Summary
Urolithiasis, also called calculi, is a condition which involves the process of stone formation in the kidney, bladder, and/or urethra. Kidney stone is one of the oldest and widespread diseases known to man. Many stones are asymptomatic until they begin to move down the ureter, causing pain due to obstruction. The pain often begins suddenly when a stone moves in the urinary tract, causing irritation or blockage. Typically, a person feels a sharp, cramping pain in the back and side in the area of the kidney or in the lower abdomen. Sometimes nausea and vomiting occur. Extra-corporeal shockwave lithotripsy, ultrasonic waves or shockwaves are used to break up stones so that they may be expelled in the urine or removed with an endoscope. Lithotripsy may be an alternative to surgery.

Urinary excretion of oxalate and deposition of calcium oxalate crystals in the renal tubules damage renal epithelial cells and this injury is mediated by lipid peroxidation reaction through the generation of oxygen free radicals. Free radical scavengers, such as catalase and superoxide dismutase (SOD), glutathione peroxidase (GPx), glutathione reductase could provide significant protection against renal tubular cell injury induced by oxalate and calcium oxalate crystals.

The recurrence is quite common with these endoscope procedures and patient has to be subjected to careful follow up for a number of years. Thus, there is need for more effective alternative therapy.

The medicinal plants have played a significant role in various ancient traditional systems of medication. Medicinal plants remain an important source of new drugs which are considered as quite safe, with minimal or no side effects. This study was carried out for evaluation of in vitro and in vivo antiurolithiatic activity of Terminalia arjuna bark as preventive and curative agent hindering the formation of calcium oxalate crystals. Leaf, stem and bark of T. arjuna Wight & Arn. (Combretaceae) were collected from Rajkot, Gujarat, India in December, 2012. The plant parts were washed thoroughly with tap water and distilled water. They were shade dried, uniformly powdered and packed in air tight bottles.
Pharmacognosy is a simple and reliable tool, by which complete information of the crude drug can be obtained. The process of standardization can be achieved by stepwise pharmacognostic studies like microscopic, macroscopic, physicochemical and phytochemical analysis. These studies help in identification and authentication of the plant material. In the pharmacognostic study of leaf, stem and bark of *T. arjuna*, macroscopic and microscopic characters and powder microscopic were studied. In physicochemical parameters, loss on drying, total ash, acid insoluble ash, water soluble ash, petroleum ether soluble extractive, ethyl acetate soluble extractive, acetone soluble extractive, methanol soluble extractive, water soluble extractive, solubility test were analyzed. The preliminary qualitative phytochemical analysis of crude powder revealed the presence of alkaloids, flavonoids, cardiac glycosides, saponins, tannins and triterpenes. flavonoids and triterpenes were present in more amount as compared to other phytoconstituents. Quantitatively estimated total phenol content was higher than that of flavonoid content in the bark methanol extract. Fluorescent analysis of the leaf, stem and bark showed different colors in visible light and UV light when mounted in different solvents and chemical reagents.

The extraction was done by individually extracted. The dried powder was first defatted with petroleum ether and then extracted with ethyl acetate, methanol and water by using Soxhlet apparatus and methanol extracts was used for fractionation.

From the different solvent extract of leaf, stem and bark of *T. arjuna*, bark methanol extract showed better FRAP and DPPH quenching activity than the other extracts. Leaf methanol extract showed highest ABTS radical cation scavenging activity and superoxide anion radical activity than other solvent extracts. In fractionation, FS I showed better FRAP activity than the FS II. In DPPH free radical, FS I showed better activity than the FS II. In ABTS, all fractions had similar scavenging activity. In superoxide anion scavenging activity, FS II had lowest IC$_{50}$ than the FS I. Positive correlations between antioxidant capacity and total phenolic content were found in almost all the parts and all the solvent extracts.
Summary

*In vitro* antiurolithiatic activity was done by single diffusion gel growth technique, double diffusion gel growth techniques and turbidometric method. The growth inhibition of hydroxyapatite crystals in the presence of 3% bark methanol extract had comparatively lesser diffusion length and highest growth inhibition capacity than 1%, 2% bark methanol extract and cystone while in growth inhibition study of calcium hydrogen phosphate dihydrate crystal in the presence of 3% bark methanol extract had highest growth inhibition capacity than that of different concentration of leaf, stem, bark extracts and cystone. Similarly 3% bark methanol extract produced maximum inhibition of calcium oxalate crystal growth than that of different concentration of leaf, stem and bark methanol extract and cystone. In turbidometric method, maximum growth inhibition was observed in 15mg/5ml bark methanol extract than that of different concentration of leaf, stem and bark methanol extract and cystone.

The *in vitro* antioxidant and antiurolithiatic activity of bark methanol extract was the best amongst the three different parts and the solvents studied. Hence bark methanol extract (TABME) was further evaluated for its *in vivo* antiurolithiatic activity.

*In vivo* antiurolithiatic activity was done by ethylene glycol and ammonium chloride induced rat model. Male Wistar albino rats weighing between 150-200 g each were used for this experiment. Cystone was received as standard drug at higher dose of 750 mg/kg in prophylactic and curative groups. The bark methanol extract was administrated orally with ethylene glycol for 28 days at the lower dose of 150 and higher dose of 350 mg/kg b.w. in prophylactic while in curative groups, bark methanol extract was administrated after 14 days. In this model, different urine and serum biochemical parameters (Calcium, oxalate, magnesium, phosphate, urea, uric acid, total protein, albumin, creatinine, alkaline phosphatase, aspartate aminotransferase and alanine aminotransferase), kidney homogenate analysis (lipid peroxidation, calcium, oxalate), antioxidant enzymes from kidney homogenate (glutathione reduced, catalase, glutathione peroxidase, superoxide dismutase) and kidney histopathological study was carried out.
In the present study, administration of ethylene glycol and ammonium chloride caused significant changes in the urine and serum biochemical parameters and it also caused significant changes in antioxidant enzyme levels in kidney as compared to the normal control group. Treatment with *T. arjuna* bark methanol extract (TABME) restored the urine and serum biochemical parameters and antioxidant enzymes in kidney. Antiurolithiatic effect of TABME was also confirmed by histopathological study. Extensive intratubular crystal depositions, tubular necrosis, degenerative tubular structures were found in ethylene glycol treated rats. Calcium oxalate crystal deposition and renal damage was significantly less in TABME treated groups. The result of histopathological study supported the results obtained in urine, serum and kidney homogenate analysis.

Overall it can be concluded that methanol extract of *T. arjuna* bark has good antioxidant and antiurolithiatic potential and further experimental and clinical studies are required to elucidate the chemical constituents of the extract and mechanism responsible for its antiurolithiatic activity.