Li, X-Q, Zhu, J-Y, Pan, R-R, Shen, Y-L, Rahman, K, Zhang, C-Y, Zhang, L-J, Luan, X and Zhang, H

Therapeutic effect of Dongbai-Tonglin-Fang, a Chinese herbal formula, on urinary tract infection in rat model.

Therapeutic effect of Dongbai-Tonglin-Fang, a Chinese herbal formula, on urinary tract infection in rat model

Xiao-Qin Li[a,b1], Jian-Yong Zhu[c1], Rong-Rong Pan[a,c], Yu-Li Shen[a,c], Khalid Rahman[d], Chun-Yan Zhang[c], Li-Jun Zhang[a,*], Xin Luan[a,*], Hong Zhang[a,*]

[a] *Institute of Interdisciplinary Integrative Medicine Research, Shanghai University of Traditional Chinese Medicine, Shanghai 200030, PR China*

[b] *School of Pharmacy, Chengdu University of Traditional Chinese Medicine, Chengdu, China*

[c] *Central Laboratory, Seventh People's Hospital, Shanghai University of Traditional Chinese Medicine, Shanghai 200062, PR China*

[d] *School of Pharmacy and Biomolecular Sciences, Faculty of Science, Liverpool John Moores University, Liverpool L3 3AF, England, UK*

* Corresponding authors:
E-mail addresses: hqzhang51@126.com (H. Zhang), luanxin@shutcm.edu.cn (X. Luan), zhanglijun0407@163.com (L.-J. Zhang).
[1] These authors contributed equally to this work.

Abstract

Ethnopharmacological relevance:

Traditional Chinese Medicine (TCM) has many obvious advantages in the treatment of chronic conditions such as urinary tract infection (UTI). Dongbai-Tonglin-Fang (DBTL), a Chinese herbal formula, has been used for the treatment of UTI for more than 40 years with proven efficacy. However, its mechanism of action is still unknown.

Aim of the study:

The purpose of this study is to evaluate the therapeutic efficacy of DBTL and its mechanism of action in a rat UTI model.

Materials and methods:

E. coli solution induced UTI rat model was used to evaluate the therapeutic effect of DBTL on UTI. Biochemical indicators related to UTI were measured. The kidney tissue was stained with hematoxylin-eosin (HE) to observe pathological changes whilst the ear swelling, feet swelling, hot plate and body torsion tests were used to estimate the anti-inflammatory and analgesic effects of DBTL.

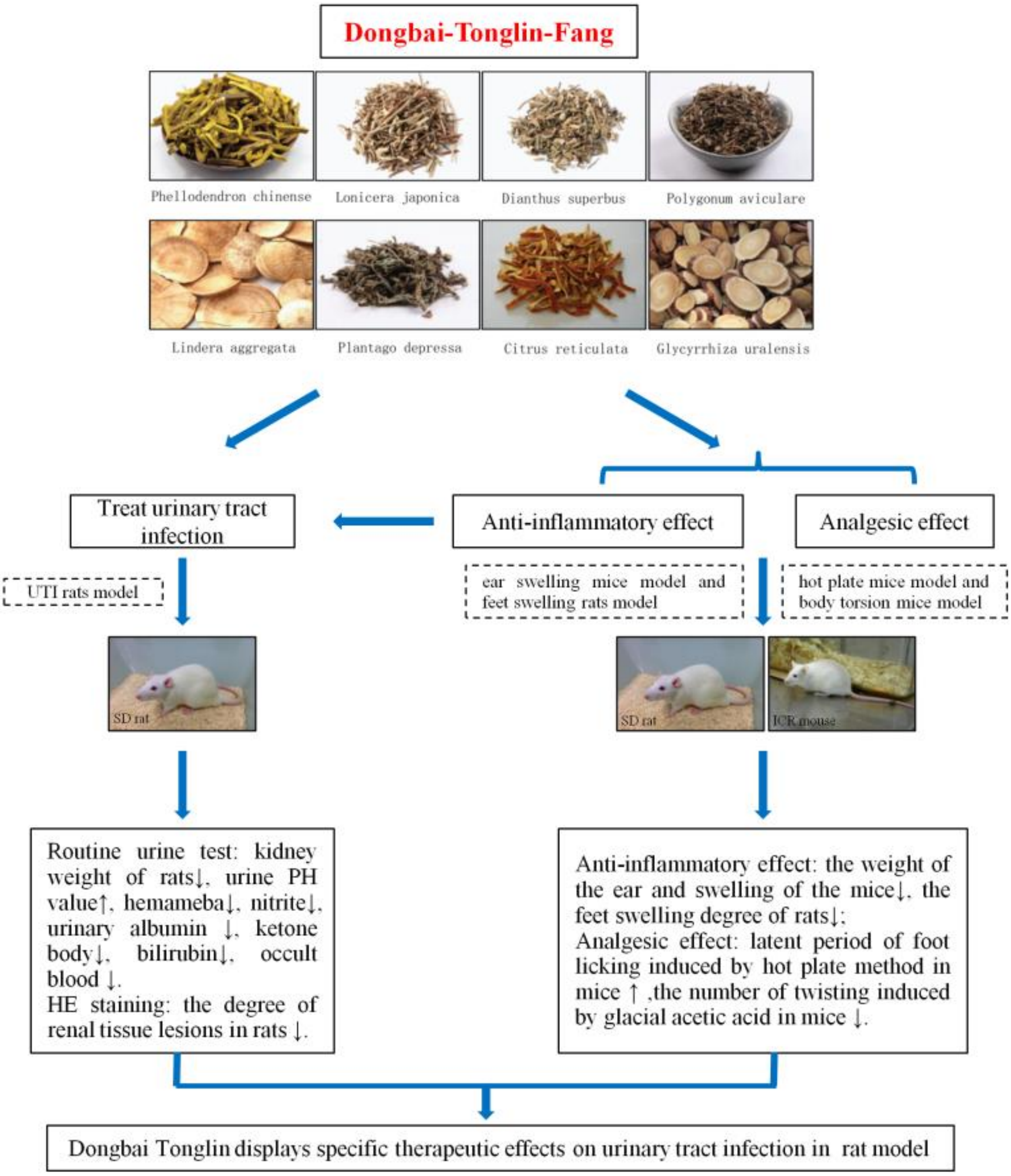
Results:

