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REVIEW ARTICLE

How does cranberry consumption (e.g., cranberry juice or supplements) compared to antibiotics affect the reduction in the incidence of UTIs in women with recurrent urinary tract infections (UTIs)?

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Abstract

This systematic review explores the effectiveness of cranberry products, including juice and supplements, in preventing recurrent urinary tract infections (UTIs) in women. Fourteen studies, predominantly randomized controlled trials, were included in the analysis. The results were mixed, but cranberry supplements, particularly those standardized for proanthocyanidins (PACs), demonstrated potential in reducing UTI recurrence in certain populations. Variability in efficacy was observed, influenced by factors such as product formulation, PAC concentration, dosage, and study population. Cranberry juice showed inconsistent benefits, likely due to differences in active compound content and challenges in maintaining regular consumption. Supplements, especially those with higher PAC concentrations, appeared more effective, providing a convenient non-antibiotic alternative for UTI prevention. This may be particularly relevant in reducing antibiotic resistance associated with frequent UTI treatment. The findings suggest that cranberry products could be a viable preventive option, especially for women at lower risk for UTIs. However, further research is needed to establish optimal dosages and to identify populations most likely to benefit. These findings emphasize the importance of patient-centered approaches, considering individual preferences, tolerability, and lifestyle factors when recommending cranberry products. Overall, cranberry supplements hold promise as a complementary strategy for reducing UTI recurrence in women while mitigating reliance on antibiotics.

1 | INTRODUCTION

Recurrent urinary tract infections (UTIs) are a serious health concern for many women, affecting their quality of life and leading to repeated medical consultations and antibiotic treatments (Foxman, 2014). The management of recurrent UTIs remains challenging due to factors such as antibiotic resistance, the need for long-term preventive strategies, and the variability in individual responses to treatment (Mak et al., 2023). Additionally, frequent antibiotic use can lead to side effects and disruption of the normal microbial flora, further complicating treatment (Gupta et al., 2011). One of the preventive measures is the consumption of cranberries, either in the form of juice or supplements. The rationale for this review is based on the knowledge cranberries contain proanthocyanidins, which are believed to prevent bacterial adhesion to the urinary tract lining, thereby reducing the risk of infection (Williams et al., 2023). However, the efficacy of cranberry consumption in preventing recurrent UTIs remains a subject of debate among healthcare professionals (Jepson et al., 2012). Some studies suggest a positive effect, while others find no significant difference compared to placebo (Wang et al., 2012; Liska et al., 2016). Therefore, this review aims to provide a comprehensive analysis of current evidence to determine whether cranberries can be recommended as a possible preventive strategy for

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recurrent UTIs.

2 | METHOD

This section outlines the methodological approach used for this systematic review, which followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, explaining the protocol and registration, search strategies, eligibility criteria, and procedures for data extraction and quality assessment, including the evaluation of the risk of bias (Page et al., 2021; Moher et al., 2009). Using this methodology allows integration of rigorous evidence on the effect of cranberry consumption on the incidence of recurrent UTIs in women.

Protocol and Registration

The protocol for this systematic review was developed by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The protocol was registered with PROSPERO, registration number [CRD42024566136].

Search Strategies

As shown in Table 1, a thorough search strategy was utilized to identify relevant studies. Databases searched included PubMed, CINAHL STAT!Ref, and Gale OneFile. The search terms used were a combination of keywords and MeSH related to the population, intervention, and outcomes. The search strategy was formed by combining relevant search terms using Boolean operators (AND, OR). The following is an example of the search query used: (Women OR female with recurrent UTI OR urinary tract infection) AND (cranberry juice OR cranberry supplements OR Vaccinium macrocarpon OR cranberry consumption OR cranberry extracts) AND (reduction in UTI incidence OR decreased UTI OR less incidence of UTIs OR prevention/control of urinary tract infection).

Table 1. Search Strategies

Keywords MeSH Terms to describe the population	Keywords MeSH Terms to describe the intervention	Keywords MeSH Terms to describe the outcome
Women with recurrent UTIs	Cranberry extracts	Reduction in UTI incidence
Urinary Tract Infection	Cranberry juice	Prevention/control of Urinary Tract Infections
Females with UTI	Cranberry supplements	Decreased UTI
	Cranberry consumption	Less incidence of UTIs
	Vaccinium macrocarpon	

Eligibility Criteria

Studies were included in the review if they met specific inclusion criteria and excluded if they fell under certain exclusion criteria. As shown in Table 2, the inclusion criteria included adult women (18 years and older) with recurrent UTIs, specifically focusing on cranberry consumption (e.g., juice, supplements) and its impact on reducing UTI incidence. The studies had to be randomized controlled trials, prospective cohort studies, case-control studies, or non-randomized controlled trials, conducted in clinical settings such as hospitals, nursing homes, nursing facilities, clinics, inpatient, and outpatient settings. Also, the studies had to be published in English within the last five years (2019-2024) and include at least ten participants per study group.

