos*,"stone") is the condition where urinary calculi are formed or located anywhere in the urinary system, or the process of formation of stones in the kidney, bladder or ureters. In the global countries, people suffering from urinary stone problem, are increasing. Approximately 50% of patients with previous urinary calculi have reappearance within 10 years. Stone disease is 2-3 times more common in males than in females. Urinary stone disease is a common disorder estimated to occur in approximately 12% of the population, with a recurrence rate of 70–81% in males, and 47–60% in females[1].Not only the humans but also animals and birds also suffer from urinary stone problem [2].

Urolithiasis occurs in patients at the age between 20–49 years of age. Urinary tract calculi are far less common in native Americans as compared to the prevalence in Asians and Whites, Africans, African Americans and some natives of Mediterranean regions. Urolithiasis occurs more frequently in hot, arid than in temperate regions[3]. The areas of high incidence of urinary calculi include Mediterranean countries, Scandinavian countries, Central Europe, British islands, Northern Australia, Northern India and Pakistan[2]. In India, 15% of the population of Northern India suffers from kidney stones. Nearly, 12% of the population is expected to have urinary stones, out of which 50% may end up with loss of kidneys or renal damage. Few cases of urinary calculi are found in Southern India, which may be due to regular dietary intake of tamarind [4].

Calcium containing stones are the most common comprising about 75% of all urinary calculi, which may be in the form of pure calcium oxalate (50%) or calcium phosphate (5%) and a mixture of both (45%) [5]followed by magnesium ammonium phosphate (Struvite) to an extent of 15-20%, uric acid 10% and cystine 1% [6]. The stone formation requires supersaturated urine which also depends on urinary pH, ionic strength, solute concentration and complexions. Various substances in the body have an effect on one or more of the above processes, thereby influencing a person's ability to promote or prevent stone formation [7]. Kidney stone can be composed of variety of substances, these substances in the body have an effect the above stone forming processes and thereby influencing a person's ability of the body to promote or prevent stone formation (Basavaraj *et al*., 2007).

In modern medicine only three effective drugs namely Allopurinol, D-Pencillamine and acetazolamide are available against cystine and uric acid stones. Several drugs such as thiazides, cellulose phosphates, magnesium oxide and pyridozine etc. have been tried, but there is no satisfactory effect in dissolving the urinary stones [8]. Therefore, it is worthwhile to look for an alternative to these means by using medicinal plants [9].

Since ancient times Indian medicine ''Ayurveda'' recommends several medicinal plants for the successful treatment of urolithiasis [10]. They are effective with fewer side effects and are also inexpensive. Hence, the Indian plants are constantly being evaluated for possible antilithiatic effects in a systematic manner [11]. On the other hand, traditional system of Indian medicine Ayurveda recommends *Crateva magna* to be antilithiatic, but scientific data supporting this statement is still lacking. *Crateva magna* belongs to the family Capparaceae that represent about 33 genera and 700 Species. The plant is nontoxic, available in rural areas, culturally acceptable, and found to be effective for urinary disease and disorders. Hence the present study was undertaken to assess antiurolithiatic activity of *Crateva magna*.

The bark and root extracts have been used to cure cough, obesity, blood disorders, rheumatoid arthritis and heart diseases. The external application of *C. magna* leaf paste and the Oral consumption of leaf juice is used in the treatment of piles [12]. The whole plant is used for the medical purpose such as diuretic,

laxative, thanotropic, antirheumatic, antiperiodic, bitter tonic, rubefacient and counterirritant [13]. The plant used as an antidote in snake bite and the bark used for kidney and bladder stones, contraceptive and cytotoxic, fever, vomiting and gastric infections [14,15]. Fruit juice, leaves and bark are useful to cure snakebite, infected wound and cuts. It increases appetite and controls other skin diseases [16]. *Crateva magna* is a potent medicinal plant in the Indian systems of medicine. Traditionally used for inflammation, fever, arthritis, bronchitis, urinary calculi and cough.

It is also useful in disorders of urinary organs, urinary tract infections, pain, intermittent fever, asthma, bronchitis, renal and vesicle calculi. Bark yields triterpenoids (α and β- amyrin, ceryl alcohol, lupeol, friedelin, betulinic acid, 4-taraxasterol, lupenone), flavonoids (rutin, catechin, quercetin) and alkaloids [17, 18].

