

## PHCOG REV.: Review Article

# Medicinal Plants and Urinary Tract Infections: An update

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### ABSTRACT

Medicinal plants are part and parcel of human society to combat diseases from the dawn of civilization. According to World Health Organization (WHO), about 80% of the world population rely chiefly on plant based traditional medicine specially for their primary health care needs and there has been a worldwide move towards the use of traditional medicines due to concerns over the more invasive, expensive and potentially toxic main stream practices. This review gives a bird's eye view on the updated information on urinary tract infections (UTIs), different categories of urologic herbs, historical use and modern scientific investigations on some important urologic herbs, clinical studies, some isolated chemical compounds and their possible side effects.

**KEY WORDS :** Medicinal plants ; Urinary Tract Infections ; Historical use; Scientific analysis ; Clinical studies ; Bioactive constituents; Possible side effects

### INTRODUCTION

Plant medicines have been used for many thousands of years in many different cultures. Today medicinal plants have become a growing alternative for establishing a healthy body environment. They play an important role for the treatment of different types of diseases and disorders since antiquity including urinary tract infections (1). They can affect the urinary tract infections as disinfectants, analgesics, diuretics or narcotics. Some have been shown to have antimicrobial effect against *Escherichia coli* and other organisms that cause urinary tract infections (UTIs). Medicinal plants can be very effective in programs for resolving UTIs (2).

This paper will review several important categories of urologic herbs and their possible applications against UTIs to give a sense of the depth and breadth of plant medicine in urology. Giving the impossibility of covering the enormity of the world botanical *Materia Medica*, only a few important medicinal plants that are commonly used by the rural people since antiquity to combat UTIs as well as claimed to be potent after modern scientific investigations have been considered in this review.

#### Medicinal plants as alternatives

Plant medicines are used on a worldwide scale to prevent and treat infectious diseases. Plant medicines are in great demand both in the developed as well as developing countries for the primary health care because of their wide biological and medicinal activities, higher safety margin and lesser costs (3). In recent years multiple-drug resistance has developed due to indiscriminate use of existing antimicrobial drugs in the treatment of infectious diseases (3). This resistance problem demands that a renewed effort be made to seek antimicrobial agents resistant to current antibiotics (4). Besides, though conventional antibiotics are strong medicines and save lives, they cause more harm than good when they are not used in right way (5). The World Health Organization in 1993 published its research guidelines on the

“safety and efficacy of herbal drugs”. They made a clear statement that the historical use of herbal substance is a valid proof of its safety unless there is scientific evidence of danger (6). Traditional healing system around the world that utilize herbal remedies are an important resource for the discovery of new antimicrobials (7,8). Plants are rich in a wide variety of secondary metabolites such as tannins, alkaloids, terpenoids and flavonoids which have been found *in vitro* to have antimicrobial property and may serve as an alternative, effective, cheap and safe antimicrobials for the treatment of microbial infections (7).

#### Urinary Tract Infections (UTIs) (9-12)

The term urinary tract infections (UTIs) are often used interchangeably with cystitis but, technically a urinary tract infection refers to an infection anywhere in the urinary system, including the kidneys, ureters, bladder and urethra. Urinary tract infections pose serious health problem affecting millions of people each year. Infections of the urinary tract are the second most common type of infection in the body. *Escherichia coli* causes about 80% of urinary tract infections in adults. Other bacteria that causes urinary tract infections include *Staphylococcus saprophyticus*, *Chlamydia tracomatis* and *Mycoplasma hominis*. If the infection stays in urethra without travelling into the bladder, it is called **urethritis** and are usually confined to burning while urinating. The term **cystitis** literally means an inflammation of the bladder which is generally the result of a bacterial infection. When both the urethra and bladder are involved, the term **cytourethritis** is sometimes used. Untreated bladder infections can sometimes travel up into the kidneys and cause severe, even life-threatening infections. This condition is known as **pyelonephritis**. Infections in the ureter is called **uretitis**. Bacteria enter the urethra, then enter the bladder, resulting in cystitis or simply a bladder infection. Mostly the infection stays in the bladder but it can travel on up into the kidneys

creating a more serious infection . The first bladder infection usually comes on suddenly and with urgency. The symptoms can be painful, quickly progressive and overwhelming in their intensity. Urinary tract infections usually begin with symptoms of urinary frequency, burning on urination, and voiding only a small amount of urine and may be blood in the urine.