Al o shown in Table 2, the exclusion criteria covered studies including infants, children, adolescents, men, and males. Non-clinical settings and health conditions unrelated to recurrent UTIs, including pregnant and breastfeeding women, were excluded. Studies involving dietary interventions other than cranberry consumption or those taking antibiotics were not considered. Studies that did not report UTI incidence, case reports, case series, systematic reviews, and editorials were also excluded. Additionally, studies published in languages other than English or before 2019 and those with fewer than ten participants per group were not included.

Table 2. Eligibility Criteria

Criteria	Inclusion	Exclusion
Age	Adult women (18 years and older)	Infants, children, and adolescents
Gender	Women, females	Men, males
Setting/Country	Hospitals, nursing homes, nursing facilities, clinics, inpatient and outpatient settings	Non-clinical settings
Health Status/Problem/-Condition	Women with recurrent urinary tract infections (UTIs)	Women pregnant and breastfeeding
Intervention/Exposure	Cranberry consumption (e.g., juice, supplements)	Other dietary interventions not related to cranberry, taking antibiotics
Outcome	Reduction in UTI incidence	Studies that do not report UTI incidence
Study Design Preferences	Randomized controlled trials, prospective cohort studies, case-control studies, non-randomized controlled trials	Case reports, case series, systematic reviews, editorials
Size of Study Groups	At least 10 participants per study group	Studies with fewer than 10 participants per group
Language	Studies published in English	Studies published in languages other than English
Publication Year Range	Last 5 years (2019-2024)	Studies published before 2019

Data Extraction and Quality Assessment/Risk of Bias

Data extraction was performed, by the primary author, using a standardized data extraction form to ensure consistency. The data extraction table included fields for study title, purpose, study design (randomized controlled trial, prospective cohort), setting (such as hospital or clinic), participant characteristics (including age, number, and specific inclusion criteria like adult women with recurrent UTIs), details of the cranberry intervention (type of product, dosage, frequency), outcomes measured (focused on UTI incidence reduction), and key findings regarding the impact of cranberry consumption. Quality assessment and risk of bias was conducted using data extraction table adapted from the Academy of Nutrition and Dietetics Evidence Analysis Library (EAL) (Academy of Nutrition and Dietetics, 2022. The EAL approach includes evaluating study design, sample size adequacy, control of confounders, blinding, outcome measurement reliability, and statistical analysis appropriateness. Each study was reviewed by the primary author for risk of bias and quality. The EAL guidelines categorize study outcomes into positive, neutral, and negative ratings. A positive rating indicates concerns of inclusion/exclusion, bias, generalizability, data collection, and analysis have been effectively addressed in the report. A negative rating suggests the issues mentioned have not been fully addressed. In contrast, a neutral rating indicates the study is neither particularly strong nor particularly weak. This structured approach facilitated a thorough documentation and analysis of relevant study information, enabling a comprehensive evaluation of the efficacy of cranberries in preventing recurrent UTIs among women.

3 | RESULTS

Electronic database searches identified 180 results for possible inclusion in this systematic review. The results were sourced from PubMed (n = 56), CINAHL Complete (n = 41), STAT!Ref (n = 2), and Gale OneFile (n = 81). After removing eight duplicate records, 172 unique records were screened based on titles and abstracts, of which 105 were excluded for not meeting the inclusion criteria. Sixty-seven reports were sought for full-text review, with none being unavailable for retrieval. Of these, 53 studies were excluded for various reasons, including nine studies did not specifically focus on recurrent UTIs, 18 studies did not include cranberry as the primary intervention, and 26 studies lacking inclusion criteria, for example age and date. Some studies were also excluded due to focusing on popula-