MATERIALS AND METHODS

Utilisation of resources

Laboratory

Experiments were carried out in different laboratories based on the study requirements. The pharmacognostic, preliminary phytochemical analysis and in vitro crystallization studies were carried out in the research lab of the Department of Botany, Avinashilingam University for Women, Coimbatore, Tamil Nadu, India. In vivo analysis was carried out at the Department of Pharmacy, KMCH Pharmacy College, Coimbatore, Tamil Nadu, India.

Chemicals

All the chemicals utilized for the research were of analytical grade from Sigma Chemicals and Co (St. Louis, MO), Merck (Darmstadt, Germany) and HiMedia Laboratories (Mumbai, India) unless otherwise specified.

Sample collection and identification

The fresh plant materials of *Crateva magna* (Lour.) DC. were collected from Singanallur (Coimbatore district) in Tamil Nadu, India. The collected plant material was identified and their authenticity was confirmed by comparing the voucher specimen at the herbarium of Botanical Survey of India, Southern Circle, Coimbatore, Tamil Nadu, India. The herbarium register number was BSI/SRC/5/23/2013-14/Tech/1019

Processing of the plant material

Freshly collected plant material was cleaned to remove adhering dust, divided into small parts and then dried under shade. The dried samples were powdered and used for further studies.

Successive solvent extraction

The air dried, powdered plant materials was macerated using hot water with occasional stirring for 24 h and the aqueous extract was filtered. The extracts were freeze dried and stored in desiccators until further analysis.

Selection of animals for *in vivo* studies

Healthy adult male wistar albino rats weighing about 150 to 200 g were collected from animal breeding centre, Kerala Agricultural University, Mannuthy, Thrissur, Kerala, India. The ethical committee permission license number is KMCRET/Ph.D/2/2013-14. The rats were kept in properly numbered large polypropylene cages with stainless steel top grill having facilities for pelleted food. The animals were maintained in 12h light and dark cycle at 28ºC ± 2ºC in a well ventilated animal house under natural conditions and they were acclimatized to laboratory conditions for 10 days prior to the commencement of the experiment. The animals were fed with standard pelleted diet. All animal experiments were performed according to the ethical guidelines suggested by the Institutional Animal Ethics Committee (IAEC). Paddy husk was used as bedding material and changed twice a week.

Toxicity study

The acute oral toxicity study was carried out as per the 423guideline set by Organisation for Economic Co-operation and Development (Ecobichon,1997). The aqueous extract was administered at the dose level of 2000mg/kg and observed mortality after 24 h. One tenth of the median lethal dose (LD_{50}) was taken as an effective dose.

Ethylene glycol- induced urolithiasis

The male wistar albino rats were divided in five groups each of six animals.

Group I: Control rats - received normal pelleted diet

Group II: Urolithiasis induced rats - received 1% ethylene glycol in water for 28 days

Group III: Standard drug cystone treated rats: urolithiasis induced rats received cystone (100 mg/kg body weight) by oral administration for subsequent 28 days at a rate of 1.0 ml / rat / day.

Group IV: Plant drug treated rats - urolithiasis induced rats received C.magna bark extract (100 mg / kg body weight) by oral administration for subsequent 28 days at a rate of 1.0 ml / rat / day

Group V: Plant drug treated rats - urolithiasis induced rats received C.magna bark extract (200 mg / kg body weight) by oral administration for subsequent 28 days at a rate of 1.0 ml / rat / day. The extract and standard were given once daily by oral route.

Analysis of urine samples

At the end of the treatment, all the animals were kept in individual metabolic cages and 24 h urine samples were collected and measured on 28th day. Animals had free access to drinking water during the urine collection period. A drop of concentrated hydrochloric acid was added to the collected urine before being stored at 4ºC. The urine was analysed for protein, calcium, phosphate, magnesium, uric acid, urea, oxalate and creatinine and blood urea nitrogen using commercially available kits (Molybdate U.V., OCPC, Calmagite, Erba diagnostics Mannheim Gmbh methods).

Analysis of blood samples

The blood was collected from the retro-orbital sinus under anaesthetic condition and serum was separated by centrifugation at 10,000 rpm for 10 minutes and analysed for protein, calcium, phosphate, magnesium, uric acid, urea, oxalate, creatinine and blood urea nitrogen using commercially available kits (Molybdate U.V., OCPC, Calmagite, Erba diagnostics Mannheim Gmbh methods).

