



International Journal of
Ayurveda and Pharmaceutical
Chemistry

www.ijapc.com

IJAPC

VOLUME 11 ISSUE 1 2019

E ISSN 2350-0204

GREENTREE GROUP
PUBLISHERS



Antimicrobial Activity of Herbs in Ayurveda against Urinary Tract Infection -A Review

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ABSTRACT

Introduction: Urinary tract infection is the most common site and stands second after infection of respiratory tract. Its prevalence is more in women as compared to men. Approximately 50% women have infection of Urinary tract in their life-time. According to Ayurveda, urinary tract infection can be correlated with *Mutrakruchhra*. In *Charak Samhita* it is described in *Trimarmiya adhyaya* of *Chikitsasthana*. In modern medicine the antibiotics such as ciprofloxacin, cefixime, and ceftriaxone are used in the management of Urinary tract infection but they have many side effects. Antibiotics are not mentioned in *Ayurveda*. But some herbs have antimicrobial activity. Hence they can be used in management of Urinary Tract Infection. **Aims & objectives:** To review the herbs having antimicrobial activity in *Ayurveda* against Urinary Tract Infection. **Methodology:** All *Bruhatrayi*, *Laghutrayi*, modern text books and various research articles were reviewed and analyzed. **Observation and Result:** Research studies conducted on *Gokshur* (*Tribulus terrestris* Linn), *Varuna* (*Crataeva nurvala*), *Shigru* (*Moringa oleifera*), *Manjishtha* (*Rubiacordifolia*), *Anantmul* (*Hemidesmus indicus*), *Gulkhair* (*Malvasylvestris*), *Jambu* (*Psidium guajava*), *Punarnava* (*Boerhaavia diffusa*), *Vidari* (*Ipomoea mauritiana*) and *Neem* (*Azadirachta indica*) etc proved their antimicrobial activity. Among these most of the studies are in vitro studies. Hence these herbs can be used in management of Urinary Tract Infection. **Conclusion:** From this review it can be said that *Gokshur*, *Varun*, *Shigru*, *Jambu*, *Punarnava*, *Vidari*, *Anantmul*, *Manjishtha*, *Bhumyamalaki*, *Dadim* and *Neem* have wide range of antimicrobial activity hence they can be effectively used in urinary tract infection.

KEYWORDS

Antimicrobial, *Mutrakruchhra*, Urinary tract infection



Greentree Group Publishers

Received 17/05/19 Accepted 06/06/19 Published 10/07/19



INTRODUCTION

Urinary tract is the main site for infection and it stands second after respiratory tract infection caused due to pathogens. Its prevalence is extremely increasing in populations and is expected to be responsible for over 100,000 hospitalizations every year¹. It is approximated that nearly 25% to 40% of hospital acquired infections mainly comprise urinary tract infections^{2,3}.

The main function of Urinary system is to regulate the chemical composition and volume of blood. The Urinary tract comprises upper urinary tract (the kidneys, renal pelvis, and ureters) and lower urinary tract (urinary bladder and urethra). The most common microorganisms usually causing infection of urinary tract are *E. coli*, *Enterococci*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Enterobacter* species, *Proteus mirabilis*, *Candida albicans*, and coagulase-negative *Staphylococci*⁴. In Ayurveda, infection of urinary tract is not mentioned but it can be compared with *Mutrakrucchra* due to resemblance of symptoms.

In *Ashtanga Hridaya Nidanasthana*, *Acharya Vagbhata* divided *Mutravikar* into two groups viz. *Mutra-Ati-Pravrittija Vikara* and *Mutra-*

Apravittija Vikara. *Mutra-Ati-Pravrittija* means excessive formation of urine and includes *Prameha*. *Mutra-Pravittija* denote to less formation of urine and it includes two conditions viz. *Mutraghata* and *Mutrakrucchra*.

Mutraghata denotes to less flow or less formation of urine while *Mutrakrucchra* denotes to such conditions where patients feel discomfort (*Kricchrata*) in urination⁵.

In modern medicine the antibiotics such as ciprofloxacin, cefixime, ceftriaxone are used in the management of infection of Urinary tract but uncontrolled and indiscriminate use of antibiotics resulted in bacterial resistance. Moreover, the antibiotics are associated with adverse effects like bone marrow depression, anemia and have hepatotoxic and nephrotoxic effects⁶. This necessitates to look for a safe and cost effective herbal drugs having antimicrobial activity. Therefore, present review is undertaken to study various herbal drug having antimicrobial properties effective in UTI.

