International Journal of Medicine
pISSN 1468-3814 | eISSN 2667-7008
https://theinternationalmedicine.com/

*Original Researcher Article* *DOI: 10.61336/im/26-2-12*

# Cranberry Extract Versus D-Mannose in Reducing Recurrent Urinary Tract Infection: A Retrospective Cohort Study at a Tertiary Care Centre.

**Dr.(Prof.) Hemant Kumar[1]*, Dr. Shashi Kumar MBBS[2].**

*[1]MBBS(Gold Medalist), MD, DM(Nephro), FISN(USA), FRCP(Edin) Former Professor & HOD, Nephrology, Patna Medical College, Patna, Bihar, India.*

*[2]MBBS, MD, DM(Nephro), FASN, FICP Director & HOD, Nephrosciences, Paras HMRI Hospital, Patna, Bihar, India.*

**Correspondence:**
***Dr.(Prof.) Hemant Kumar..***
*MBBS(Gold Medalist), MD, DM(Nephro), FISN(USA), FRCP(Edin) Former Professor & HOD, Nephrology, Patna Medical College, Patna, Bihar, India.*

**Received:** 12-12-2025
**Revised:** 29-12-2025
**Accepted:** 08-01-2026
**Published:** 25-01-2026

## Abstract

***Background:*** Recurrent urinary tract infection (rUTI) affects 25–30% of women following an index episode and poses a growing challenge amid escalating antimicrobial resistance. Non-antibiotic prophylactic agents are urgently needed. Cranberry extract and D-mannose have biological plausibility but have not been compared head-to-head in an adequately powered Indian cohort. ***Objective:*** To compare the efficacy and safety of standardised cranberry extract (proanthocyanidin [PAC] 36 mg/day) with D-mannose (2 g/day) versus standard care in preventing rUTI over 12 months, based on retrospective review of clinical records. ***Study Design:*** Retrospective cohort study conducted using medical records from a tertiary care teaching hospital in Lucknow, India. ***Results:*** At 12 months, there was no difference between Groups A and B; recurrence was lower in Groups A (24.5%) and B (27.3%) compared to C (57.6%; $p<0.001$); time-to-recurrence was longer in A (214 d) and B (197 d) compared to C (112 d). The CFU reduction was highest in A (1.8 $\log_1^1$) compared to B (1.5) and C (0.4), and both treatments were well tolerated with no significant side effects. ***Conclusion:*** Cranberry extract, standardised to PAC 36 mg/day, and D-mannose 2 g/day are associated with significantly reduced rUTI recurrence compared with standard care and represent effective, resistance-sparing prophylactic options. Cranberry extract demonstrated slightly better bacteriological results, but clinical recurrence rates were similar between the active groups. These data support use of either agent as a non-antibiotic first-line prophylaxis in uncomplicated rUTI.

**Keywords:** recurrent urinary tract infection; cranberry extract; proanthocyanidins; D-mannose; retrospective cohort study; tertiary care centre; non-antibiotic prophylaxis; antimicrobial resistance; India.



## INTRODUCTION

Urinary tract infections (UTIs) are among the most common bacterial infections affecting women worldwide, with an annual global incidence exceeding 150 million cases.[1] Recurrent UTI (rUTI), defined as ≥2 microbiologically confirmed episodes within 6 months or ≥3 within 12 months, affects approximately 27% of women following an index infection and is associated with impaired quality of life, increased healthcare utilisation, and significant psychosocial morbidity.[2]

Uropathogenic Escherichia coli (UPEC) causes 75–90% of rUTI episodes and expresses virulence factors — notably type-1 (FimH) and P-fimbriae — that facilitate adherence to uroepithelial mannose and Galα(1–4)Gal receptors, respectively.[3] This adhesion-dependent pathogenesis underpins the rationale for prophylactic agents that competitively inhibit fimbrial binding without exerting direct antimicrobial pressure.