Analysis of kidney sample

The animals were sacrificed under anaesthesia and after dissection; both kidneys were removed and washed with cold

0.15 M KCl. The right kidney was minced with scissors and then homogenized in 0.15 M KCl, using Remi's glass homogenizer. The homogenate was centrifuged at 1500 rpm for 10 minutes using refrigerated research centrifuge, to remove the cell debris. The supernatant was used for estimation of calcium, oxalate and phosphate using commercially available kits (Molybdate U.V. OCPC methods).

Histopathological study

To confirm the incidence of lithiasis and its healing, the kidneys were subjected to Histopathological study. The left kidney was fixed in 10% neutral buffered formalin, processed in a series of graded alcohol and xylene, embedded in paraffin wax; cut at 5 µm intervals and the slices were stained with haematoxylin and eosin. The slides were examined for renal tubular necrosis and presence of calcium oxalate crystals under binocular microscope.

Statistical analysis

All the statistical comparison between the groups were made by means of One Way Analysis of Variance (ANOVA) and followed by Dunnett's Multiple Comparison test. The values were considered significantly different at $P < 0.05$. The data expressed were Mean ± standard error of mean (SEM).

RESULTS

Animals body weight and wet kidney weight

The body weights were recorded before the commencement of treatment. The body weight and kidney weight of animals at the end of 28 days of treatment period are summarized in Figure 1 and 2. In the treatment with the aqueous bark extract of *C. magna*, the animals gained significant body weight as compared to ethylene glycol treated groups. The wet kidney weights were taken and compared between the groups. The wet kidney weight was significantly increased in the ethylene glycol treated groups (Group II), which was almost decreased in the plant extract treated groups.

A decrease in body weight in the ethylene glycol treated animals observed in the present study indicated the stone formation. However, cystone and plant extract treated groups showed less kidney weight, when compared to EG treated group. The cystone and plant extract treated groups showed diuretic activity, which might have prevented from stone aggregation, so animals were relieved from pain. This might be the reason for increased food consumption, which led to significant increase in body weight

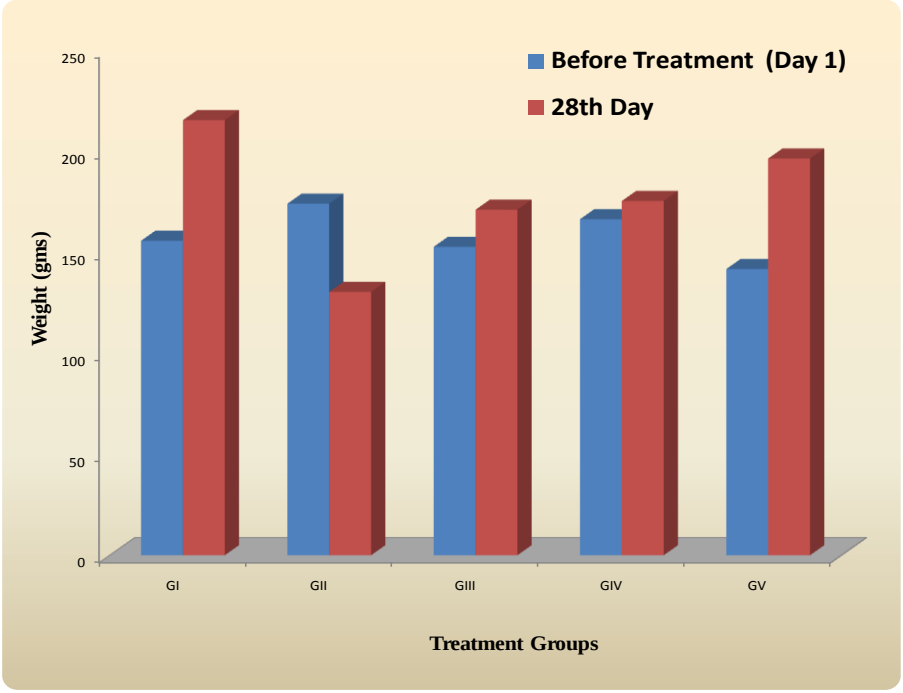

Figure 1: Effect of *C. magna* aqueous bark extract on animal body weight in control and experimental groups