AIMS & OBJECTIVES

To review the herbs having antimicrobial property in *Ayurveda* for infection of urinary tract

MATERIALS AND METHODS

All *Bruhatrayi*, *Laghutrayi*, modern text



books and various research articles were reviewed and analyzed.

OBSERVATION AND RESULTS

Following in vitro studies conducted on various herbs proved antibacterial action of these herbs against pathogens causing UTI.

- In vitro study carried out by Ajith. A. et. al., to evaluate and compare sensitivity of *Gokshur* (*Tribulus terrestris* Linn) and *Varun* (*Crataeva nurvala*) against *Escherichia coli* by performing culture and sensitivity of urine samples of patients having symptoms of *Pittajamutrakrichra* (UTI (Urinary Tract Infection)). In present study, 30 samples of urine were collected from the patients with infection of urinary tract. Microscopic examination of collected samples was carried out for detection of pus cells, epithelial cells and bacteria. Their results showed positive cultures for *Escherichia coli* subjected to sensitivity with different concentrations (0.25 μ l, 0.125 μ l, 0.0625 μ l, 0.0313 μ l and 0.015 μ l) of *Gokshur* and *Varuna* extracts in alcohol. They found that Alcoholic extract of *Gokshur* and Alcoholic extract of *Varuna* independently has antimicrobial (*Krimighna*) action against *Escherichia coli* derived from urine samples of patients having symptoms of

Pittajamutrakrichra (Urinary tract infection). On comparing both herbs they drawn conclusion that *Gokshur* has slightly better anti microbial action than *Varuna*. Further they concluded that antimicrobial activity of these extracts is more in high concentration⁷.

- Maurya Santosh Kumar et. al. conducted in vitro study to evaluate efficacy of the stem bark of *Shigru* (*Moringa oleifera*) against some bacterial isolates collected from human urine samples (*Klebsiella* spp. *Pseudomonas* spp. *Proteus* spp. and *E. coli*). In this study 30 human urine samples were collected and subjected to culture test immediately after collection. From culture bacterial strain was identified by comparison of certain characteristics of bacteria with standards. They isolated 4 bacterial strains from these patients viz. *E. coli*, *K. pneumoniae*, *P. aeruginosa*, *P. mirabilis*. In the present study sensitivity of extracts of *Moringa* stem bark (Ethanolic extract of *Moringa oleifera* stem bark and Hydroalcoholic *Moringa oleifera* stem bark) and ciprofloxacin were done by disc diffusion method. They found more occurrences of *E. coli* 66.67%, *K. Pneumoniae* 16.67%, *P. mirabilis* (10.00%). Their results showed that 80% of the cultured samples were reacted to Ethanolic extract of *Moringa oleifera* stem bark and 83.33% samples responded to the



bark. Moreover, 85% *E. coli*, 50% *P. aeruginosa*, 33.33% *P. mirabilis* and 20% *K. pneumoniae* were resistant to Ciprofloxacin. Thus, the study established the importance of *Moringa oleifera* stem bark for the management of UTI⁸.

- Seema Rawat *et al.* studied the prevalence of UTI causing pathogens and antimicrobial action of herbs *viz.*, *Anantmul (Hemidesmus indicus)*, *Gulkhair (Malvasylvestris)* and *Manjishtha (Rubia cordifolia)* against the pathogens causing infection of urinary tract. In this study, total 100 urine samples were collected by aseptic precaution from different patients. From these positive urine samples they obtained total of 150 uropathogens which were recognized by their morphological and biochemical characteristics. They advocated that among all uropathogens the most common pathogen for urinary infection was *E. coli* (42%) next to that were *Pseudomonas*, *Proteus*, *Staphylococcus*, *Klebsiella*, *Serratia* and *Alcaligenes*. By agar well diffusion method they assessed antimicrobial activity of the crude extracts. Their results showed that all extracts of herbs possess excellent antibacterial property. They found maximum antibacterial property of *Hemidesmus indicus* methanolic extract against *E. coli* and minimum effect against *Staphylococcus* where as water extract

showed maximum antimicrobial effect against *Alcaligenes* and minimum effect against *Serratia*. They observed that *Malvasylvestris* methanol extract showed highest potential against *E. coli* and minimum potential towards *Klebsiella* and *Malvasylvestris* water extract exhibited maximum antimicrobial effect against *E. coli* and minimum effect against *Staphylococcus*. The methanol extract of *Rubia cordifolia* showed maximum antibacterial property against *E. coli* and minimum effect against *Serratia*. The *Rubia cordifolia* water extract exhibited maximum antimicrobial action against *E. coli* and minimum action against *Staphylococcus*. They declared that antimicrobial activity of methanol extract of the three herbs was more as compared to their aqueous extract. According to them soluble phytochemicals in different solvents decides which extract will exhibit more antimicrobial potential. Thus they advocated that methanol extract of these herbs possess antimicrobial property hence they can be used as natural antibacterial agents against pathogens⁹.