After treatment with different doses of DBTL (1, 2, 4 g/kg), a decrease in weight of the kidney in the UTI rat model was observed. The contents of white blood cell, nitrite, urinary albumin, ketone body, bilirubin and occult blood in the urine were also reduced whilst an increase in the pH of urine was observed. HE staining showed that the pathological changes in the kidney tissue were alleviated. At the same time, ear swelling assay showed that the weight and the degree of swelling of the ear of the mice in DBTL groups were decreased remarkably. DBTL also reduced the degree of feet swelling of the rats caused by the adjuvant. Furthermore, with the DBTL treatment, the latency period of foot licking induced by thermal stimulation was increased while the number of twists was lessened.

Conclusion:

These results show that DBTL has an excellent therapeutic effect on UTI rats accompanying with anti-inflammation and analgesia. The data presented here lays the foundations for further investigations in the treatment of UTI.

Graphical abstract



Keywords: Dongbai-Tonglin-Fang, urinary tract infection, anti-inflammation, analgesia

List of abbreviations

TCM , traditional Chinese medicine; UTI, urinary tract infection; DBTL, Dongbai-Tonglin-Fang; HE, hematoxylin-eosin; SD, Sprague Dawley; WBC, white blood cell

1. Introduction

Urinary tract infections (UTI) refer to the inflammation of urinary system caused by the reproduction of a large number of microorganisms in the urethra, of which the bacterial infection is the most common. Its main clinical symptoms include frequent urination, urgent urination, urinal pain, purulent urine, fever, chills, pain in the waist and flank, and percussion pain in the kidney area. Due to the different sites and symptoms of infection, it can be divided into upper urinary tract infections (mainly pyelonephritis) and lower urinary tract infections (mainly cystitis and urethritis). This disease is a common multiple disease, ranking second only to respiratory tract infections. Its incidence rate in China accounts for 0.91% of the total population and moreover it tends to occur in women (Dong and Ye, 2003; Pu Yan, 2017; Stamm and Norrby, 2001; Yang, H. et al., 2018). About 50% of women have at least one UTI in their lifetime. More significantly, UTI is dangerous in infants and children because it can lead to kidney disease thus endangering lives. It can also elevate the risk of pyelonephritis, premature delivery, and fetal mortality among pregnant women, and is also associated with impaired renal function and end-stage renal disease among pediatric patients (Bjornsdottir et al., 1998; Foxman, 2003).

UTI belongs to the category of drench syndrome in Traditional Chinese Medicine (TCM) which has great advantages in the treatment of this diseaseas it displays multiple target sites and has integrity, and little toxic and side effects (Yang and Mai, 2012). TCM can also significantly reduce the frequency of recurrence of this disease and further investigation in the mechanism of action of TCM for the treatment of UTI can provide more effective guidance for its use in clinical practice (Yang and Mai, 2012).