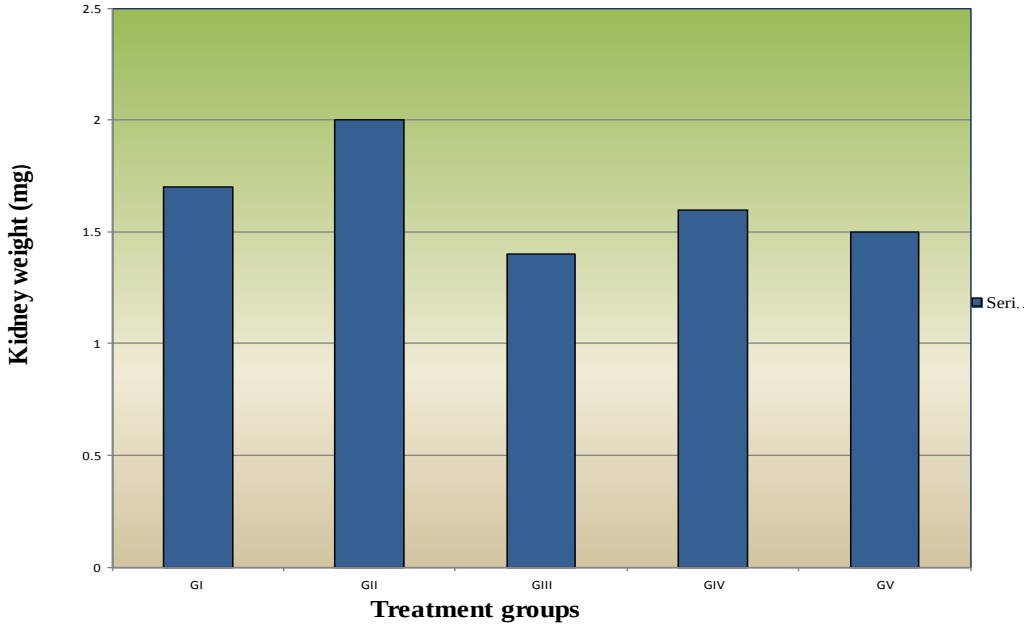

Figure 2: Effect of *C. magna* aqueous bark extract on animal kidney weight in control and experimental groups

Effect of aqueous bark extract of *C.magna* on calcium, magnesium, phosphate and oxalate contents in urine and serum parameters on control and experimental animals

Table 1 represents the urine mineral constituents including calcium, magnesium, phosphate and oxalate. Calcium, phosphate and oxalate play a vital role in renal calculogenesis. In ethylene glycol induced rats (group II) the levels of urine calcium, phosphate and oxalate (20.13±0.06, 7.60±0.56, 6.83±0.40 mg/dl respectively) were significantly high, whereas the level of magnesium (3.50±0.10) was significantly decreased.

There was significant reduction in the contents of calcium, phosphate and oxalate in group V, aqueous bark extract treated animals (19.47 ±0.40, 7.33 ±0.61,3.33 ± 3.23 mg/dl respectively), whereas magnesium content (2.20±0.10 mg/dl) was significantly decreased. Table 2 represents the serum calcium, phosphate and oxalate were maximum in group II (21.50±1.13, 14.81±0.51, 4.00 ±0.10 mg/dl respectively). The aqueous bark extract treated group V showed 20.00 ±0.23, 13.61±0.59 and 2.0±0.10 mg/dl respectively. This results give a supportive evidence for the antiurolithiatic activity of aqueous bark extract of *C.magna*, which is similar to that of standard drug cystone.

Table 1: Effect of *Crateva magna* Lour. (DC). aqueous bark extract on urine parameters in control and experimental animals

Group	Protein (g/dl)	Magnesium (mE/l)	Calcium (mg/dl)	Phosphate (mg/dl)	Urea (mg/dl)	Uric Acid (mg/dl)	Creatinine (mg/dl)	Oxalate (mg/dl)
GI	3.6 ± 0.10	4.73 ± 0.06	19 ± 0.10	3.63 ± 0.21	6.20±0.10	11.37 ±0.32	0.80 ± 0.10	1.50 ± 0.10
GII	5.3 ± 0.26a**	3.50 ± 0.10a**	20.13±0.06a**	7.60±0.56a**	16.40 ±0.10a**	18.43±0.38a**	0.85 ± 0.21	6.83± 0.40a**
GIII	3.8 ± 0.10b**	4.53 ± 0.38b**	18.97±0.21b**	3.17±0.21b**	11.83±0.06b**	11.47±0.15b**	0.50±0.10b*	1.53±0.18b**
GIV	4.03 ± 0.15b**	4.47 ± 0.32b**	18.3±0.10b**	6.90±0.50b*	13.20±0.10b**	8.17±0.21b**	0.50±0.10b*	3.27±0.21b**
GV	4.47 ± 0.32b**	4.40 ± 0.10b**	19.47±0.40b**	7.33±0.61	7.20±0.17b**	12.50±0.20b**	0.80±0.10	3.33±0.23b**