Low-dose antibiotic prophylaxis (LDAP) achieves recurrence reduction of 50–95% but drives the emergence of multi-drug-resistant (MDR) uropathogens, disrupts the vaginal and gut microbiome, and is increasingly contraindicated given the global antimicrobial resistance (AMR) crisis.[8,9] India bears a particularly high MDR-UTI burden: >60% of community-acquired UPEC isolates now harbour resistance to fluoroquinolones and trimethoprim–sulfamethoxazole in tertiary-care settings, making alternative prophylaxis strategies an urgent clinical priority.[3]

Cranberry extract has anti-adhesion activity due to A-type proanthocyanidins (PACs), which inhibit the expression and binding of type-1 and P-fimbriae.[4,5] Anti-adhesion activity in urine is dose-dependent and consistently observed only at PAC concentrations equivalent to ≥36 mg/day of standardised extract, according to in vitro and ex vivo data.[4] D-mannose is a simple monosaccharide that saturates FimH lectins and prevents their engagement with uroepithelial mannose residues, thereby promoting bacterial clearance in urine rather than mucosal colonisation.[6,7]

Despite biological plausibility for both agents, existing head-to-head comparative data are sparse. Published studies are limited by small sample sizes, variable cranberry product composition, short follow-up periods, and near-exclusive recruitment from Western populations.[13,14,17] No adequately powered, retrospective analysis comparing standardised cranberry extract and D-mannose has been conducted at a tertiary care centre in the Indian subcontinent, where baseline bacteriological profiles, dietary factors, and microbiome composition differ substantially from European and North American cohorts.

We therefore conducted a retrospective cohort study to evaluate whether cranberry extract (PAC 36 mg/day) and D-mannose (2 g/day), as documented in clinical records, were each associated with at least a 40% reduction in 12-month rUTI recurrence compared with standard care, and to determine whether the two active regimens differed meaningfully in clinical and microbiological outcomes.

## MATERIALS AND METHODS

### Study Design and Setting

Medical records from the Department of Urology, SGPGIMS, Lucknow, Uttar Pradesh, India were reviewed for the period September 2020 to March 2023. This was a single-centre, retrospective cohort study with three comparison groups based on the clinical management documented in the records.

### Participants

**Inclusion criteria:** (i) Non-pregnant women aged 18–65 years; (ii) ≥2 microbiologically confirmed UTI episodes (midstream urine [MSU] culture ≥$10^5$ CFU/mL of a single uropathogen) in the 6 months prior to the index clinical visit; (iii) no antibiotic use within 4 weeks of the index visit; (iv) documented follow-up of at least 12 months in the hospital records.

**Exclusion criteria:** Pregnancy or planning pregnancy; current breastfeeding; urological structural anomaly (e.g., vesicoureteric reflux, neurogenic bladder); indwelling urinary catheter; immunosuppressive therapy; diabetes mellitus with HbA1c >8%; active nephrolithiasis; chronic renal failure (eGFR <45 mL/min/1.73 $m^2$); or documented allergy to cranberry or mannose.

### Patient Grouping

Patients were classified into three groups based on the documented clinical management strategy at the index visit: Group A comprised patients in whom standardised cranberry extract (PAC 36 mg/day, Vaccinium macrocarpon standardised extract, one capsule orally once daily in the evening with food) was prescribed for 12 months; Group B comprised patients prescribed D-mannose powder (2 g dissolved in 200 mL water, once daily in the evening) for 12 months; and Group C comprised patients managed with standard supportive care alone, including hydration advice, voiding habit guidance, and hygiene measures.

Grouping was based solely on treating physician documentation in the medical record. Participants in all groups had standardised written advice on hydration (≥1.5 L/day), voiding frequency, post-coital voiding, and hygiene documented in their records. Use of topical oestrogens in post-menopausal women was recorded where applicable. Episodic breakthrough UTIs were treated with a 5-day course of nitrofurantoin 100 mg twice daily per institutional protocol.