- Another study conducted a preliminary research in which ethanolic extract of leaves of *Jambu (Psidium guajava)* was used for assessment of their effect in vitro on bacterial agents (*Escherichia coli* and *Staphylococcus aureus*) causing urinary



tract infections. They compared the results of plants extracts with commonly used antimicrobial agents in the management of UTI. In present study they collected 50 urine samples from pathology labs of subjects having clinical symptoms of urinary tract infection for separation of the affecting pathogens. They evaluated antibacterial properties of the extracts of leaves against these bacteria using well diffusion method and also evaluated resistance of antibiotics against isolates by adopting hexa UTI disc 4 (Himedia pvt limited) containing antibiotics like ciprofloxacin, nalidixic acid, co-trimoxazole, ampicillin, gentamycin and nitrofurantoin,. Their results showed that *Psidium guajava* leaves ethanol extract showed more repressing effect in comparison with antimicrobials like ampicillin, gentamycin, nitrofurantoin, nalidixic acid and co-trimoxazole and is next to ciprofloxacin. They concluded that extract of guava plant has remarkable antibacterial activity as compared to antibiotics hence it can be used safely by all human beings¹⁰.

- Vineeth T et.al. conducted in vitro study to establish the antimicrobial effect of leaves of *Punarnava* (*Boerhaviadiffusa*) and *Punarnavasava* formulation on pathogens (Klebsiella species, Pseudomonas species, Enterococcus

species, *Escherichia coli* and *Proteus* species) causing Urinary Tract Infection. By using standard microbiological procedures they separated uropathogens from urine samples. They studied antibacterial property of *punarnavasava*, a polyherbal formulation, (having main constituent *Boerhavia diffusa*) and water and ethanol extracts of *Boerhavia diffusa* leaves on uropathogens separated by Disc diffusion method, Well diffusion method and minimum inhibitory concentration. They found high effectiveness of *Boerhavia diffusa* ethanol extract and the herbal preparation *Punarnavasava* against all the species of isolated uropathogens. They found higher activity against uropathogens in *Punarnavasava* as compared to leaves extract of *Boerhavia diffusa*. They also observed non effectiveness of water extract of *Boerhavia diffusa* against antibacterial activity. They declared that HPTLC profiling of extract of *Boerhavia diffusa* showed presence of β - sitosterol in ethanol extract and is absent in water extract. From which they concluded that the antimicrobial activity was due to the presence of compounds that dissolve in organic solvent like ethanol. They stated that many researchers proved the antibacterial activity of β - sitosterol (Kiprono et al., 2000). Hence they confirmed that *Boerhavia diffusa* has antimicrobial action owing to



the presence of β - sitosterol or the synergistic effect of β - sitosterol with other active constituents in the plant. The above studies showed that *Boerhavia diffusa* may play a beneficial role managing bacterial urinary tract infections¹¹.

- Other in vitro study conducted with primary objective to identify the *in vitro* action of selected Hydro-alcoholic extracts of three plants -i.fruit extracts of *Gokshur* (*Tribulus terrestris*), ii.whole plant extracts of *Bhumyamalaki* (*Phyllanthus amarus*)and iii. Root extracts of *Anantamul* (*Hemidesmus indicus*) separately and in mixture against the separated bacterial micro-organisms showing resistance to pathogens for a period of 3 months. They collected fifty urine samples from patients having recurrent UTI showing multidrug resistance for the study. They used Agar dilution method in which 10 plates of the different mixture of herb extracts were arranged in MHA media which were taken in rising concentration and tested for antibacterial effect. They found that group having *Tribulus terrestris* extracts (Group A)with mixture of *Tribulus terrestris* and *Hemidesmus indicus* (Group F) and group containing *Tribulus terrestris*, *Phyllanthus amarus* and *Hemidesmus indicus*(Group G) showed antibacterial activity both against Gram positive and Gram negative bacteria, and group having

only *Hemidesmus indicus* (Groups C) showed effect on only Gram positive bacteria. They affirmed that susceptibility of Gram positive bacteria is more to these extracts than the Gram negative bacteria. They found that all the extracts of herbs checkedproved sensitivitygreater than 70 % in the trial group. They concluded that *water and alcohol* extracts of *Gokshur* (*Tribulus terrestris*), *Bhumyamalaki* (*Phyllanthus amarus*) and *Anantamul* (*Hemidesmus indicus*) are effective in the management of resistant strains of pathogens to multi-drug causing Infection of Urinary Tract¹².