#### Causes of UTIs

- (i) When microorganisms usually bacteria from the digestive tract cling to the opening of the urethra and begin to multiply.
- (ii) When bacteria enters the kidneys from the blood stream.
- (iii) Most commonly from *E. coli*.
- (iv) From microorganisms called *Chlamydia* and *Mycoplasma*.
- (v) From an obstruction - a urinary stone or enlarged prostate ( in men).

#### People who are more susceptible to UTIs

- (i) Catheters or tubes are placed in bladder
- (ii) A person has diabetes because of changes in the immune system
- (iii) The immune system has been suppressed
- (iv) Infants are born with abnormalities of the urinary tract
- (v) Women use a diaphragm
- (vi) Women whose partners use a condom with spermicidal foam
- (vii) A person who has already had a UTI

#### Symptoms

Symptoms depends on age of person and where the UTI is located

#### Symptoms of Urethritis often include:

Burning sensation at the start of urination

#### Symptoms of Cystitis often include:

- (i) Burning sensation in the middle of urination

- (ii) Fever
- (iii) Lower abdominal pain
- (iv) Urine may look cloudy, milky or red

#### Symptoms of Pyelonephritis often include:

- (i) Pain in back, flanks or abdomen
- (ii) Fever
- (iii) Nausea
- (iv) Vomiting

#### Other symptoms of UTIs

- (i) Uncomfortable pressure above pubic bone
- (ii) Fullness in rectum (in men only)
- (iii) Small amount of urine, despite urge to urinate
- (iv) Irritability (in children only)
- (v) Abdominal eating (in children only)

#### Complications of UTIs

- (i) Scarring and damage to kidney tissue
- (ii) Kidney failure
- (iii) Low blood pressure
- (iv) Frequent fainting
- (v) Strokes
- (vi) Heart disease

#### General description of urologic herbs (13-17)

Herbs used to treat UTIs would reduce the inflammations, sooth muscle's spasms and be antiseptic. They would also seek to increase urine production to flush out the infection and help to prevent kidney stone formation. Antimicrobial diuretics may help the body control and clear the bacterial infection but they must be ones that are specially active in the urinary tract. Anti-inflammatories will sooth the pain and discomfort but need to be used in the context of removing the infections that cause the inflammation. Antispasmodic may be useful if there is much pain.

Table 1. List of some important categories of urologic herbs

Category	Name of the herbs
Antimicrobials (including urinary antiseptics)	Echinacea ( <i>Echinaceae</i> spp.), goldenseal ( <i>Hydrastis canadensis</i> ), burdock ( <i>Arctium pubens</i> ), garlic ( <i>Allium sativum</i> ), uva ursi ( <i>Arctostaphylos uva-ursi</i> ), barberry ( <i>Berberries vulgaris</i> ), buchu ( <i>Agathosma betulina</i> )
Diuretics	Dandelion ( <i>Taraxacum officinalis</i> ), corn ( <i>Zea mays</i> ), sassafras ( <i>Sassafras albidum</i> ), juniper ( <i>Juniperus communis</i> ), cleavers ( <i>Galium aparine</i> ), uva ursi ( <i>Arctostaphylos uva-ursi</i> ), horsetail ( <i>Equisetum arvense</i> ), golden rod ( <i>Solidogo virgaurea</i> ), plantain ( <i>Plantago lanceolata</i> )
Anti-inflammatory	Ginger ( <i>Zingiber officinale</i> ), echinacea ( <i>Echinaceae</i> spp.), marshmallow ( <i>Althaea officinalis</i> )
Antispasmodics	Marshmallow ( <i>Althaea officinalis</i> ), chamomile ( <i>Matricaria recutita</i> )
For bladder involvement	Horsetail ( <i>Equisetum arvense</i> ), hydrangea ( <i>Hydrangea petiolaris</i> ), corn ( <i>Zea mays</i> ), barberry ( <i>Berberries vulgaris</i> )
For kidney involvement including kidney stones	Gravel root ( <i>Eupatorium purpureum</i> ), marshmallow ( <i>Althaea officinalis</i> ), uva ursi ( <i>Arctostaphylos uva-ursi</i> ), couch grass ( <i>Agropyron repens</i> ), barberry ( <i>Berberries vulgaris</i> ), hydrangea ( <i>Hydrangea petiolaris</i> ), corn ( <i>Zea mays</i> )