### Outcome Measures

Primary outcome: Proportion of patients with ≥1 microbiologically confirmed UTI recurrence (MSU culture ≥$10^5$ CFU/mL of a single uropathogen in the context of ≥2 lower urinary tract symptoms) over the 12-month follow-up period, as documented in the clinical records**.**

Secondary outcomes: (i) Time-to-first recurrence; (ii) total UTI episodes per participant-year; (iii) urinary symptom severity score (USSQ 0–45); (iv) antibiotic courses for breakthrough UTIs; (v) urinary E. coli CFU reduction (log CFU/mL); (vi) QoL score (0–100); (vii) treatment adherence; and (viii) adverse events recorded in the clinical notes.

### Data Collection and Follow-up

Data were extracted from outpatient records, laboratory reports, and follow-up documentation at 1, 3, 6, 9, and 12 months from the index visit. At each documented clinic review, MSU culture and sensitivity results were retrieved regardless of symptoms. Symptom diary entries, adherence assessments, and adverse event notes were systematically collected from the records. 282 patient records (94%) had complete 12-month follow-up data.

### Microbiological Methods

Midstream urine samples had been processed within 2 hours of collection. Standard quantitative culture was performed on CLED agar. Species identification was carried out via VITEK-2. Antimicrobial susceptibility was determined by Kirby-Bauer disc diffusion per CLSI 2021 breakpoints. E. coli isolates underwent PCR for fimH (type-1 fimbriae) and papG (P-fimbriae) virulence genes.

### Statistical Analysis

Analysis was done according to protocol. Chi-square was used to compare recurrence (RR, 95% CI). Time-to-recurrence was evaluated using Kaplan-Meier/log-rank and adjusted Cox regression. ANOVA with Bonferroni correction was performed for continuous outcomes, and propensity scoring was employed to account for confounding. Significance: $p<0.05$. R v4.3 and SPSS v28.0 were used for analysis.First.

## RESULTS

### Patient Flow and Baseline Characteristics

After screening 420 patient records, 120 were eliminated (46 had incomplete records, and 74 did not match the inclusion criteria). There were 300 records total, 100 for each group. For 282 patients (94%), full 12-month follow-up data were available. All groups had similar baseline clinical and demographic characteristics (Table 1; all $p > 0.05$.[11]

**Table 1. Baseline Demographic and Clinical Characteristics of the Study Population**

| Characteristic | Group A: Cranberry (n=100) | Group B: D-Mannose (n=100) | Group C: Control (n=100) | p-value |
|---|---|---|---|---|
| Age, mean ± SD (years) | 38.4 ± 10.2 | 39.1 ± 11.4 | 37.8 ± 10.8 | 0.742 |
| Premenopausal, n (%) | 71 (71.0) | 73 (73.0) | 70 (70.0) | 0.886 |
| BMI, mean ± SD (kg/m²) | 24.7 ± 3.8 | 25.1 ± 4.1 | 24.4 ± 3.6 | 0.511 |
| UTI episodes in prior 6 mo, mean | 2.8 ± 0.6 | 2.9 ± 0.7 | 2.7 ± 0.5 | 0.213 |
| E. coli as causative organism, n (%) | 82 (82.0) | 79 (79.0) | 81 (81.0) | 0.807 |
| fimH-positive isolate, n (%) | 74 (74.0) | 71 (71.0) | 73 (73.0) | 0.831 |
| Prior antibiotic prophylaxis, n (%) | 28 (28.0) | 31 (31.0) | 29 (29.0) | 0.849 |
| Sexually active, n (%) | 64 (64.0) | 61 (61.0) | 63 (63.0) | 0.887 |
| Baseline USSQ score, mean ± SD | 18.4 ± 4.3 | 19.1 ± 4.7 | 18.7 ± 4.1 | 0.624 |
| Baseline QoL score, mean ± SD | 49.2 ± 8.7 | 48.6 ± 9.1 | 50.1 ± 8.3 | 0.561 |

### Primary Outcome: UTI Recurrence at 12 Months

At 12 months, UTI recurrence was 24.5% in Group A, 27.3% in Group B, and 57.6% in Group C ($p<0.001$). Both active groups had significantly lower recurrence vs standard care (A: RR 0.43; B: RR 0.47; $p<0.001$), with no difference between Groups A and B ($p=0.481$).[4,6]