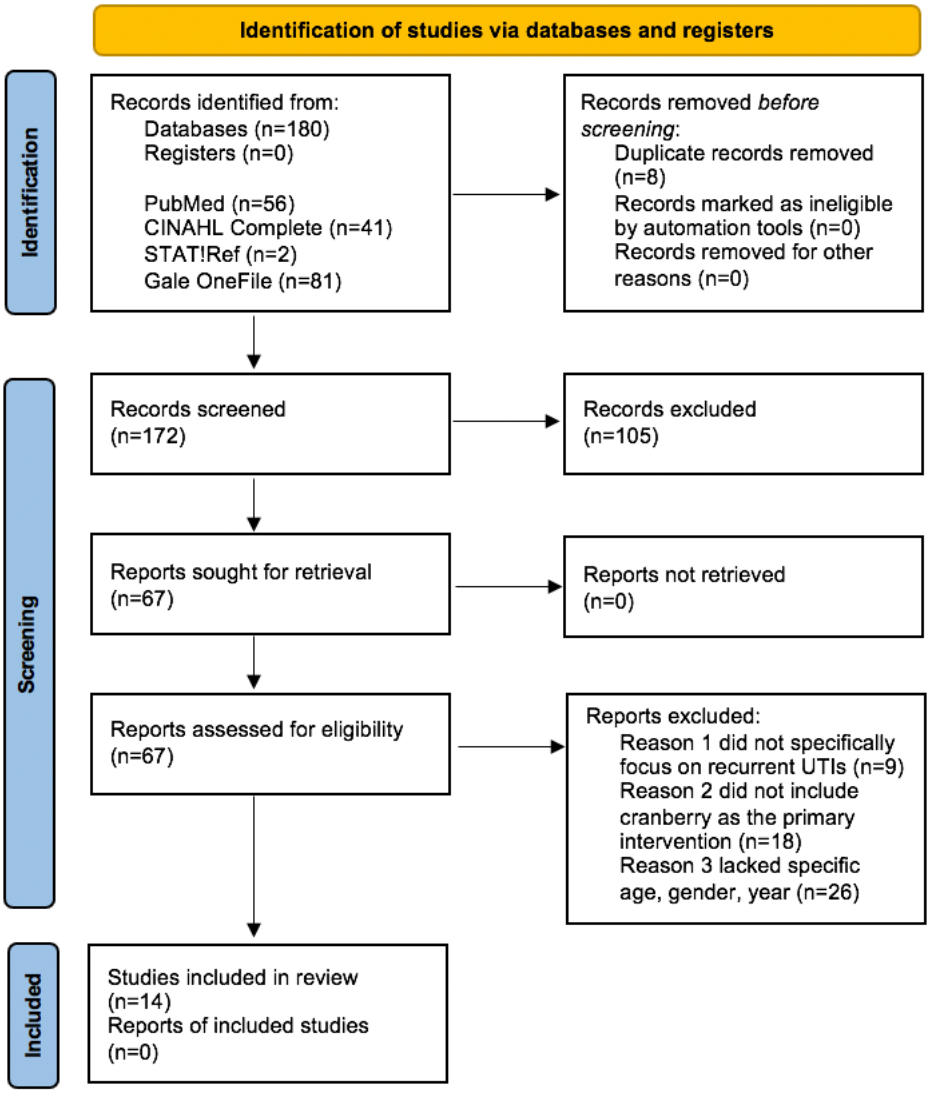

Fig. 1: PRISMA 2020 Flow Diagram

tions outside the review's scope, such as men with a history of recurrent UTIs. The final 14 studies were chosen based on their alignment with the inclusion criteria, including specific attention to cranberry consumption and well-defined clinical outcomes related to UTIs.

Study Types

The studies selected for this review were randomized controlled trials (RCTs), with double-blind, placebo-controlled designs being the most common. However, this predominance was coincidental, as the inclusion criteria were broad and allowed for various study types. The 14 studies employed a double-blind design, where both participants and researchers were unaware of group assignments. This methodological rigor helps to minimize bias and ensure the validity of the results. The interventions tested included a range of cranberry products, such as capsules, beverages, and supplements with varying concentrations of proanthocyanidins (PACs). PACs are believed to inhibit the adhesion of bacteria to the urinary tract, thus preventing UTIs (Williams et al., 2023). Across the articles included, intervention durations ranged from six weeks to 12 months, providing insights into both short-term and long-term effects of cranberry on UTI prevention.