Dongbai-Tonglin-Fang (DBTL), a Chinese herbal formula, is a hospital preparation of Shanghai Seventh's Hospital, and has a history of more than 40 years for the treatment of treating UTI (Dai et al., 2017; Shi et al., 2014; Sun, 2008; Yang and Ye, 2010; Zhu et al., 2018; Zhu, 1995). DBTL is composed of 8 herbs, namely *Phellodendron chinense* C.K. Schneid. (Rutaceae), *Lonicera japonica* Thunb. (Caprifoliaceae), *Dianthus superbus* L. (Caryophyllaceae), *Polygonum aviculare* L. (Polygonaceae), *Lindera aggregata* (Sims) Kosterm. (Lauraceae), *Plantago depressa* Willd. (Plantaginaceae), *Citrus reticulata* Blanco. (Rutaceae) and *Glycyrrhiza uralensis* Fisch. (Leguminosae sp.), as shown in Table 1. Among these herbs, *Phellodendron chinense* C.K. Schneid. has damp-drying, heat-clearing, and detoxifying effects. In addition, it is also used clinically for conditions such as dampness-heat diarrhea, jaundice, hot drench, hemorrhoids, night sweats, spermatorrhea etc. (Li et al., 2014). *Lonicera japoni*ca Thunb. can clear heat and can detoxicate (Zhang et al., 2009). *Dianthus superbus* L. and *Polygonum aviculare* L. are effective as diuresis inducers for the treatment of stranguria (Liu, 2011; Yang et al., 2016). *Lindera aggregata* (Sims) Kosterm*is* reported to warm the kidney and regulates Qi and relieves pain (Xing et al., 2017). *Citrus reticulata* Blanco. can regulate Qi, remove dampness and strengthen the spleen (Zhao, 2013). *Plantago depressa* Willd. can dissipate the heat, and displays diuretic and detoxification properties (Yang et al., 2011). *Glycyrrhiza uralensis* Fisch. invigorates the spleen, replenishing Qi, clearing away heat and displays detoxicating potential (Yang, M. et al., 2018). Thus this formula is excellent treating UTI, and is very popular among patients.

Herein, DBTL was administered in the rat-induced UTI model with E. coli solution. At the same time, ear swelling assay, feet swelling assay, hot plate assay, and body torsion assay were used to estimate the anti-inflammatory and analgesic effect of DBTL.

Table 1. The composition of Dongbai-Tonglin-Fang (DBTL)

Scientific name	Chinese name	Weight (g)	Ratio (%)
Phellodendron chinense C.K. Schneid. (Rutaceae)	Huangbai	12	8.11
*Lonicera japoni*ca Thunb. (Caprifoliaceae)	Rendongteng	40	27.03
Dianthus superbus L. (Caryophyllaceae)	Qumai	24	16.22
Polygonum aviculare L. (Polygonaceae)	Bianxu	24	16.22
Lindera aggregata (Sims) Kosterm. (Lauraceae)	Wuyao	12	8.11
Plantago depressa Willd. (Plantaginaceae)	Cheqiancao	24	16.22
Citrus reticulata Blanco. (Rutaceae)	Chenpi	8	5.40
Glycyrrhiza uralensis Fisch. (Leguminosae sp.)	Gancao	4	2.70
Total amount	8	148	100

2. Materials and methods

2.1. Preparation of DBTL

The 8 herbs of DBTL were purchased from Shanghai Kangqiao Chinese herbal pieces co., LTD. All the herbs were prepared in proportion by soaking in 10 times their weight in pure water and were then extracted three times by refluxing for 1 h. This solution was then filtered and the filtrate concentrated, to a thick paste with a relative density of 1.25-1.34 (80 ℃).

2.2. HPLC/ESI-MS and fingerprint analysis

An Agilent 1100 HPLC system, equipped with a quaternary pump, an autosampler, a degasser, an automatic thermostatic column compartment, a DAD and an LC/MSD Trap XCT ESI mass spectrometer (Agilent Technologies, MA, USA), was used for the separation of the constituents of DBTL. The separation was performed on a GS-120-5-C18-BIO chromatographic column (5 μm, 250 × 4.6 mm i.d.) with the column temperature set at 35°C. A linear gradient elution of A (0.1% formic acid water) and B (acetonitrile) was used with the gradient procedure as follows: 0 min, B 5%, to 60 min B 40% (v/v). The flow rate was 1.0 mL/min and the injection volume was 10 μL. DAD was on and the target wavelength was simultaneously set at 210 nm the split ratio to the mass spectrometer was 1:3. The acquisition parameters for negative ion mode were: collision gas, ultra high-purity helium (He), nebulizer gas (N2), 35 psi, drying gas (N2), 10 L/min, drying temperature, 350°C, HV, 3500 V, mass scan range, m/z 100-2200, target mass, 500 m/z, compound stability, 100%, trap drive level, 100%. All the data were analysed by Chemstation software.

2.3. Establishment of UTI model in rats and Animal treatment

Male Sprague Dawley (SD) rats were obtained from Shanghai Xipul-Bikai Experimental Animal Co., Itd.. As reported (Hou et al., 1998), the rats were denied access to water for 18 hours, and were then anesthetized by intraperitoneal injection of 10% chloral hydrate. An incision of approximately 2 cm was made in the middle of the lower abdomen of the rats and the left posterior abdominal wall was exposed and the left ureter identified. Following this the angle pin of $4^{\#}$ thread was inserted from both sides of the middle part of the ureter to the lateral side of the posterior abdominal wall respectively. The bladder was then exposed and the penis was closed with an arterial clamp. The $5^{\#}$ syringe containing 0.75 ml of the prepared $1x10^5$/mL escherichia coli bacteria (ATCC25922) solution was inserted into the bladder slowly. Both ends of the silk thread on the outside of the abdominal wall were then tightened. And the ureter was ligated with appropriate tightness. At last, the abdominal cavity was cleaned and the wound was stitched. 20 h later, the ligation line of the ureter outside the abdominal wall was removed to re-open the ureter. For the normal control group, 10 SD rats had their abdominal cavity opened in the same way, without any treatment, and both groups were allowed access to water and food. The compound to be tested was intragastricly administered consecutively for 7 days.