**Table 2. Primary Outcome: UTI Recurrence at 12 Months by Treatment Group**

| Outcome Measure | Group A Cranberry (n=94) | Group B D-Mannose (n=96) | Group C Control (n=92) | RR (95% CI) vs Control | p-value |
|---|---|---|---|---|---|
| UTI recurrence, n (%) | 23 (24.5%) | 26 (27.3%) | 53 (57.6%) | — | <0.001 |
| Group A vs Control | — | — | — | 0.43 (0.30–0.60) | <0.001 |
| Group B vs Control | — | — | — | 0.47 (0.34–0.66) | <0.001 |
| Group A vs Group B | — | — | — | 0.91 (0.58–1.43) | 0.481 |
| Number needed to treat | 3.0 | 3.3 | — | — | — |
| Absolute risk reduction (%) | 33.1% | 30.3% | — | — | — |

**Time-to-First Recurrence**

UTI-free survival varied significantly, according to Kaplan-Meier analysis (log-rank $\chi^2 = 47.3$, df = 2, $p < 0.001$). In Group A, Group B, and Group C, the median time to first recurrence was 214 days, 197 days, and 112 days, respectively. Comparing Group A (HR 0.38; 95% CI 0.24–0.60) and Group B (HR 0.42; 95% CI 0.27–0.65) to standard care, adjusted Cox regression revealed a lower risk for recurrence ($p < 0.001$.[15,20]

**Secondary Outcomes**

Groups A (0.31) and B (0.35) had fewer UTI episodes than Group C (0.89; $p<0.001$), according to secondary outcomes (Table 3). Better QoL in active groups ($p<0.001$), fewer antibiotic courses (A: 0.8, B: 0.9 vs. C: 2.4; $p<0.001$), and improved symptom scores (A: 3.2, B: 3.8 vs. C: 6.7; $p<0.001$). Urinary *E. coli* was reduced more in Group A (1.8) and B (1.5) than in Group C (0.4; $p<0.001$), with Group A having somewhat superior clearance ($p=0.003$).[4,16]

**Table 3. Secondary Outcome Measures at 12-Month Follow-up**

| Secondary Outcome | Group B: D-Mannose (n=96) | Group C: Control (n=92) | p-value (ANOVA/log-rank) |
|---|---|---|---|
| Median time-to-recurrence (days, 95% CI) | 197 (178–216) | 112 (98–126) | <0.001 |
| UTI episodes/participant-year (mean ± SD) | 0.35 ± 0.14 | 0.89 ± 0.28 | <0.001 |
| USSQ score at 12 mo (mean ± SD) | 3.8 ± 1.6 | 6.7 ± 2.1 | <0.001 |
| Antibiotic courses required (mean) | 0.9 | 2.4 | <0.001 |
| QoL score at 12 mo (mean ± SD /100) | 68.7 ± 8.8 | 51.3 ± 10.4 | <0.001 |
| E. coli CFU reduction ($log_{10}$, mean ± SD) | 1.5 ± 0.5 | 0.4 ± 0.3 | <0.001 |
| Treatment adherence (≥80% doses, %) | 89.5% | 85.1% | 0.298 |
| USSQ = Urinary Symptom Severity Questionnaire subscale (lower = better); QoL = quality of life (higher = better). Post-hoc Bonferroni: Group A vs C and B vs C significant at $p < 0.001$ for all outcomes; Group A vs B significant only for CFU reduction ($p = 0.003$). | | | |

**Microbiological Findings**

Of 282 evaluable patients at baseline, E. coli was the causative uropathogen in 81.2% of cases. PCR demonstrated fimH positivity in 72.7% and papG positivity in 34.4% of isolates. Among patients who experienced recurrence, fimH-positive strains were significantly more prevalent in the standard care group versus active arms (89.6% vs 56.5% Group A vs 61.5% Group B; $p = 0.003$), consistent with the anti-adhesion mechanism of both agents.[3,16,24]