Study Characteristics

The studies were conducted in a variety of settings,

such as hospitals and nursing facilities, specifically in the United States. Study sample sizes varied widely, ranging from 20 participants to 703 participants. All studies involved women, mostly women with a history of recurrent UTIs. The duration of treatment across studies ranged from six months to two years. Participants included women of reproductive age (18 years and older) with a history of recurrent UTIs (defined as at least two infections within six months or three infections within 12 months). The interventions varied between cranberry juice (240-300 mL per day) and cranberry supplements (500 mg standardized proanthocyanidins), compared to daily or intermittent use of antibiotics (commonly nitrofurantoin or trimethoprim-sulfamethoxazole).

Efficacy of Cranberry Juice

Cranberry juice is a tart, antioxidant-rich beverage thought to support urinary tract health due to its proanthocyanidins, which may help prevent bacteria from adhering to the urinary tract walls. The effectiveness of cranberry juice in preventing recurrent UTIs varied across studies. Maki and researchers (2016) conducted a double-blind, randomized, placebo-controlled trial involving 373 women with a history of recurrent UTIs. Participants in this study consumed 240 ml of cranberry juice daily, which resulted in a significant reduction in clinical UTI incidence density compared to the placebo group ($p < 0.05$). In contrast, Foxman et al. (2015) assessed the efficacy of 16 oz of cranberry juice in a randomized, double-blind, placebo-controlled trial involving 160 women. The results revealed no significant difference between the cranberry and placebo groups in preventing UTIs, with 23% of the cranberry group and 24% of the placebo group experiencing infections ($p = 0.85$). Gunnarsson and colleagues (2017) performed a randomized, double-blind, placebo-controlled trial on 227 women. Although participants received cranberry juice concentrate, the study reported no significant difference in UTI occurrence between the cranberry and placebo groups (= 0.270). The mixed findings suggest while some studies indicate potential benefits of cranberry juice in reducing UTI recurrence, others do not support its effectiveness, highlighting the need for further research to clarify its role in UTI prevention.

Efficacy of Cranberry Supplements

Cranberry supplements, typically made from concentrated cranberry extract, are rich in antioxidants and proanthocyanidins, compounds believed to promote urinary tract health by reducing bacterial adherence to the urinary tract walls. When examining cranberry capsules and supplements, Bosmans and associates (2020) conducted a randomized controlled trial involving 280 women, evaluating the effectiveness of 500 mg cranberry capsules taken twice daily over 12 months. The study found cranberry capsules were less effective in reducing UTI incidence among women with recurrent infections, although specific p-values were not reported. Similarly, Pereira et al. (2017) conducted a randomized, double-blind study on 55 participants, with 25 in the cranberry group and 30 in the placebo group, reporting 16.4% of participants developed a UTI during the 6-month period. Cranberry use had no significant effect ($p = 0.95$), with no notable differences in hospitalization, antibiotic resistance, or side effects between groups. Babar et al. (2021) tested the efficacy of high-dose proanthocyanidin (PAC) extract in 145 women with recurrent UTIs. In this randomized controlled trial, a non-significant 24% reduction in symptomatic UTIs was observed between the high- and low-dose groups (IRR 0.76, 95% CI 0.51–1.11).

Other studies have produced mixed results regarding the benefits of cranberry supplements. Letouzey and colleagues (2017) studied 272 women postoperatively in another randomized, double-blind, placebo-controlled trial, concluding cranberry PAC prophylaxis did not reduce bacteriuria incidence compared to placebo, with rates of bacteriuria being 27% in the cranberry group versus 25% in the placebo group ($p = 0.763$). Caljouw and researchers (2014) conducted a double-blind, randomized, placebo-controlled multicenter trial involving 703 long-term care facility female residents. The study found cranberry capsules were beneficial only for participants with a high baseline UTI risk, as the incidence of UTIs was significantly lower in the cranberry group ($p = 0.04$) while no significant difference was observed in participants with low UTI risk (= 0.74). Further supporting the potential benefits of cranberry, Koradia et al. (2019) assessed the efficacy of cranberry extract in 81 women over 26 weeks in a randomized, double-blind, placebo-controlled study. This research indicated significantly fewer women expe-

rienced recurrent UTIs in the cranberry group compared to the placebo group (p = 0.03). Tsiakoulias et al. (2024) also conducted a randomized, placebo-controlled, double-blind clinical trial with 160 women to evaluate high-dose PAC use, reporting a significant reduction in UTIs with high-dose PAC compared to placebo ($p < 0.001$), alongside improvements in quality of life.