The rats were divided into normal control group, model control group, positive control groups (0.05 g/kg levofloxacin tablets and 0.348 g/kg Sanjin tablets), DBTL-L group (1 g/kg), DBTL-M group (2 g/kg), and DBTL-H group (4 g/kg), each group contained 10 animals. Urine collection began an hour after the last administration for urine bacterial culture and routine urine examination. The rats were then sacrificed by cervical dislocation, kidneys were removed, weighed and kidney tissure prepared for hematoxylin-eosin (HE) staining for pathological examination.

2.4 Inflammation models and Animal treatment

2.4.1 Ear swelling assay

Fifty mice were divided into model control group, positive control group (0.36 g/kg, aspirin), and DBTL groups (1, 2, and 4 g/kg). Mice were orally administered daily for one week and 1 hour after the last dose, mice were treated with 0.1 mL xylene on both sides of the right ear, and the left ear was used as a normal control. After a further 1h, the mice were anesthetized by 3% chloral hydrate and their ears were cut along the baseline of auricle, then punched down with the round piece in the same part of the left and right ear with a ear piercer, weighed and the degree of inhibition rate of ear swelling calculated as shown below.

Inhibition rate = (right ear weight / left ear weight) / left ear weight *100.

2.4.2 Feet swelling assay

Fifty male rats were divided into model control group, positive control group (0.36 g/kg, aspirin), and DBTL groups (1 g/kg, 2 g/kg, and 4 g/kg). The oral gavage was performed daily for a week and 1 h after the last administration, 0.1 mL adjuvant was injected into the right posterior foot plantar fascia of rats to induce inflammation. The diameter of the right posterior foot was measured by vernier caliper every 1 hour before and 1-6 h post-inflammation.

2.5 Establishment of pain model in mice and Animal treatment

2.5.1 Body torsion assay

Fifty mice were divided into model control group, positive control group (0.36 g/kg, aspirin), and DBTL groups (1 g/kg, 2 g/kg, and 4 g/kg). The oral gavage was performed daily for a week and 1 h after the last administration, 0.7% glacial acetic acid was injected intraperitoneally (10 mL/kg). Meanwhile the number of torsions (including abdominal contraction and coved, stretched the hind legs, raised hip, crawl) within 15 minutes after administration were recorded in each group.

2.5.2 Hot plate assay

A water bath was heated to a constant temperature of 55 ± 0.5℃, the bottom of the beaker touched the water and was heated by thermal stimulation. A stopwatch was used to record the time between mice being placed on the hot plate to the time they appeared to lick their feet as exceeding the threshold of pain. The female mice were placed on the hotplate and the pain threshold was measured three times. The licking of the feet was regarded as pain response index and those mice displaying a pain response of 30 seconds were selected. A total number of 50 mice were selected.

The selected mice were divided into model control group, positive control group (0.36 g/kg, aspirin), and DBTL groups (1 g/kg, 2 g/kg, and 4 g/kg). The oral gavage was performed daily for one week and 1 h after the last administration, the mice were placed in a constant temperature beaker (55 ± 0.5 °C), room temperature was 20.0 ± 1 °C, and the time taken to perform the first licking of feet was recorded in each group.

2.6 Statistical analysis

The results are expressed as means ± standard deviation (SD). Analysis of variance (ANOVA) and Kruskal-wallis H test was used to test the significance of the difference. All statistical analyses were two-sided and performed using the Statistical Package for the Social Sciences software version 17.0 (SPSS, Inc., Chicago, IL, USA). A p-value < 0.05 was considered statistically significant.

2.7. Statement

The experiments were carried out in accordance with the guidelines issued by the Experimental Animal Ethical Committee of Seventh People's Hospital of Shanghai University of Traditional Chinese Medicine.

3. Results

3.1 Identification of ten compounds in DBTL

The aqueous extract of the mixture of 8 Chinese medicinal materials was separated by high-performance liquid chromatography coupled with electrospray mass spectrometry (HPLC/ESI-MS) in negative and positive-ion mode (**Fig. 1**). Ten compounds **1–10 (Fig. Sl)**, with the retention time of 0.74 min, 7.40 min, 7.71 min, 9.29 min, 10.62 min, 11.63 min, 12.81 min, 16.27 min, 8.34 min, and 9.62 min respectively, were identified as phellodendrine (**1**), isochlorogenic acid (**2**), methyl chlorogenate (**3**), gycycoumarin (**4**), myricitrin (**5**), naringin (**6**), hesperidin (**7**), glycyrrhizin (**8**), isocorypalmine (**9**), and norboldine (**10**), on the basis of the observation of the pseudomolecular ion peak at *m/z* 377.0924 $[M + Cl]^-$ (**1**), *m/z* 353.0908 $[M - H]^-$ (**2**), *m/z* 367.1064 $[M - H]^-$ (**3**), *m/z* 367.1094 $[M - H]^-$ (**4**), *m/z* 463.0915 $[M - H]^-$ (**5**), *m/z* 579.1761 $[M - H]^-$ (**6**), *m/z* 609.1894 $[M - H]^-$ (**7**), *m/z* 821.4018 $[M - H]^-$ (**8**), *m/z* 342.1737 $[M + H]^+$ (**9**), *m/z* 314.1762 $[M + H]^+$ (**10**), in HPLC/ESI-MS chromatogram, in accordance with the molecular weights of ten compounds (phellodendrine, isochlorogenic acid, methyl chlorogenate, gycycoumarin, myricitrin, naringin, hesperidin, glycyrrhizin, isocorypalmine, and norboldine). A total of 10 compounds were unambiguously identified by comparing the retention times and the MS data with the reference standards.