**Safety and Tolerability**

Both active regimens were well-tolerated (Table 4). Gastrointestinal adverse events were most common: nausea or bloating occurred in 8 patients (8.5%) in Group A, 6 (6.3%) in Group B, and 3 (3.3%) in Group C. All were mild-to-moderate and self-limiting as documented in the clinical records. No serious adverse events, anaphylaxis, or clinically significant laboratory abnormalities attributable to either agent were identified. There was no significant difference in adverse event rates between groups ($p = 0.21$). No patient required dose reduction or discontinuation due to adverse events.[5,12]

**Table 4. Adverse Events Recorded During 12-Month Follow-up**

| Adverse Event | Group A: Cranberry (n=100) | Group B: D-Mannose (n=100) | Group C: Control (n=100) | p-value |
|---|---|---|---|---|
| Any adverse event, n (%) | 14 (14.0) | 11 (11.0) | 7 (7.0) | 0.214 |
| Nausea/bloating | 8 (8.0) | 6 (6.0) | 3 (3.0) | 0.218 |
| Headache | 3 (3.0) | 2 (2.0) | 2 (2.0) | 0.834 |
| Rash/pruritus | 2 (2.0) | 1 (1.0) | 1 (1.0) | 0.772 |
| Dysuria (not UTI) | 1 (1.0) | 2 (2.0) | 1 (1.0) | 0.768 |
| Serious adverse events | 0 (0.0) | 0 (0.0) | 0 (0.0) | — |
| Withdrawal due to AE | 0 (0.0) | 0 (0.0) | 0 (0.0) | — |
| AE = adverse event. p-values from Fisher's exact test. All adverse events were grade 1–2 (CTCAE v5.0). | | | | |

**Table 5. Microbiological Profile of Causative Uropathogens at Baseline**

| Parameter | Group A (n=100) | Group B (n=100) | Group C (n=100) | Total (N=300) |
|---|---|---|---|---|
| E. coli, n (%) | 82 (82.0) | 79 (79.0) | 81 (81.0) | 242 (80.7) |
| Klebsiella pneumoniae, n (%) | 9 (9.0) | 11 (11.0) | 10 (10.0) | 30 (10.0) |
| Staphylococcus saprophyticus, n (%) | 5 (5.0) | 6 (6.0) | 5 (5.0) | 16 (5.3) |
| Proteus mirabilis, n (%) | 4 (4.0) | 4 (4.0) | 4 (4.0) | 12 (4.0) |
| fimH-positive isolates (%) | 74 (74.0) | 71 (71.0) | 73 (73.0) | 218 (72.7) |
| ESBL-positive isolates (%) | 18 (18.0) | 21 (21.0) | 19 (19.0) | 58 (19.3) |
| Fluoroquinolone resistance (%) | 52 (52.0) | 49 (49.0) | 51 (51.0) | 152 (50.7) |

## DISCUSSION

To our knowledge, this is the first adequately powered, retrospective cohort study conducted at a tertiary care centre in India directly comparing standardised cranberry extract and D-mannose versus standard care for the prevention of rUTI over a 12-month period. Our principal findings are: (i) both cranberry extract (PAC 36 mg/day) and D-mannose (2 g/day) are associated with significantly reduced 12-month UTI recurrence by approximately 57% and 53%, respectively, compared with standard care; (ii) the two active regimens do not differ significantly in clinical recurrence rates; (iii) cranberry extract achieves marginally superior bacteriological clearance; and (iv) both agents are safe and well-tolerated with no serious adverse events.[4,5,6].

The observed recurrence rate in the standard care group (57.6%) aligns closely with published natural history data for rUTI in premenopausal women, validating our comparison population.[2,15] The magnitude of recurrence reduction in our active groups (33.1 and 30.3 percentage points absolute risk reduction) compares favourably with the best published single-agent non-antibiotic data: Kranjcec et al.[6] reported a 24-week recurrence rate of 14.6% with D-mannose vs 60.8% with placebo — a larger absolute reduction than ours but over a shorter timeframe — while Maki et al.[14] reported a 40% reduction in clinical UTI episodes with cranberry beverage, though that product contained non-standardised PAC concentrations.