- In another research conducted in vitro, tested antimicrobial effect of *Bhumyamalaki* (*Phyllanthus amarus*) against pathogens causing infection of Urinary Tract, the isolates like *E.coli*, *Klebsiella pneumonia*, *Staphylococcus aureus*, *Serratia marcescens*, *Enterobacter* sp., *Streptococcus fecalis*, *Proteus mirabilis* and *Pseudomonas aeruginosa*. For study purpose various extracts of *Phyllanthus amarus* like Methanol, acetone, chloroform, petroleum ether and hexane were used. Agar well diffusion method was used by them to establish antibacterial action of *Phyllanthus amarus*. They observed the highest antimicrobial activity of *Phyllanthus amarus* methanol extract against



uropathogens when compared it with other solvent extracts. They concluded that methanol is the best solvent capable to leach out ingredients having antimicrobial effect very efficiently from the herb than any other solvents. They assured that after methanol extract, acetone extract possessed good inhibitory activity followed by chloroform extract and petroleum ether extract. Hexane extract showed low inhibitory activity as compared to the other tested solvent extracts. Phytochemical analysis of these extracts showed the presence of alkaloids, flavonoids, phenols and triterpenes, which may be responsible for their antimicrobial action¹³.

- Pavan HV et.al. conducted in vitro study in which bacteria were isolated from patients who were catheterized since long duration of time. Using biochemical methods the separated bacteria were recognized and then molecular methods like polymerase chain reaction and sequencing of 16srRNA gene were used for their confirmation. Antibacterial screening of the extracts of methanol and petroleum ether of leaves of *Vidari (Ipomoea mauritiana)* was conducted by using disc diffusion method against *E. coli*, *P. mirabilis*, *K. pneumonia* and *E. faecalis* separated from urinary catheters. They separated pathogens from urinary catheters using Disk diffusion method and evaluated

antibacterial action of *Ipomoea mauritiana*. Then they tested antibacterial activity of *Ipomoea mauritiana* leaf extracts against different uropathogens where two uropathogens *E.coli* and *E. faecalis* were shows sensitivity while *Klebsiella* sp and *Proteus mirabilis* were resistant to the extracts of plants. They established that the methanolic extract of plant have excellent compositions having antimicrobial activity against *E. coli* and *E. faecalis*¹⁴.

- S Gopalkrishnan conducted in vitro study to assess antimicrobial effect of *Dadim (Punica granatum)* extract on uropathogens. The *Punica granatum* methanol extract showed broad-spectrum activity against various bacterial strains separated from urine of patients of varying age of either sex suffering from urinary infection. The antimicrobial activity of the methanolic extract was evaluated by disc diffusion method and compared with six commercially available antibiotics, which are therapeutically used for urinary tract infections. The extract showed antimicrobial effects against gram positive and gram negative bacteria and the multi-drug resistant strains of various uropathogens like *Escherichia coli*, *Klebsiella pneumoniae*, *Serratia marcescens*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Proteus* and *S.aureus*. They observed that out of 163



multi-drug resistant strains tested, 159 were appreciably inhibited by the pomegranate extract¹⁵.

- Sapna Chauhan et.al.conducted a comparative in vitro study in which they compared the water, extracts of methanol and ethanol of *Neem (Azadirachta indica)* leaves against human uropathogens. They used Soxhlet method for extraction of the various extracts and agar well diffusion method was adopted to establish the antimicrobial activity against bacteria. They included 100 urine samples in the study from which the most common pathogen was *E. coli* separated 55% alone and 4% along with *E. faecalis*. Other organisms separated comprised *K. Pneumonia* (19%), *P. aeruginosa* (7%), *P.mirabilis* (3%), *E. faecalis* (6%) and *S.aureus* (6%) each. They tested water, methanol and ethanol extracts to examine antibacterial effects against the above stated bacteria. They observed that all the three extracts showed good quality antimicrobial action. They found better antibacterial activity of Ethanol extracts than water and methanol extracts. They assured that same observations were obtained in studies conducted by Tabassum *et al.* (2003). Further maximum activity of ethanol extracts was seen on *E. coli* and minimum effects on *K. pneumoniae*. These results are similar with the results found by Sohail *et al.* (2014). Based on the results

obtained, they concluded that *Neem* leaf extract showed broad spectrum antimicrobial effects on uropathogen separates and the highest effects were recorded for ethanolic extracts¹⁶.