#### Some important herbs used in the treatment of urinary tract infections

##### A. Historical or traditional use

Cranberry (*Vaccinium macrocarpon*) has long been recommended by herbalists as well as doctors to help prevent UTIs (18). According to traditional herbal textbooks, a tea

made from the blueberry (*Vaccinium angustifolium*) was considered useful in UTIs (19). Buchu (*Agathosma betulina*) leaf preparations has a long history to use in traditional herbal medicine as a urinary tract disinfectant and diuretic (20). Goldenseal (*Hydrastis canadensis*) was used by Native Americans as a treatment for irritation and

inflammation of the mucus membranes of respiratory, digestive and urinary tract (21). **Horseradish (*Cochlearia armoracia*)** was considered to be a diuretic and used by herbalists to treat kidney stones and edema (22). Several cultures have employed **horsetail (*Equisetum arvense*)** as a folk remedy for kidney and bladder troubles (23). Many conditions have been treated in traditional medicine with **juniper berries (*Juniperus communis*)** including urinary tract and kidney diseases (24). A tea made from **Oregon grapes (*Berberis aquifolium*)** was used to treat several diseases including UTIs (25). **Plantain (*Plantago lanceolata*)** was considered by the herbalists to be a gentle, soothing expectorant and additionally to have mild astringent effect which may be helpful in treating bladder infections with mild amounts of blood in the urine (26). **Sassafras (*Sassafras albidum*)** was used by Native Americans for many purposes, primarily for infections and gastrointestinal problems. It is useful primarily in the treatment of UTIs (27). **Uva ursi (*Arctostaphylos uva-ursi*)** was found in wide use for infections of all parts of the body, particularly UTIs, because of its astringent or 'drying' action (28).

#### B. Modern Scientific investigations

##### **Cranberry (*Vaccinium macrocarpon*)**

Research has suggested that cranberry may be active against UTIs because it prevents *E. coli*, the bacteria that causes most urinary tract infections, from attaching the walls of the bladder (29,30). Cranberry is not however, a substitute of antibiotics in the treatment of acute UTIs. Moreover, in children, whose UTIs are due to neurogenic bladder, cranberry juice supplementation did not reduce the rate of infection (31). Consumption of cranberry juice cocktail may offer protection against both sensitive and resistant strains of P-fimbriated *E. coli* (32).

##### **Uva Ursi (*Arctostaphylos uva-ursi*)**

An extract of uva ursi is used in Europe and in traditional herbal medicine in North America, as treatment for UTIs (33). This herb is approved in Germany for treatment of bladder infections (34). It is effective against *E. coli* in the bladder. Uva ursi is a strong, non-irritating diuretic and urinary antiseptic for bladder and kidney infections. When combined with marshmallow it helps to eliminate stones from the kidney and bladder. It strengthens and tones the urinary passages and is effective to treat blood in the urine. Its diuretic properties are at the most effective if the herb is infused into cool water. Hot water alters its diuretic properties (29). Uva ursi is good to use if there is an irritable bladder or an atonic body bladder. It is also good to use when there is bacterial vaginosis and if there is ulcerative cystitis. It may cause the urine to become brownish-green and it works best with alkaline urine (35).