Our microbiological data provide mechanistic corroboration of the findings. The significantly lower prevalence of fimH-positive UPEC in recurrent isolates from active-regimen patients (56.5–61.5%) versus the standard care group (89.6%) directly supports the proposed anti-adhesion mechanism.[3,4,16] The marginally superior CFU reduction in Group A relative to Group B (1.8 vs 1.5 $\log_{10}$; $p = 0.003$) may reflect the broader anti-adhesin spectrum of cranberry PACs, which inhibit both FimH (type-1) and PapG (P-fimbriae) adhesins, whereas D-mannose acts exclusively on FimH-mediated binding.[4,7]

The high baseline ESBL prevalence (19.3%) and fluoroquinolone resistance (50.7%) in our cohort exemplify the AMR burden in North Indian tertiary centres and underscore the clinical urgency of non-antibiotic prophylaxis. Neither active agent exerts antibiotic selection pressure, and neither was associated with emerging resistance, in stark contrast to published LDAP data where trimethoprim resistance increases from baseline rates of 4–8% to 24–40% after 6–12 months of prophylaxis.[9,19] The number needed to treat (NNT) of 3.0 for cranberry and 3.3 for D-mannose compares very favourably with pharmacological prophylaxis, particularly when the absence of resistance pressure is factored into clinical decision-making.[11,12]

Adherence rates were high and similar across the three groups (≥85%) as documented in the clinical records. This differs from several smaller studies where differential adherence confounded interpretation of outcomes.[13,17] Tolerability was excellent; the only notable adverse events were gastrointestinal symptoms (nausea/bloating) in 8.5% and 6.3% of Groups A and B, respectively, consistent with the published safety literature,[5,7,21] and significantly lower than rates reported with LDAP nitrofurantoin (14–19%).[9]

### Limitations

The retrospective design precludes definitive causal inference; residual confounding by unmeasured variables, including physician prescribing preferences, socioeconomic factors, and patient-initiated dietary changes, cannot be fully excluded despite propensity score adjustment. The study was conducted at one tertiary centre, limiting generalisability to primary care settings and non-referral populations.

Cranberry extract was normalised by PAC content, but individual variability in PAC absorption and urinary excretion — which depends on gut microbiome composition and co-ingested polyphenols — was not captured in the records.[4,23] The 12-month follow-up is the longest reported in an Indian cohort, but recurrences beyond this window may have been missed

in women with refractory rUTI. Finally, the absence of an LDAP comparison arm limits direct efficacy comparisons with antibiotic prophylaxis.

## CONCLUSION

This retrospective cohort study from a tertiary care centre demonstrates that standardised cranberry extract (PAC 36 mg/day) and D-mannose (2 g/day) are associated with significantly reduced 12-month recurrence rates of rUTI in adult Indian women, with NNTs of 3.0 and 3.3 respectively, versus standard care.

Both agents were clinically equivalent in prevention of recurrence. Cranberry extract demonstrated marginally better bacteriological clearance. Both are safe, well-tolerated, adherence-friendly, and free of antimicrobial resistance burden. These findings support consideration of either agent as a non-antibiotic first-line prophylactic option in uncomplicated rUTI, particularly relevant in the Indian subcontinent where >50% of UPEC isolates carry fluoroquinolone resistance.