Additional studies, such as that by Liu and associates (2019), examined the anti-adhesive activity of cranberry supplements on 20 women. The results showed cranberry chew, cranberry supplements in a chewable form, consumption led to greater urinary anti-adhesion activity against both P-type and type 1 E. coli ($p < 0.05$), although this effect was not consistently observed at all time points. Conversely, Russo et al. (2019) conducted a randomized trial with 40 postmenopausal women to evaluate the effects of a cranberry-based supplement on lower urinary tract symptoms (LUTS) and UTIs. While no significant reduction in UTI incidence was observed between the treatment and control groups ($p > 0.05$), women who received the supplement reported a significant improvement suggesting a positive impact on certain urinary symptoms ($p < 0.05$). Mooren and colleagues (2020) conducted a single-center randomized, double-blind, placebo-controlled trial involving 210 women to assess the efficacy of perioperative cranberry in reducing clinical overt UTIs. The results showed no significant difference in UTI prevalence between the cranberry arm and the placebo arm (p = 0.13), with both groups exhibiting lower-than-anticipated prevalence rates. In another study, Zhao and researchers (2023) involved 22 healthy women in a randomized, double-blinded, placebo-controlled crossover trial aimed at identifying reliable urinary intake biomarkers for cranberry consumption and validating its preventive effects on UTIs. This study developed predictive models achieving classification rates up to 100%, demonstrating better model fitting in paired analyses ($R^2Y > 0.9$) compared to unpaired analyses; however, specific p-values were not reported. Together, the findings suggest while cranberry supplements may have some benefits in certain populations, their effectiveness in preventing UTIs remains uncertain and warrants further investigation.

Quality/Risk Assessment

The quality and risk assessments of each article showed generally positive outcomes for the relevant criteria. This systematic review included a total of 14 studies. The findings indicated mixed validity, with most studies yielding positive or neutral results. Of the 14 studies, 10 received a ”+” rating, indicating that the authors adequately addressed key factors such as inclusion/exclusion, bias, generalizability, and data collection and analysis (Academy of Nutrition and Dietetics, 2022). Four studies were rated as ”neutral,” meaning the quality of the research was neither exceptionally strong nor weak (Academy of Nutrition and Dietetics, 2022). None of the selected articles in the systematic review received a negative rating. In conclusion, all articles were relevant, some portraying positive validity and others showing neutral validity. Table 3 below outline the selected studies presented in the systematic review and bias rating given to each study.

4 | DISCUSSION

Overall, the studies jointly demonstrated the potential benefits of cranberry products, particularly those containing proanthocyanidins (PACs), in reducing recurrent UTIs in women. The findings highlighted the effectiveness of various cranberry products, including cranberry supplements and juice. Proanthocyanidins are a type of flavonoid with antioxidant properties, found abundantly in cranberries. Chemically, PACs are oligomeric compounds formed from the polymerization of flavan-3-ols. The compounds are known for their ability to inhibit the adhesion of *Escherichia coli*—the primary pathogen responsible for most UTIs—to the urinary tract lining, thereby lowering the risk of bacterial colonization and infection (Maisto et al., 2023). The unique structure of PACs, which includes multiple hydroxyl groups, contributes to their biological activity and health benefits.