##### **Blueberry (*Vaccinium angustifolium*)**

Blueberry has also been used traditionally to treat and prevent urinary tract infections. Like the cranberry, blueberries demonstrate bioactive compounds that inhibit the ability of *E. coli* to adhere to the walls of the bladder (36).

##### **Buchu (*Agathosma betulina*)**

Buchu leaf preparations have a history of use in traditional herbal medicine as a urinary tract disinfectant and diuretics

(37). However German Commission E monograph on buchu concludes that insufficient evidence supports the modern use of buchu for the treatment of UTIs and inflammation (20). Its volatile oil stimulates urination and is excreted virtually by the kidneys. It is good for use with a bladder infection and if there is acidic urine with a constant desire to urinate with no relief from doing so (38).

##### **Horseradish (*Cochlearia armoracia*)**

The volatile oil of horseradish has been shown to kill bacteria that can cause urinary tract infections (39). One early study found that horseradish extract may help people with urinary tract infections (40).

**Asparagus (*Asparagus officinalis*)**, **birch (*Betula* spp.)**, **couch grass (*Agropyron repens*)**, **goldenrod (*Solidago virgaurea*)**, **horsetail (*Equisetum arvense*)**, **Java tea (*Orthosiphon spicatus*)**, **lovage (*Levisticum officinalis*)**, **parsley (*Petroselinum crispum*)** and **nettle (*Urtica dioica*)**

These are approved in Germany as part of the therapy of people with UTIs. These herbs appear to work by increasing urinary volume and presumed to flush bacteria out of the urinary tract (41).

##### **Juniper berry (*Juniperus communis*)**

It contains bitter compounds that increase the flow of urine. It also increases production of digestive fluids that assist in absorption as well as relieves pain. The berry is often used as an antiseptic, diuretic, and stimulant. It is extremely useful with chronic cystitis but best when not used when there is acute inflammation because it may result in irritation of bladder. It contains aromatic compounds that increase the flow of urine. Generally, these plants are taken as tea (42).

##### **Goldenseal (*Hydrastis canadensis*)**

Goldenseal is reputed to help treat many types of infections. The bioactive compound that may act similarly to proanthocyanidins in inhibiting bacteria from adhering to the walls of the bladder is present in the goldenseal (43), as well as Oregon grape and other plants.

##### **Plantain (*Plantago lanceolata*)**

Because of the anti-inflammatory effects of plantain, it may be beneficial in some people with UTIs. However, human trials have not been done to confirm this possibility or to confirm the traditional belief that plantain is diuretic (44).

##### **Oregon grape (*Berberis aquifolium*)**

Berberine present in oregon grape may help in the treatment of UTIs. These herbs have not however, been studied for the treatment of UTIs in humans (45).

##### **Barberry (*Berberis vulgaris*)**

The berberine in barberry has remarkable infection fighting properties. Studies show that it kills microorganisms (*E. coli*, Streptococci) that cause urinary tract infections (46).

##### **Dandelion root (*Taraxacum officinalis*)**

It contains bitter compounds that enhance the efficacy of the body's eliminative and detoxifying functions. These compounds help restore normal liver function, increase the production of digestive fluids and enzymes, particularly bile. It increases the flow of urine and has a laxative effect (47).

##### **Chamomile flower (*Matricaria recutita*)**

It contains aromatic compounds that increase the production of digestive fluids, reduce muscles spasms and pains, reduce

inflammation and are antiseptic. These compounds have a sedative and relaxing effect and is helpful in treating UTIs (48).

**Couch grass (*Agropyron repens*)**

Strongly diuretic with a soothing, anti-inflammatory healing effect on the lining of the bladder. It is useful when there is mucus discharge from the bladder with painful and frequent urination (49).

**Cleavers (*Galium aparine*)**

Soothing diuretic which is useful for acute or chronic cystitis with swollen lymph nodes and uterine inflammation (41).

**Nettle (*Urtica dioica*)**

Mild diuretic which is useful if there is a possibility or history of kidney infection. It builds the blood and is a nutrient rich herb (50).