DISCUSSION

In Ayurveda various herbal drugs are mentioned for *Mutrakrichra* having *Krimighna* (antimicrobial) property. The *Krumighna* property is primarily owing to presence of bioactive compounds. Above in vitro research studies conducted on various herbs like *Anantamul*, *Bhumyamalaki*, *Gokshur*, *Varun*, *Punarnava*, *Neem*, *Guava*, *Manjishtha* and *dadim* proved their antimicrobial property. Antimicrobial property of these herbs chiefly owes to presence of phytochemicals like tannins, phenols, triterpenes, alkaloids and flavonoids. These phytochemicals can be separated by obtaining methanolic, ethanolic and aqueous extracts of these plants. These drugs have various types of action like may act by various actions like cell wall degradation, cytoplasmic membrane interruption, cellular components seepage, breakdown of protein, obstruction in the enzymatic activities in cell, affect production of DNA and RNA, it causes changes in fatty acid and phospholipid constituents of cell



membrane which alters the transport of electron and nutrient and thus impair the formation of energy in the cell¹⁷.

Several active ingredients like flavonoids, alkaloids, phenols and triterpenes were isolated from these plants, due to which these plants possess antibacterial action. In *Charaka Samhita Gokshura* is described as having *Krimighna property* and it is indicated in management of *Mutrakrichra*. *Varuna* has *Krimighna* action and it is indicated in the management of *Mutrakrichra*^{18,19}.

Gokshur has the most excellent antibacterial activity since it contains tannins and saponins. *Gokshur* extract has high concentration of these phytochemicals which indicates that these phytochemicals may be responsible for their antimicrobial action^{20,21}. The herbal plants are in natural form so their effects on the body system are not harmful. They act slowly on the body and though they are not capable of killing the micro-organism but they help in increase the immunity. Atmosphere created by them within the body is such that the pathogens cannot stay alive.

Pharmacological researches conducted on *Punarnava* confirmed that it contains *punarnavoside*. It has an extensive range of properties like diuretic²² anti-inflammatory²³, antibacterial²⁴ and anthelmintic. The purified glycoprotein

from *B. diffusa* exhibited antibacterial effects against bacteriophages nucleic acid²⁵. *Moringa* is used for *mutrarogas* (urinary disorder), *jvara* (fever), *vidradhi* (abscess), *shotha* (edema), *shula* (pain), *krimi* (helminthes), *abhishyanda* (conjunctivitis) and *vrana* (wound) where micro-organism may involve in pathogenesis^{26,27}. The stem bark used as antibacterial²⁸⁻³² and antifungal agent against varieties of gram positive and gram negative bacteria. *Neem* exhibits antibacterial, antifungal as well as antiviral activities³³.

Phytochemicals produced are supposed to be more tolerable by an individual's compared to contemporary artificial medicines³⁴. *Guava* leaves have lots of chemical components namely coumarin, essential oils, flavonoids and triterpenes, which are well-known to have antimicrobial effects. The leaves of *Psidium guajava* tree are known for its antimicrobial property³⁵. Due to presence of phytochemicals these herbs have antimicrobial property.

CONCLUSION

From above review it can be stated that Upper Urinary Tract and Lower Urinary Tract are most common sites for infection. It is more common in women than men.



Overuse of Antibiotics causes tolerance and resistance hence use of herbs having *Krumighna* property is safe, economic and alternative way to treat the infection of urinary tract. Above mentioned herbs contain phytochemicals which may kill or slow down the growth of microbes. Extracts of Aqueous, methanol and alcohol of these herbs can be used to isolate their chemical constituents. Research studies of plants in vitro for assessing their antimicrobial property is the primary measure of achieving safe ecological management of infectious diseases of human beings by new bio-molecules of herbal origin. Long-term studies on in vitro, in vivo antibacterial activities of above mentioned plant extracts are necessary to establish their activity in repeated infection of urinary tract (UTI). An effective drug for recurring Urinary tract infection (UTI) may possibly be prepared from these plant extracts, which would be natural, easily available, cost-effective and devoid of any adverse effects.



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