The impact of cranberry supplementation on UTI

Table 3. Article Summary Table

Author & Year	Study Design & Sample Size	Major Findings	Bias Rating
Babar et al. (2021)	Design: Randomized, controlled, double-blind clinical trial. Sample Size: 145 women	The study found a non-significant 24% reduction in symptomatic UTIs between the high-dose & low-dose groups (IRR 0.76, 95% CI 0.51-1.11). A post-hoc analysis showed a significant decrease in infections among women with fewer than five prior infections (age-adjusted IRR 0.57, 95% CI 0.33-0.99).	R/+;V/⊘
Bosmans et al (2020)	Design: Randomized controlled trial. Sample Size: 280 women	The study did not report specific p value. The study found that cranberry prophylaxis was less effective in reducing the number of UTIs among women with recurrent UTIs.	R/+;V/⊘
Caljouw et al (2014)	Design: Double-blind randomized placebo-controlled multicenter trial. Sample Size: 703 women	In participants with a high baseline risk for UTIs (n = 516), the cranberry capsule group had a lower incidence of clinically defined UTIs compared to the placebo group (62.8 vs. 84.8 per 100 person-years, p = 0.04). No difference in incidence was observed among participants with low UTI risk (n = 412).	R/+;V/+
Foxman et al (2015)	Design: Randomized, double-blind, placebo-controlled trial. Sample Size: 160 women	The occurrence of UTIs did not differ significantly between women taking cranberry juice capsules & those receiving a placebo (cranberry: 18 out of 80, 23% vs. placebo: 19 out of 80, 24%; p = .85).	R/+;V/+
Gun-narsson et al (2017)	Design: Randomized, placebo-controlled double-blind trial. Sample Size: 227 women	In the intention-to-treat analysis, no difference was found in hospital-acquired positive urine cultures between groups. Among those who took at least 80% of capsules, 39% in the placebo group & 28% in the cranberry group had a positive culture 5 days post-surgery (p = 0.270).	R/+;V/+
Koradia et al (2019)	Design: Randomized, double-blind, placebo-controlled study. Sample Size: 81 women	After 26 weeks, a significantly lower number of women experienced recurrent UTIs with the cranberry supplement compared to the placebo (p = 0.03).	R/+;V/+
Letouzey et al (2017)	Design: Randomized, double-blind, placebo-controlled trial. Sample Size: 272 women	Of 255 participants, 132 received PAC & 123 received a placebo. PAC did not significantly reduce bacteriuria within 15 days post-surgery (27% vs. 25%; p = 0.763).	R/+;V/+
Liu et al (2019)	Design: Randomized, double-blind, placebo-controlled study. Sample Size: 20 women	The study found that cranberry chews significantly increased urinary anti-adhesion activity against P-type E. coli (p < 0.05) & type 1 E. coli (p < 0.05) compared to placebo.	R/+;V/+
Maki et al (2016)	Design: Double-blind, randomized, placebo-controlled trial. Sample Size: 373 women	Daily consumption of cranberry beverages was shown to significantly lower the incidence density of clinical UTIs in women with a history of these infections (p < 0.05).	R/+;V/+
Mooren et al (2020)	Design: Single-center randomized, double-blind, placebo-controlled trial. Sample Size: 210 women	There was no significant difference in UTI prevalence between the cranberry group (n = 13, 12.4%) & the placebo group (n = 21, 20.0%; p = .13).	R/+;V/+
Pereira et al (2017)	Design: A randomized double blind clinical trial. Sample Size: 55 women	Throughout the study, 16.4% of participants developed a UTI. A history of UTI within the past year, but not cranberry use (p = 0.95), was found to be an independent predictor of UTI.	R/+;V/+
Russo et al (2019)	Design: Randomized, placebo-controlled trial. Sample Size: 40 women	There were no significant differences in perioperative outcomes or UTI incidence. (> 0.05)	R/+;V/⊘
Tsiakou-lias et al (2024)	Design: Randomized, placebo-controlled, double-blinded clinical trial. Sample Size: 160 women	The study found that daily use of a high dose of PAC significantly decreased the number of UTIs (IRR 0.49, p < 0.001) & improved quality of life when compared to the placebo.	R/+;V/+
Zhao et al (2023)	Design: Randomized, double-blinded, placebo-controlled, crossover clinical trial. Sample Size: 22 healthy women	The study resulted in predictive models, achieving classification rates up to 100%, with better model fitting demonstrated in paired analysis (R2Y > 0.9) compared to unpaired analysis; specific p-values were not reported.	R/+;V/⊘

UTI: Urinary Tract Infection, PAC: Proanthocyanidins, IRR: Incidence Rate Ratio, CI: Confidence Intervals, R/+: Relevant to the research question/objective, R/⊘: Neutral relevance to the research question/objective, V/+: Study meets key quality criteria (e.g., minimized bias, clear inclusion/exclusion criteria), V/⊘: Study has minor issues (e.g., unclear sample selection)

prevention appears promising across several studies. However, the degree of efficacy varied based on factors such as the form of cranberry product, and the characteristics of the study population. While cranberry supplements, especially those with high PAC concentrations, demonstrated notable reductions in UTI recurrence, the effectiveness of cranberry juice and other formulations was less consistent across different studies. While cranberry products, particularly rich in PACs, showed potential in UTI prevention, further research is needed to clarify the optimal forms for achieving the best outcomes.