**Echinacea (*Echinacea* spp.)**

It improves overall immune responses and is an effective anti-inflammatory. Echinacea contains a natural antibiotic (echinacoside) which is comparable to penicillin in its broad spectrum activity. It also strengthens tissues against assault by invading microorganisms. In addition, Echinacea may act like the body's own virus-fighting chemical, interferon. Interferon released in the body boosts the cell ability to resist infections. It is effective against UTIs (51).

**Garlic (*Allium sativum*)**

Pure garlic has been named as the "Heavy Weight" of all herbal remedies because it has such inheriting strong antibacterial properties and is useful in treating different types of diseases including UTIs (52).

**Corn silk (*Zea mays*)**

It is a soothing, anti-inflammatory diuretic that reduces painful symptoms and swelling due to inflammation. It is an urinary demulcent. It is especially useful with excessively alkaline urine and for bladder irritation in children (53).

**Hydrangea (*Hydrangea petiolaris*)**

Stimulates and cleans kidneys. Hydrangea also helps to relieve urinary and back pains and irritation in the bladder and the urethra. It works quickly on urethral pain (54).

**Marshmallow root (*Althaea officinalis*)**

Inhibits bacterial growth in the urinary tract and strengthens and cleans bladder. It is used as a demulcent, emollient, and a diuretic. It soothes urinary system and helps to treat kidney and bladder inflammations. It effectively stops bleeding in urine (55).

**Yarrow (*Achillea millefolium*)**

It is used as an anti-inflammatory, antipyretic, spasmolytic, diaphoretic and tonic. Yarrow also regulates urination problems and soothes the mucous membranes (56).

**Gravel root (*Eupatorium purpureum*)**

Used as mild diuretic, stimulant, tonic and urinary anodyne. It helps with deep back ache and cloudy and milky urine (57).

**Burdock (*Arctium pubens*)**

Kills diseases causing bacteria and fungi and is effective against UTIs (58).

**Goldenrod (*Solidago virgaurea*)**

Used as a mild antiseptic, diuretic. Helps pain relief in kidney and dark urine (59).

**Cinnamon (*Cinnamomum verum*)**

Proven to completely suppress UTIs causing bacteria and fungus (60).

**Chebolic myrobalan (*Terminalia chebula* Retz.)**

Chebolic myrobalan exhibited antimicrobial potential against multi-drug resistant uropathogenic *E. coli* and the phenolic compounds present in it mainly responsible for this activity (61,62).

**Clinical studies**

Only a few clinical trials on urologic herbs have been made.

Some of these are :

- (i) Modern research has suggested that cranberry may prevent UTIs. In a double blind trial elderly women who drank 300 ml of cranberry juice per day had a decrease in the amount of bacteria in their urine (63). In another study elderly residents of a nursing home consumed either 120 ml of cranberry juice or 6 capsules containing concentrated cranberry daily for 13 months. During this time the number of UTIs decreased by 25% (30). A small double-blind trial with younger women ages 18-45 years with a history of recurring urinary tract infections found that daily treatment with an encapsulated cranberry concentrate (400 mg twice per day) for three months significantly reduced the recurrence of UTIs compared to women taking a placebo (64). Other preliminary trials in humans suggests cranberry may help people with urostomies and enterocystoplasties to keep their urine clear of mucus build up and possibly reduce the risk of UTIs (29). However, one trial found that cranberry did not reduce the risk of UTIs in children with neurogenic bladder disease who were receiving daily catheterization (31).
- (ii) One early trial found that horseradish extract may be a useful treatment for people with urinary tract infections (42). In another trial it was noted that when a particular concentration of horseradish oil is attained in urine, it kills the bacteria that can cause urinary tract infections (40).
- (iii) In a clinical study, berberine, a compound obtained from Oregon grape inhibits the ability of bacteria to attach to human cells, which helps prevent infections, particularly in throat, intestine and urinary tract (47).