## REFERENCES

1. Foxman B. Epidemiology of urinary tract infections: incidence, morbidity, and economic costs. Am J Med. 2002;113(Suppl 1A):5S-13S.
2. Hooton TM. Recurrent urinary tract infection in women. Int J Antimicrob Agents. 2001;17(4):259-68.
3. Flores-Mireles AL, Walker JN, Caparon M, Hultgren SJ. Urinary tract infections: epidemiology, mechanisms of infection and treatment options. Nat Rev Microbiol. 2015;13(5):269-84.
4. Howell AB, Botto H, Combescure C, et al. Dosage effect on uropathogenic Escherichia coli anti-adhesion activity in urine following consumption of cranberry powder standardised for proanthocyanidin content. BMC Infect Dis. 2010;10:94.
5. Vasileiou I, Katsargyris A, Theocharis S, Giaginis C. Current clinical status on the preventive effects of cranberry consumption against urinary tract infections. Nutr Res. 2013;33(8):595-607.
6. Kranjcec B, Papes D, Altarac S. D-mannose powder for prophylaxis of recurrent urinary tract infections in women: a randomized clinical trial. World J Urol. 2014;32(1):79-84.
7. Domenici L, Monti M, Bracchi C, et al. D-mannose: a promising support for acute urinary tract infections in women. Eur Rev Med Pharmacol Sci. 2016;20(13):2920-5.
8. Gupta K, Grigoryan L, Trautner B. Urinary tract infection. Ann Intern Med. 2017;167(7):ITC49-ITC64.
9. Albert X, Huertas I, Pereiro I, et al. Antibiotics for preventing recurrent urinary tract infection in non-pregnant women. Cochrane Database Syst Rev. 2004;(3):CD001209.
10. Stapleton AE, Au-Yeung M, Hooton TM, et al. Randomized, placebo-controlled phase 2 trial of a Lactobacillus crispatus probiotic given intravaginally for prevention of recurrent urinary tract infection. Clin Infect Dis. 2011;52(10):1212-7.
11. Anger J, Lee U, Ackerman AL, et al. Recurrent uncomplicated urinary tract infections in women: AUA/CUA/SUFU guideline. J Urol. 2019;202(2):282-9.
12. Sihra N, Goodman A, Zakri R, Sahai A, Malde S. Nonantibiotic prevention and management of recurrent urinary tract infection. Nat Rev Urol. 2018;15(12):750-76.
13. Jepson RG, Williams G, Craig JC. Cranberries for preventing urinary tract infections. Cochrane Database Syst Rev. 2012;(10):CD001321.
14. Maki KC, Kaspar KL, Khoo C, et al. Consumption of a cranberry juice beverage lowered the number of clinical urinary tract infection episodes in women with a recent history of urinary tract infection. Am J Clin Nutr. 2016;103(6):1434-42.
15. Scholes D, Hooton TM, Roberts PL, et al. Risk factors for recurrent urinary tract infection in young women. J Infect Dis. 2000;182(4):1177-82.
16. Ejrnaes K. Bacterial characteristics of importance for recurrent urinary tract infections caused by Escherichia coli. Dan Med Bull. 2011;58(4):B4187.
17. Lenger SM, Bradley MS, Thomas DA, et al. D-mannose vs other agents for recurrent urinary tract infection prevention in adult women. Am J Obstet Gynecol. 2020;223(2):265.e1-265.e13.
18. Falagas ME, Betsi GI, Tokas T, Athanasiou S. Probiotics for prevention of recurrent urinary tract infections in women. Drugs. 2006;66(9):1253-61.
19. Harding GK, Ronald AR, Nicolle LE, Thomson MJ, Gray GJ. Long-term antimicrobial prophylaxis for recurrent urinary tract infection in women. Rev Infect Dis. 1982;4(2):438-43.
20. Williams G, Hahn D, Stephens JH, Craig JC, Hodson EM. Cranberries for preventing urinary tract infections. Cochrane Database Syst Rev. 2023;4(4):CD001321.
21. Xia JY, Yang C, Xu DF, et al. Consumption of cranberry as adjuvant therapy for urinary tract infections in susceptible populations. Medicine. 2021;100(27):e26514.
22. Lee BSB, Bhuta T, Simpson JM, Craig JC. Methenamine hippurate for preventing urinary tract infections. Cochrane Database Syst Rev. 2012;(10):CD003265.

23. Hisano M, Bruschini H, Nicodemo AC, Srougi M. Cranberries and lower urinary tract infection prevention. Clinics. 2012;67(6):661-8.
24. Brumbaugh AR, Mobley HL. Preventing urinary tract infection: progress toward an effective Escherichia coli vaccine. Expert Rev Vaccines. 2012;11(6):663-76.
25. Gágyor I, Bleidorn J, Kochen MM, et al. Ibuprofen versus fosfomycin for uncomplicated urinary tract infection in women. BMJ. 2015;351:h6544.