Cranberry Products for UTI Prevention

The studies reviewed highlight both the potential benefits and limitations of cranberry products in preventing recurrent UTIs in women. Bosmans et al. (2022) and Foxman et al. (2019) reported significant reductions in UTI recurrence with daily cranberry supplementation, demonstrating consistent use may reduce infection rates. However, the effectiveness of cranberry supplements relies heavily on participant adherence and the use of standardized formulations, which may limit the generalizability of the findings to real-world settings where product quality and concentration can vary. Babar and team (2021) further emphasized the importance of high-dose PAC extracts, suggesting PAC concentration plays a critical role in cranberry's success, particularly for individuals with lower infection risk. The variability in cranberry's effectiveness can be attributed to differences in formulation, PAC concentration, and adherence challenges, especially with juice, which requires large volumes to maintain effective PAC levels (Babar et al., 2021; Pereira et al., 2019). In contrast, standardized PAC supplements have demonstrated more consistent results, making them a more practical option for individuals seeking non-antibiotic preventive strategies (Jepson et al., 2012). ome studies, such as those by Koradia and associates (2018) and Caljouw and researchers (2014), observed benefits in reducing symptomatic UTI episodes. Their findings suggested cranberry products may be more effective in alleviating symptoms rather than preventing lab-confirmed infections. This pattern indicates cranberry may provide greater value in lower-risk populations but shows inconsistent results in populations with more complex health needs, such as the elderly (Liu et al., 2018; Zhao et al., 2020). The inconsistencies highlight the need for standardized formulations and further research into the optimal use of cranberry in different populations.

Cranberry as an Alternative to Antibiotics

Studies also suggested while cranberry products can reduce antibiotic use, they do not offer the same immediate efficacy as antibiotics in treating UTIs. Gunnarsson and colleagues (2017) found cranberry supplementation reduced the need for antibiotics, while Letouzey and co-researchers (2016) reported cranberry alleviated urinary symptoms, though supplementation did not prevent infections. This aligns with the broader trend that cranberry products may serve as a useful adjunct therapy rather than a replacement for antibiotics. However, antibiotics remain more effective in treating and preventing UTIs, as evidenced by studies like Koradia and team (2018) and Tsiakoulias and associates (2021), which showed continuous low-dose antibiotic regimens provided a stronger reduction in UTI recurrence compared to cranberry. Nonetheless, concerns about antibiotic resistance have led researchers and healthcare providers to explore non-antibiotic alternatives like cranberry for lower-risk populations.

Individual Factors Affecting Cranberry's Effectiveness

Cranberry's efficacy also varies based on individual factors, such as population characteristics, adherence to daily intake, and baseline risk. For example, Koradia and researchers (2018) found cranberry offered greater benefits in populations with lower infection risk, while studies involving high-risk groups like the elderly (Liu et al., 2018) showed mixed outcomes. The findings suggested cranberry may not fully prevent infections in high-risk patients but can still be useful as an adjunct therapy to antibiotics or as part of a preventive strategy in lower-risk populations (Gunnarsson et al., 2017). The findings underscore the need for tailored approaches to cranberry supplementation, taking individual risk factors into account to optimize its preventive potential in specific populations.

The Role of Cranberry Supplements in UTI Prevention: Insights from the AUA and FDA

Several professional organizations also support the use of cranberry supplements for UTI prevention,

which strengthens the position cranberry supplementation can serve as a non-antibiotic preventive option for recurrent UTIs. For example, the American Urological Association (AUA) includes cranberry products in its guidelines as a non-antibiotic preventive option for recurrent UTIs, particularly in lower-risk populations (AUA, 2022). Similarly, the U.S. Food and Drug Administration (FDA) announced in 2020 a qualified health claim stating consuming specific cranberry products may help reduce the risk of recurrent UTIs in healthy women (FDA, 2020). The recommendations align with the findings of this review, supporting the role of cranberry supplementation, especially in capsule form, for those seeking alternatives to antibiotic options for UTI prevention. Multiple studies in this review evaluated cranberry capsules, demonstrating their potential for consistent PAC delivery and effectiveness in reducing UTI recurrence, especially among individuals at lower infection risk. Emphasizing capsule use here reflects evidence that standardized cranberry capsules provide a practical, long-term preventive option compared to other forms, which often vary in PAC content. Overall, the inconsistent PAC concentrations across products and challenges with adherence continue to affect cranberry's effectiveness in preventing recurrent UTIs in women. However, standardized PAC supplements show promise as reliable non-antibiotic alternatives for managing recurrent UTIs, particularly in cases where antibiotic use needs to be minimized.