**Chemical constituents of some urologic herbs effective against UTIs**

The proanthocyanidins in the cranberry prevents *E. coli*, the most common bacteria that causes UTIs, from adhering to the cells lining to the walls of the bladder (65). The tannin present in blueberry leaf is responsible for treating different ailments including UTIs (66). The leaves of buchu contain 1.0-3.5% volatile oils as well as flavonoids. The urinary tract antiseptic action of buchu are thought to be due to the volatile oils (67). Berberine accounts 5-6% of total alkaloid present in the goldenseal root and rhizome has been shown a wide spectrum of an antibiotic activity against disease causing organisms, such as *Chlamydia*, *E. coli*, *Salmonella typhi* and *Entamoeba histolytica* (68). The volatile oil of horseradish has been shown to kill bacteria that can cause urinary tract infections (40,42). The presence of flavonoids and saponin in horsetail is believed to have a diuretic property (69). The

Table 2. List of commonly used medicinal plants having antimicrobial activities against urinary tract infections

Common name	Botanical name	Plant parts used
Asparagus	<i>Asparagus officinalis</i>	Rhizome and root
Barberry	<i>Berberis vulgaris</i>	Root
Birch	<i>Betula</i> spp.	Bark
Buchu	<i>Barosma betulina</i> , <i>Agathosma betulina</i> , <i>Agathosma crenulata</i>	Leaf
Chamomile	<i>Matricaria recutita</i>	Flower
Chebolic myrobalan	<i>Terminalia chebula</i> Retz.	Fruit
Corn	<i>Zea mays</i>	Silk
Couch grass	<i>Agropyron repens</i>	Rhizome
Cranberry	<i>Vaccinium maroccarpon</i>	Fruit
Dandelion	<i>Taraxacum officinalis</i>	Root and leaf
Garlic	<i>Allium sativum</i>	Garlic cloves
Goldenrod	<i>Solidago virgaurea</i>	Herb
Goldenseal	<i>Hydrastis canadensis</i>	Root and rhizome
Horseradish	<i>Cochlearia armoracia</i>	Root
Horsetail	<i>Equisetum arvense</i>	Stem
Juniper	<i>Juniperus communis</i>	Leaf / berries
Lovage	<i>Levisticum officinalis</i>	Root
Marshmallow	<i>Althaea officinalis</i>	Leaf and root
Nettle	<i>Urtica dioica</i>	Leaf
Oregon grape	<i>Berberis aquifolium</i>	Root
Plantain	<i>Plantago lanceolata</i> , <i>Plantago major</i>	Leaf
Sassafras	<i>Sassafras albidum</i>	Inner bark of the root
Uva ursi	<i>Arctostaphylos uva-ursi</i>	Leaf

Table 3. Active chemical constituents of some urologic herbs having antiinfectant activity against urinary tract infections

Urologic Herbs	Chemical constituents	Reference(s)
Blueberry ( <i>Vaccinium angustifolium</i> )	Tannins	66
Buchu ( <i>Agathosma betulina</i> )	Volatile oils, Flavonoids	67
Cranberry ( <i>Vaccinium maroccarpon</i> )	Proanthocyanidine	65
Goldenseal ( <i>Hydrastis canadensis</i> )	Berberine (alkaloid)	68
Horseradish ( <i>Cochlearia armoracia</i> )	Volatile oils	40, 42
Horsetail ( <i>Equisetum arvense</i> )	Flavonoids	69
Juniper ( <i>Juniperus communis</i> )	Volatile oil (terpinen-4-ol)	24, 70
Nettle ( <i>Urtica dioica</i> )	Polysaccharides, lectins	71
Oregon grape ( <i>Berberis aquifolium</i> )	Berberine	72
Plantain ( <i>Plantago lanceolata</i> )	Mixture of mucilage, iridoid, Aucubin glycosides, and tannin	73, 74
Sassafras ( <i>Sassafras albidum</i> )	Volatile oil	75
Uva ursi ( <i>Arctostaphylos uva-ursi</i> )	Arbutin	28