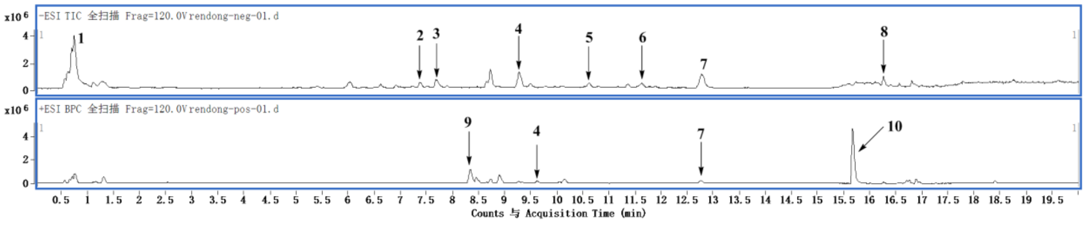


Fig. 1. HPLC/ESI-MS chromatogram of the aqueous extract in negative and positive mode.

3.2 DBTL reduced the kidney weight in UTI rats

The changes in kidney weight in rats were measured to evaluate the effect of DBTL on UTI rats are shown in Fig. 2. The kidneys of rats in model group were much heavier than those from the normal control group ($p < 0.05$). After treating with Levofloxacin, Sanjin tablets, and DBTL, the kidney weight was decreased significantly ($p < 0.05$). This reduction in kidney weight is positively correlated with the dose of DBTL.

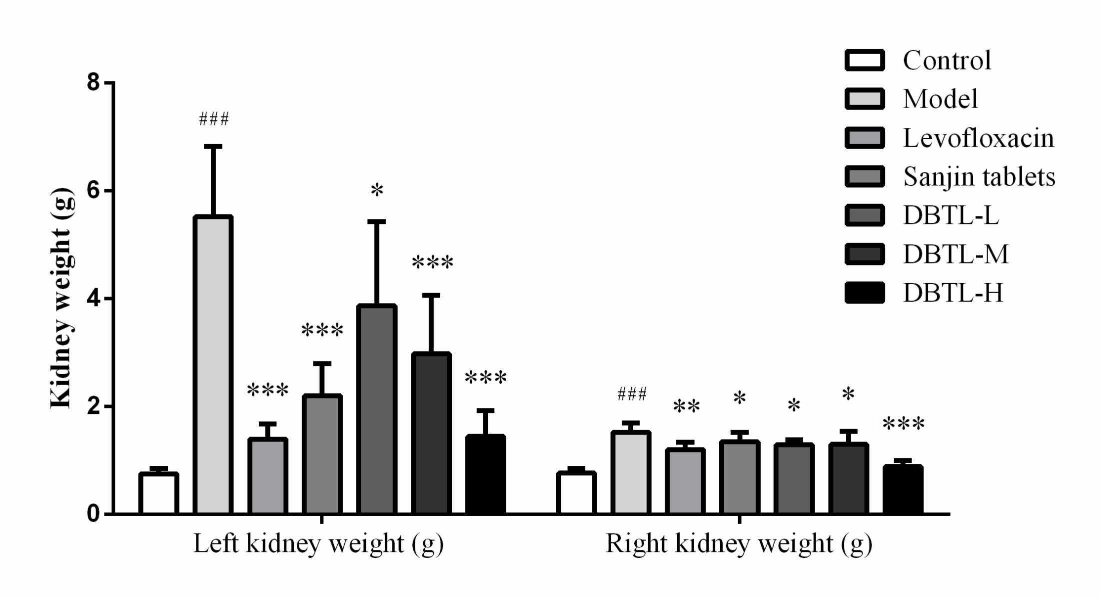


Fig. 2. DBTL reduced the kidney weight in UTI rats. The changes of left and right kidney weight in rats were measured in the model group, normal control group, Levofloxacin group, Sanjin tablets group, and DBTL groups. $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$ versus model group, $^{\#\#\#}p<0.001$ versus control group, n=10.