Values are expressed as mean ± SEM (n=6)

a - Statistical comparisons are made between Group II vs Group I; b - Statistical comparisons are made between Group II vs Group III, IV and V

Significant status *P <0.05 – Significant **P< 0.01- Highly significant

Group I - Control

Group II - Ethylene glycol (EG 1%)

Group III- EG(1%) + Cystone 100mg/kg body weight

Group IV-EG (1%) + Aqueous bark extract 100mg/ kg body weight

Group V -EG(1%)+ Aqueous bark extract 200mg/ kg body weight

Table 2: Effect of *Crateva magna* Lour. (Dc). aqueous bark extract on serum parameters in control and experimental animals

Groups	Protein (g/dl)	Magnesium (mE/l)	Calcium (mg/dl)	Phosphate (mg/dl)	Urea (mg/dl)	Uric Acid (mg/dl)	BUN (mg/dl)	Creatinine (mg/dl)	Oxalate (mg/dl)
GI	0.67 ± 0.06	2.75 ± 0.01	18.20 ± 0.10	11.33 ± 0.45	14.33 ± 0.26	3.67 ± 0.12	18.34 ± 0.33	0.37 ± 0.06	0.57 ± 0.06
GII	1.70 ±0.10a**	2.20±0.10a**	21.50±1.13a**	14.81±0.51a**	21.30±0.33a**	6.33±0.21a**	25.12±0.21a**	2.20±0.17a**	4.00±0.10a**
GIII	0.43±0.06b**	3.43±0.32b**	18.27±0.23b**	10.32±0.42b**	13.27±0.46b**	3.33±0.54b**	19.60±0.25b**	0.37±0.07b**	0.77±0.16b**
GIV	0.90 ±0.10b**	2.90±0.10b**	16.47±0.42b**	12.61±0.66b**	12.20±0.50b**	4.70±0.17ab**	20.10±0.31b**	1.70±0.18b**	2.40±0.44b**
GV	0.83 ±0.06b**	3.90±0.10a**	20.0±0.23b*	13.61±0.59b**	13.07±0.48b**	5.20±0.36ab**	22.60±0.32b**	0.53±0.09b**	2.00±0.10b**

Values are expressed as mean ± SEM (n=6

a - Statistical comparisons are made between Group II vs Group I, b - Statistical comparisons are made between Group III,IV and V vs Group II

Significant status *P <0.05 – Significant **P< 0.01- Highly significant

Group I - Control

Group II - Ethylene glycol (EG 1%)

Group III- EG(1%) + Cystone 100mg/kg body weight

Group IV-EG (1%) + Aqueous bark extract 100mg/kg body weight

Group V -EG(1%)+ Aqueous bark extract 200mg/kg body weight

Concentration of protein, urea, uric acid and creatinine in urine and serum

The urine urea, uric acid and creatinine were significantly increased in ethylene glycol treated group (group II) when compared to control, cystone and plant extract treated groups (group I, III, IV, V) (Tables 11 and 12). The urinary protein, urea, uric acid and creatinine were observed as 5.3±0.26, 16.40±0.10, 18.42±0.38, 0.85±0.21 mg/dl in group II (Ethylene glycol) animals, whereas there was a considerable reduction in these parameters for the extract treated groups (4.47±0.32, 07.20±0.17, 12.50±0.20, 0.80±0.10 mg/dl respectively). There was significant increase in the protein, urea, uric acid and creatinine content in serum as 1.70±0.10, 21.30±0.00, 6.33±0. 21, 2.20±0.17 mg/dl in group II treated animals. The aqueous bark extract treated animals showed 0.83±0.06, 13.07±0.48, 5.20±0.36, 0. 53 ±0.09 mg/dl respectively.