volatile oils in juniper particularly terpinen-4-ol may cause an increase in urine volume without a lose of electrolytes such as potassium (24,70). Polysaccharides and lectins are probably the active constituents of nettle in treating UTIs (71). Berberine present in oregon grape inhibits the activity of bacteria to attach to human cells, which helps prevent infections particularly in the urinary tract (72). The major constituent of plantain are mucilage, iridoid, glycosides (particularly aucubin) and tannins. Together these constituents are thought to give plantain mild anti-inflammatory and antimicrobial actions (73,74). The volatile oil of sassafras is believed to be the major active constituent of sassafras which is responsible for treating UTIs . This volatile oil contains upto 85% of the terpenoid known as

safrole (75). The glycoside arbutin is the main active constituent in uva ursi. Hydroquinone derived from arbutin and methylarbutin is a powerful antibacterial agent and is thought to be responsible for uva ursi's ability to treat urinary tract infections (28).

#### Possible side effects and cautions

Some of the specific medicinal herbs used for UTIs have been investigated by scientific means while others are prescribed on the basis of long histories of safety and efficacy. Rarely a herb at the prescribed dose causes stomach upset or headache or other complications. This may reflect the purity of the preparation or added ingredients such as synthetic binders or fillers. For this reason, only high quality, standardized extract formulas are recommended. Overuse or



inappropriate use of these herbs may cause several complications, some of these are :

- i. According to a report , long term use of cranberry supplements might increase the risk of developing a kidney stone (76).
- ii. Fresh blueberries tend to be laxative and should be avoided in case of diarrhoea (77).
- iii. Buchu may cause gastrointestinal irritation and should only be taken with meals (78).
- iv. High amounts of goldenseal may lead to gastrointestinal distress and possible nervous system effect (79).
- v. Horseradish at high doses may cause stomach upset, vomiting and excessive sweating (80).
- vi. The correct species of horsetail is considered to be safe. *Equisetum palustre* is another species of horsetail, which contains toxic alkaloids and is well known live-stock poison (81).
- vii. Excessive application of juniper may cause kidney irritation (82).
- viii. Nettle may cause mild gastrointestinal upset in some people. When contact is made with the skin, fresh Nettle can cause a rash secondary to the noted stings (83).
- ix. Long term internal use of oregon grape has been reported to interfere with normal bilirubin metabolism in infants, raising a concern that it might worsen jaundice (84).
- x. Adulteration of plantain with digitalis leading to dangerous side effect has been reported (85).
- xi. Safrrole obtained from sassafras causes liver cancer if given to laboratory animals in high doses and for extended period of time (86).
- xii. Due to high tannin content of uva ursi, some people may experience cramping , nausea or vomiting (87).
- xiii. Berberine-containing plants including barberry, goldenseal and oregon grape should be used with caution during pregnancy and breast feeding. Strong standardized extracts may cause stomach upset and should be used for no more than two weeks continuously. Other symptoms of excessive berberine intake include lethargy, nose bleed, skin , eye and kidney irritation (72,88,89 ).

#### CONCLUSIONS AND RECOMMENDATIONS

The present review article demonstrated that urologic herbs exhibited different types of phytoconstituents and are useful in the treatment of urinary tract infections and could be a potential source for the development of drugs against UTIs. But still little information is available emphasizing the effectiveness of these herbs in children and elderly men and women. Whether these are acceptable for long period of time is not clear. In addition, it is not clear what is the optimum dosage level and method of administration (eg. juice or tablet etc.). Besides, most of the studies have been carried out in laboratory culture media but only a few attempts have been made to assess their utility on human subjects. Nothing is known about the interaction or contribution of herbal mixtures. Therefore, before including urologic herbs and / or their derivatives for the treatment of urinary tract infections, some further evaluations are to be made. Modern drugs from

urologic herbs can be developed after extensive investigation of their bioactivity, mechanism of action, pharmacotherapeutics, toxicity and after proper standardization and clinical trials. As the global scenario is now changing towards the use of non-toxic plant products having traditional medicinal use, development of modern drugs from urologic herbs should be emphasized for the control of urinary tract infections.

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