3.3 DBTL improved the biochemical indicators in UTI rats

To evaluate the effect of DBTL on UTI rats, biochemical indicators were measured, and the results of these were presented in Fig. 3. Compared with the normal control group, the pH value was decreased significantly in UTI model group ($p < 0.05$) and the pH value was increased after treating with Levofloxacin, Sanjin tablets, and DBTL (Fig. 3a). Besides, in UTI rats, the contents of white blood cell (WBC), nitrite, urinary albumin, ketone body, bilirubin and occult blood in urine were higher than that present in the normal control group. In contrast, a significant dose dependent reduction in these parameters was observed after treatment with Levofloxacin, Sanjin tablets, and DBTL (Fig.3b-3g) ($p < 0.05$). Bacteria were detected in the urine of the model group. However, no bacteria were confirmed in the urine of normal control, Levofloxacin, Sanjin tablet, and DBTL groups.

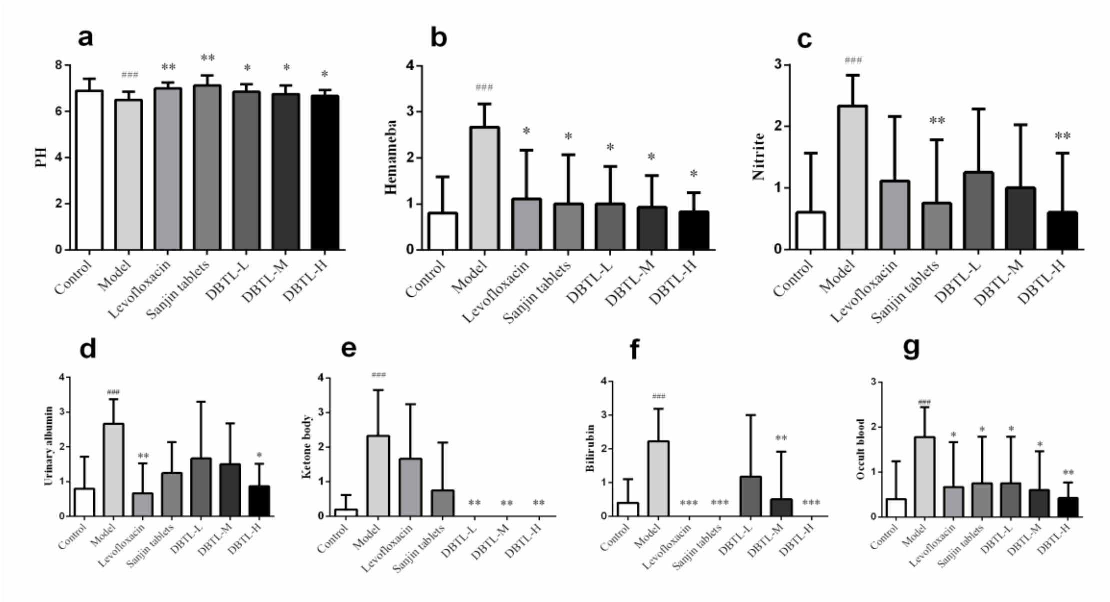


Fig. 3. DTG improved the biochemical indicators in UTI rats. The pH value, the contents of white blood cell, nitrite, urinary albumin, ketone body, bilirubin and occult blood were detected in the model group, normal control group, Levofloxacin group, Sanjin tablets group, and DBTL groups. $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$ versus model group, $^{###}p<0.001$ versus control group, n=10.

3.4 DBTL improved the abnormal histology in UTI rats

The changes in the pathology of renal tissues were observed by histology after staining with H&E. As shown in Fig. 4, there were no inflammatory cells found in renal tissue of rats in the normal control group. While in the UTI model control group, mucosa degeneration, necrosis, apoptosis, shedding with visible edema and a large number of infiltrated inflammatory cells were present in the renal tissues together with pus pellets. The renal tissue lesions were ameliorated after treating with Levofloxacin, Sanjin tablets, and DBTL. However, there was a small amount of mucosa apoptosis, degeneration, necrosis, but no apparent edema and rare inflammatory cells were observed.