Blood Urea Nitrogen (BUN)

The BUN remarkably increased (25.12 ± 0.21mg/dl) in calculi induced animals. On treatment with aqueous bark extract of *Crateva magna* BUN significantly decreased (22.60±0.32) mg/dl (Table 2)

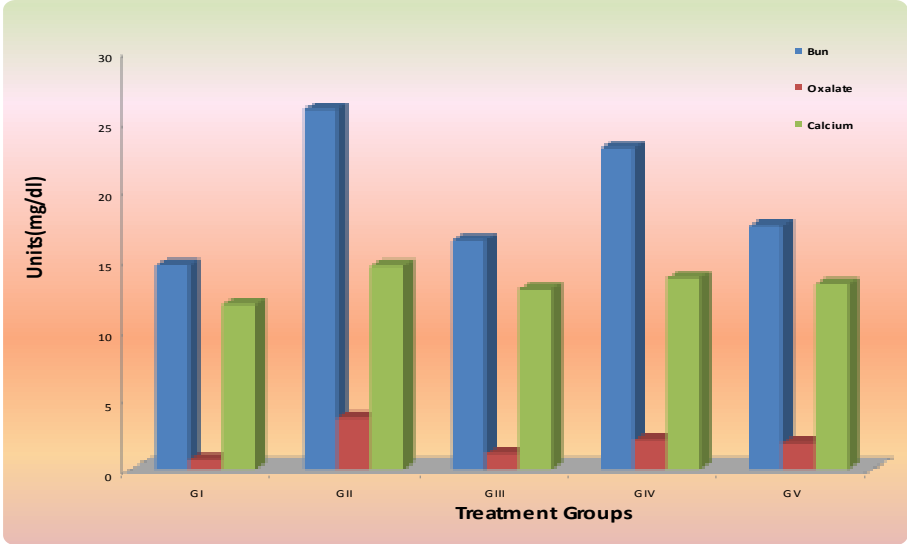

Figure 3: Effect of *Crateva magna* aqueous bark extract on kidney parameters (bun) in control and experimental animal

Histopathological examinations

The examination of kidney sections of control group showed tubules of normal size with single epithelial lining along the margin and no calcium oxalate deposits or other abnormalities in different segments of the nephrons. On the other hand, presence of calcium oxalate crystals, marked dialation of tubules and total degeneration of epithelial lining with inflammatory cells into the interstitial space were observed in ethylene glycol treated group. In cystone treated groups (100mg/kg), no deposition of calcium oxalate crystals was noted in any parts of the renal tubule and showed similar characteristics of the normal control groups. The treatment with *Crateva magna* aqueous bark extract decreased the number and size of calcium oxalate deposits in different parts of the renal tubules and also prevented damages to the tubules and calyxes.

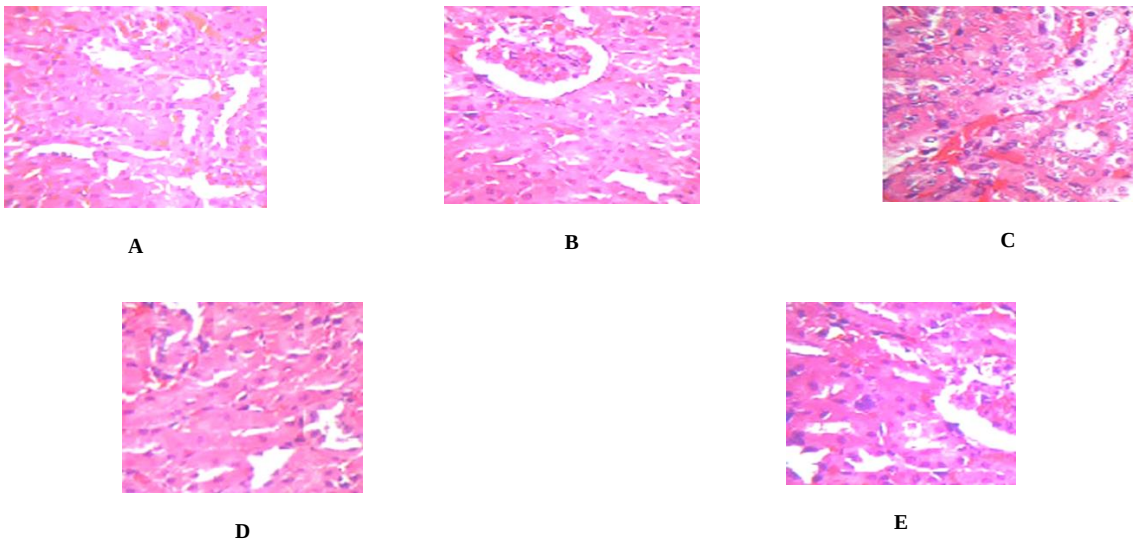

Plate 1: Histopathological photomicrographs of the kidney of different groups of rats at 400x magnifications
(A) Control, (B) Ethylene glycol treated group, (C) Cystone treated group (100mg/kg body weight), (D) Aqueous bark extract treated group (100 mg/kg body weight), (E) Aqueous bark extract treated group (200 mg/kg body weight)