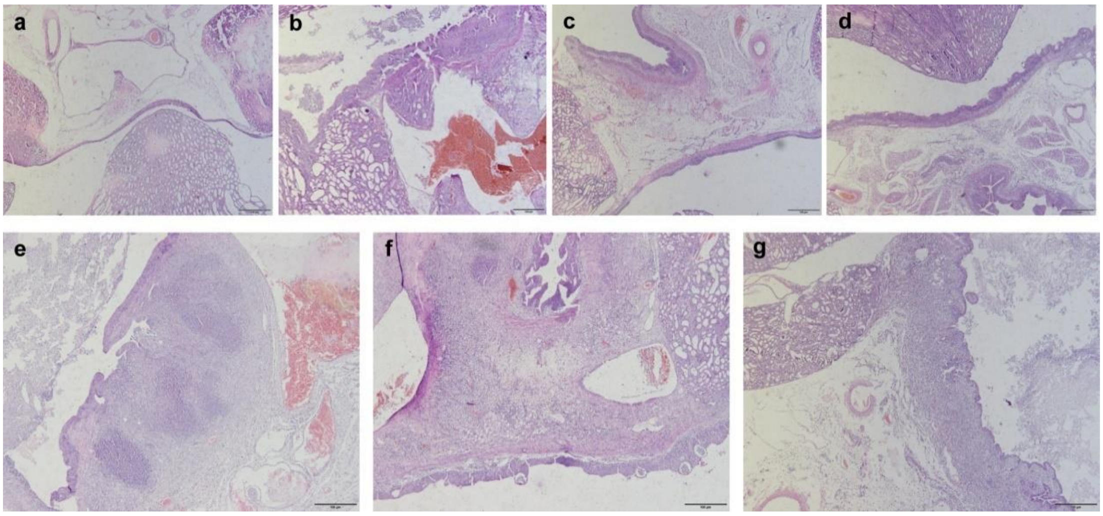


Fig. 4. Histological images of renal tissues stained with H& E. a. model group, b. normal control group, c. Levofloxacin group, d. Sanjin tablets group, e. DBTL-L group, f. DBTL-M group, g. DBTL-H group. (original magnification × 400), n=10.

3. 5 DBTL relieved pain in mice

The effects of DBTL on body torsion induced by glacial acetic acid and hot plate reaction in mice are shown in Fig. 5a and 5b. The number of twisting induced by glacial acetic acid in administration groups was decreased significantly compared with the model group ($P < 0.01$ & $P < 0.05$). The incubation period of the licking feet time induced by hot plate was sharply increased in a dose-dependent manner after treatment with aspirin and DBTL.

3. 6 DBTL resisted inflammation in mice and rats

To confirm the anti-inflammatory effect of DBTL, the mice auricle swelling model induced by xylene and the rat foot swelling model caused by adjuvant were established. As shown in Fig. 5c and 5d, after administration of DBTL and aspirin, the weight and auricle swelling degree of mice in each administration group were all alleviated compared with the model group to different degrees ($P < 0.01$ & $P < 0.05$). Likewise, the foot swelling of rat was significantly lower than the model group ($P < 0.01$ & $P < 0.05$).

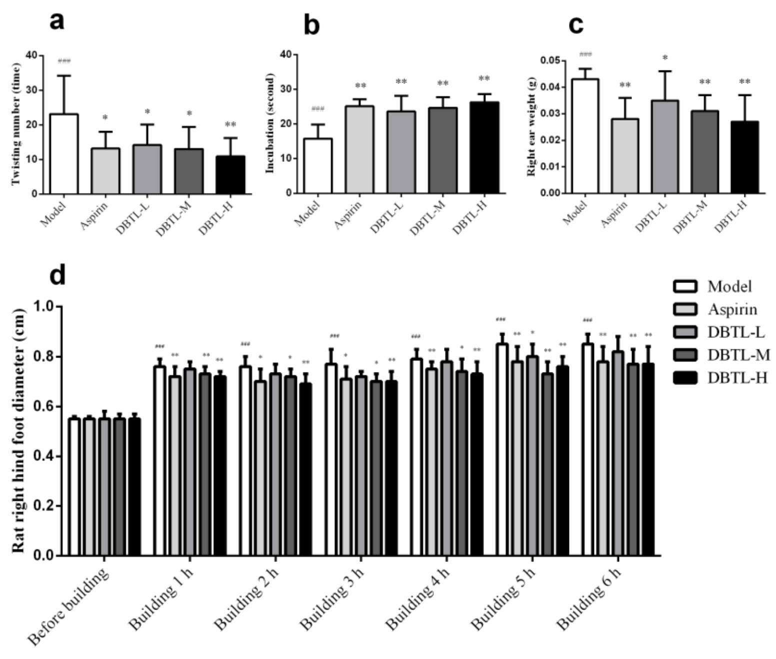


Fig. 5. DBTL alleviated pain and inflammation in mice and rats in model control group, positive control group (aspirin), DBTL groups. (a) The number of twisting induced by glacial acetic acid. *p<0.05, **p<0.01 versus model group (b) The change of incubation period of the licking feet time of mice induced by hot plate. *p<0.05, **p<0.01 versus model group (c) The change of right ear weight of mice. *p<0.05, **p<0.01 versus model group (d) The change of foot swelling of rats. *p<0.05, **p<0.01 versus model group, ###p<0.001 versus control group, n=10.

4. Discussion

UTI also known as urinary system infection is the urinary tract epithelium inflammation caused by the invasion of bacteria. The pathogenesis of UTI is understood increasingly at the level of the uropathogens and the cellular and molecular mediators of host inflammatory responses (Bien et al., 2012; Birder and Klumpp, 2016). Women, children, and the elderly are highly predisposed to developing UTI (Foxman, 2014). Unresolved inflammation during UTI can cause chronic infection and irreversible renal damage (Svanborg, 2013; Ulett et al., 2013). Due to its prevalence, frequent recurrence and rising resistance to antibiotics, UTI has become a challenge in clinical practice (Gao et al., 2017).

Therefore, Traditional Chinese Medicine which can be used to treat UTI has received considerable attention. TCM has clear advantages in treating UTI, especially for chronic patients due to its natural nature and minimum side effects. Compared with antibiotics, TCM has fewer side effects, do not cause microflora disorders, and are inexpensive, suitable for long-term use. DBTL, a Chinese herbal formula, is a hospital preparation of Shanghai Seventh People's Hospital, which has a history of more than 40 years for the treatment of UTI. In this study, administration with E. coli solution induced UTI rat model was used to evaluate the therapeutic effect of DBTL on UTI.

The UTI patients are usually investigated by performing routine urine examination, and some of these indicators have important reference significance. The changes in urine pH are closely related to UTI; low pH is beneficial in that it inhibits bacterial growth. Urinary tract infection takes hold easily if the urine pH is alkaline, so adjusting the pH value is of great significance for the prevention and treatment of UTI (Li-Ping et al., 2012; Zhou, 2007). Nitrites are important in the diagnosis and detection of urinary system diseases because they result from microorganisms that reduce nitrate to nitrous acid in urine, something that occurs especially in the UTI. In normal urine, urinary nitrite is negative because of the absence of bacteria, while positive in patients with UTI (liao, 2012; Ma et al., 2007). Urine bacteria and white blood cell (WBC) detection are also the main basis for the diagnosis of UTI. Combining urine culture with WBC counts significantly increases the diagnostic rate (Sun et al., 2012). After treatment with DBTL, the pH value was increased; the contents of WBC, nitrite, urinary albumin, ketone body, bilirubin and occult blood in urine were all reduced in UTI rats and the urine was negative for bacteria in the DBTL groups. These results indicate that DBTL has a great therapeutic effect in the treatment of UTI.

Inflammation is a defining feature of the most common form of clinical UTI and is a common symptom observed during UTI (Hooton, 2012; Rudick et al., 2010). Although the inflammatory response is triggered to clear pathogens, there's a lot of damage to host tissue. E. coli is the primary cause of UTI in healthy people (Foxman, 2010; Hooton, 2012). The results confirmed that DBTL has a significant therapeutic effect on UTI and anti-inflammatory effect. H&E staining of renal tissue also showed that DBTL could alleviate the degree of inflammation in mice.

10 compounds were identified from DBTL, including phellodendrine, isochlorogenic acid, hesperidin, and so on. Phellodendrine ameliorated the ROS-mediated inflammatory response. Li et al. found that AAPH caused a significant increase in the production of reactive oxygen species (ROS), lipid-peroxidation and cell death rate, all of which could be decreased after treating with phellodendrine dose-dependently(Li et al., 2016). Iso-chlorogenic acid A has great antioxidant and anti-inflammatory activities. It reduced the number of macrophages in zebrafish induced by $CuSO_4$ in the experimental concentration range (5-40 pg/ml) (Hou et al., 2016). Hu et al. found the

chlorogenic acid extract had obvious antibacterial activity against shigella dysenteriae and staphylococcus aureus (Hu et al., 2010). Chlorogenic acid could also treat septic arthritis caused by candida albicans, and its mechanism might be related to the inhibition of NO production and proliferation of T cells. Hesperidin had a significant inhibitory effect on secondary inflammation in rats (Li et al., 2006), and it was related to the regulation of abnormal immune function and maintenance of cytokine network balance. Therefore, the effect of DBTL on urinary tract infection in rats and anti-inflammatory may be closely related to these compounds, which can be further studied later.

The UTI is not only accompanied by some degree of inflammation, but it also causes the corresponding pain. The bladder urothelium is considered a mediator of sensory responses and appears to play a role in UTI pain responses. Pathogenic factors of uropathogens induce urothelial damage that could cause pain due to compromised bladder-barrier function (R et al., 2005; Rosen and Klumpp, 2014; Stemler et al., 2013). In addition, bacterial glycolipids are the major determinants of UTI pain independent of urothelial damage. In summary, UTI pain is a complex form of visceral pain, and its specific mechanism needs further investigation (Birder and Klumpp, 2016). Also, it was observed in this study that the DBTL can increase the latent period of foot licking induced by hot plate method and reduce the number of twisting induced by glacial acetic acid in mice, suggesting that DBTL displays an analgesic effect.

To sum up, UTI is a common but complex disease, and there is no complete specific treatment available. In this study, the UTI model in rats was established to evaluate the effect of DBTL on UTI. The results show that DBTL has an excellent therapeutic effect on UTI and furthermore displays anti-inflammation and analgesic effects. The data presented in this study provides a new idea and method for the treatment of UTI and lays the foundations for further investigation in the treatment of UTI.

Conflict of interest

None.

Acknowledgements

This work was supported by funds from the National Natural Science Foundation of China (81703755 and 81773941), Shanghai Municipal Science and Technology Commission (15401902700 and 15401971800), Shanghai Municipal Health and

Family Planning Commission (20154Y0063), Shanghai Municipal Health and Family Planning Commission of Scientific Research Fund in Chinese Medicine (2018YQ001), Outstanding Leaders Training Program of Pudong Health Bureau of Shanghai (PWR12015-05), Excellent Youth Medical Talents Training Program of Pudong Health Bureau of Shanghai (PWRq2016-05), Shanghai University of Traditional Chinese Medicine—Gaofeng Clinical Medicine Grant Support, and Pudong New Area Science and Technology Commission (PKJ2015-Y13).

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