DISCUSSION

Herbal extracts may contain substances that inhibit the growth of CaOx crystals. This property of plants may be important in preventing kidney stone formation; CaOx crystals induced by urinary macromolecules are less tightly bound to epithelial cell surfaces, which are then excreted with urine [19]. The extract may also contain substances that inhibit CaOx crystal aggregation; the agglomeration of particles is a critical step in urinary stone formation, as larger crystals are less likely to pass spontaneously in the urinary tract [20]. If the extract keeps CaOx particles dispersed in solution, they are more easily eliminated. To investigate the Urinary stone formation mechanism, many in vivo models developed in various therapeutic agents on the development and progression of diseases. Most of the earlier studies Rats used commonly to investigate the calcium oxalate deposition in the kidney's. Their genetic biological behavior characteristics closely resemble of human, a process that mimics the etiology of kidney stone formation in humans [21]. For the antiurolithatic study ethylene glycol alone or in combination with other drugs are used for crystal deposition [22].

The ethylene glycol treated animals found pain their stomach, so animals not able to consume food and there by decrease in their body weight. However, cystone and plant extract treated groups showed less kidney weight, when compared to EG treated group. The cystone and plant extract treated groups showed diuretic activity, which might have prevented from stone aggregation, so animals were relieved from pain. This might be the reason for increased food consumption, which led to significant increase in body weight.

An increased urinary calcium concentration is a factor favoring nucleation and precipitation of CaOx or apatite (calcium phosphate) in urine and subsequently crystal growth. This fact, combined with the increased urinary calcium leads to their super saturation in urine and finally stone formation. One mechanism currently proposed as an important to prevent the formation of urinary stone, is the presence of substance in urine that prevents calcium salt crystallization. By inhibiting calcium excretion, the drug decreases the supersaturation of the urine with respect to CaOx and thereby decrease the risk of stone formation. The increase in calcium and phosphate excretion could be due to defective tubular reabsorption in the kidneys [23].

Magnesium powerfully inhibits the crystallization of calcium oxalate *in vitro*, magnesium binds to oxalate to form a soluble complex, consequently reducing the concentration available for CaOx precipitation [24]. Low urinary magnesium content is a common feature in stone formers. Uric acid is known to promote calcium oxalate crystal growth [25]. Uric acid known to promote the calcium oxalate crystal growth. The uric acid binding proteins are dominance in binding calcium oxalate crystallization and play a primary role in stone formation [26]. In this study, the higher amount of uric acid is present in ethylene glycol treated groups thus may be a reason for stone formation. The plant extract treatment restored the uric acid level to normal thus reducing the risk of stone formation.

The microscopic examination of kidney sections derived from ethylene glycol induced urolithiatic rats showed polymorphic irregular crystal deposits inside the tubules which cause dilation of the proximal tubules along with interstitial inflammation. This might be attributed to oxalate. The crystal deposits are intensely birefringent, polycrystalline, and arranges in rosette characteristic of calcium oxalate crystals [21].

CONCLUSION

The treatment with *Crateva magna* aqueous bark extract decreased the number and size of calcium oxalate deposits in different parts of the renal tubules and also prevented damages to the tubules and calyxes and the above study results authenticate the use of *Crateva magna* as an effective remedy for urolithiasis.

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REFERENCES

1. Viel TA, Domingos CD Monteiro APS, Lima-Landman MTR, Lapa AJ Souccar C. Evaluation of the antiurolithiatic activity of the extract of *Costus spiralis* Roscoe in rats. Journal of Ethnopharmacology 1999; 66: 193-198.
2. Chauhan CK Joshi MJ. Growth inhibition of struvite crystals in the presence of *Citrus medica* L. Urological Research 2008; 36 : 265-273.
3. Zaki S. Evaluation and Management of Urolithiasis. Medicine Today 2007; 5(2): 54-60.
4. Mohamed FNA, Mozhiyarasi P, Nalini R Electronic Journal of Chemistry 2006: 3(12): 182- 185.
5. Menon MD, Parulkar BG Drach GW . Urinary lithiasis : Etiology, diagnosis and medical management. Campbell's Urology, Seventh ed., W.B. Saunders, Philadelphia .1998. p. 2661-2733.
6. Patankar S, Dobhada S, Bhansali M, Khaladkar S, Modi JA. Prospective randomized, controlled study to evaluate the efficacy and tolerability of Ayurvedic formulation "varuna and banana stem" in the management of urinary stones. Journal of Alternative and Complementary Medicine 2008; 14 : 1287-1290.
7. Basavaraj DR, Biyani CS, Browning AJ, Cartledge JJ. The role of urinary kidney stone inhibitors and promoters in the pathogenesis of calcium containing renal stones EAU-EBU Update series 2007; 5: 126-136.
8. Anand R, Patnaik KDK Dhawan BN. Activity of certain fractions of *Tribulus terrestris* fruits against experimentally induced urolithiaisis in rats. Indian Journal of Experimental biology 1999; 32:548-52.
9. Bisaz S, Felix R, Nelman WF, Fleesch. Quantitative determination of inhibitors of calcium phosphate precipitation in whole urine. Nephrology 1984; 8:175-179.
10. Sathish R, Natarajan K, Nikhad MM. Effect of *Hygrophila spinosa* on ethylene glycol induced urolithiasis in rats. Asian Journal of Pharmaceutical and Clinical Research 2009; 3 :61-63
11. Christina AJM, Najumudeen NAH, Vimal Kumar S, Manikandan N, Tobin GC, Venkataraman S, Murugesh N. Anti-lithiatic effect of *Melia azadirachta* on ethylene glycol induced nephrolithiasis in rats. Pharmaceutical Biology 2006; 4: 480-485.
12. Benniamin A, Manickam VS, Johnson M, Joseph LH. Micropropagation of *Crateva magna* (Lour.) DC. - a medicinal plant. Indian Journal of Biotechnology 2004; 3: 136–138.
13. Bhatachargee S.K. Handbook of Medicinal Plants. Aavishkar Publication and Distributors, Jaipur 2001, p.33-36.
14. Nadkarni AKC. Indian Materia Medica, Popular publication Pvt. Ltd, Mumbai 1979, P:52-53.

15. Gagandeep M, Khadilkar S. International Journal of Pharmaceutical Sciences 2006 ; 68: 804-806
16. Sapkota J. Chemical constituents of *Crateva religiosa*. Journal of applied biomedicine,2003: 1: 7-12
17. SethiVK, Jain MP ,Thakur RS . Planta medica 1978; 34: 223-224.
18. Lakshmi, V ,Chuhan JS. Planta Medica 1997; 32: 214-216.
19. Wesson, JA, Worcester EM, Wiessner, Mandel NS ,Kleinman JG. Control of calcium oxalate structure and cell adherence by urinary macromolecules. Kidney International 1998; 53: 952- 957.
20. Kok DJ, Khan SR. Calcium oxalate nephrolithiasis, a free or fixed particle disease. Kidney International 1994; 46: 847-854.
21. Atmania F, Slimania Y, Mimounib M , Aziza M, Hachtb B, Ziyyata A . Effect of aqueous extract from *Herniaria hirsuta* L. on experimentally nephrolithiatic rats. Journal of Ethnopharmacology 2004; 95: 87-93.
22. Fan J, Glass MA, Chandhoke PS. Impact of ammonium chloride administration on a rat ethylene glycol urolithiasis model. Scanning Microscopy 1999; 13: 299-306.
23. Sandhyarani G K ,Swathi ,Kiran G. Effect of methanolic leaf extract of *cochlosperum Vitifolium* on glycolic acid induced urolithiasis in Rats. Acta Biomedica Scientia 2014; 1 (1):32-35
24. Srinivasan S, Kalaiselvi P, Sakthivel R, Pragasam V, Muthu V , Varalakshmi V. Uric acid: an abettor or protector in calcium oxalate urolithiasis? Biochemical study in stone formers. International journal of clinical chemistry 2005; 1-2:45-51
25. Grover P.K,Royal RL ,Marshall VR. Effect of urate on calcium oxalate crystallization in human urine. Evidence for a promontory role of hyperuricosaria in urolithiasis. Clinical sciences 1990; 79: 9.
26. Kalaiselvi P, Udayapriya KL, Selvam R. Uric acid binding proteins in calcium oxalate crystallization. British Journal of Urology 1990; 83 :P: 919.

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