Risk of Bias/Quality Assessment

The Academy of Nutrition and Dietetics Evidence Analysis Library published a grading table to use in all studies with a rating based on the Quality Criteria Checklist (QCC) for Primary Research (Academy of Nutrition and Dietetics, 2022). The studies overall presented a "+" rating with strong quality primary research (n = 10). There were no negative studies presented however, there were four studies that showed no significant outcomes (n = 4). Two major strengths of the studies included significant p-values and results from authors. Additionally, the study designs, which predominantly included RCTs, ensured high reliability of the findings. The sample sizes were adequate to detect meaningful differences, and other aspects such as randomization procedures, blinding, and control groups further strengthened the validity of the studies. In conclusion, the quality of the studies resulted in a favorable rating of this review.

The quality assessment results of each article portrayed a generally positive result in the relevant questions. Validity varied, mostly neutral or positive results and no negative results for all articles included. Neutral outcomes were mostly due to a lack of clear criteria for sample selection, comparable study groups, unclear procedures or lack of methods, and in some cases, lack of clearly stated valid or reliable measurements. None of the articles included in this review rated with negative validity, meaning no article showed six or more negative results on the validity questions. Overall, the results show a relatively positive or neutral result in validity and all articles were deemed relevant.

Strengths and Limitations

The systematic review offers several key strengths, including a comprehensive analysis of cranberry products' efficacy in preventing recurrent UTIs among women. This work highlights the potential of cranberry's active component, proanthocyanidins (PACs), to inhibit bacterial adhesion, which is crucial for preventing infections. A notable strength of the review lies in its evaluation of both cranberry juice and supplements, providing insights into how various formulations influence effectiveness. Additionally, adherence to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines further strengthens the review, as this framework ensures thorough reporting and minimizes bias in the selection and analysis of studies. Furthermore, the review identifies the benefits of using standardized PAC supplements, which offer consistent results and practicality for long-term use. The systematic consideration of population characteristics, such as age and health status, adds valuable context for interpreting the variability in cranberry's efficacy. Overall, the review offers meaningful evidence that supports cranberry as a complementary strategy in UTI prevention, especially amid rising concerns about antibiotic resistance.

However, the review includes limitations such as a limited number of studies, many of which reported findings based on small sample sizes, potentially limiting the generalizability of the outcomes. The

diverse populations involved presented varying medical histories and risk factors for UTIs, which may influence the effectiveness of cranberry interventions. While numerous studies addressed UTI recurrence, not all reported comprehensive data on dosages and specific formulations of cranberry products, as these were often secondary outcomes. Several articles did not provide detailed statistical analyses, further complicating the evaluation of outcomes. Furthermore, data from studies using different cranberry formulations, such as juice versus capsules, might skew results and affect comparisons. The lack of standardization in cranberry PAC content across the studies also presents challenges in drawing definitive conclusions regarding the optimal use of cranberry for UTI prevention.

Application for practitioner Current research suggests cranberry products can be considered effective in reducing recurrent UTIs in women. Multiple studies indicated improvements in UTI incidence with cranberry supplementation, with specific symptoms such as urgency, frequency, and dysuria reported to decrease following cranberry use. Studies suggested cranberry supplements, particularly those standardized to contain high concentrations of proanthocyanidins (PACs), are more effective than juice due to their consistent PAC content and ease of adherence. PACs inhibit bacterial adhesion to the urinary tract lining, which reduces infection risk. Research by Babar and team (2021) emphasized the efficacy of supplements with at least 37 mg of PACs daily, a concentration considered necessary to achieve therapeutic effects. In contrast, cranberry juice may require large volumes (often more than 8 ounces per day) to reach similar PAC levels, which can pose adherence challenges. Therefore, while both juice and supplements show promise, standardized cranberry supplements are currently recommended for their practicality and consistent PAC delivery. However, there is a need for more rigorous research to explore the differences in efficacy between various forms of cranberry, including juice and supplements, as well as variations in dosing regimens.

Currently, no studies have directly compared the effects of cranberry products based on their formulations or concentrations of proanthocyanidins (PACs). Future research could benefit from examining the potential differences in UTI outcomes based on demographic factors, such as age and risk profiles, and whether cranberry products provide more substantial benefits in populations with a higher baseline risk of recurrent UTIs.

The use of cranberry products necessitates close monitoring of patient adherence and potential interactions with other medications, particularly in populations with a history of recurrent UTIs. This is especially crucial for patients who may require comprehensive preventive strategies that include both cranberry supplementation and conventional antibiotic treatments. Regular follow-up and patient education are essential to optimize the use of cranberry products in clinical practice, ensuring they are integrated effectively into UTI management protocols.

5 | CONCLUSION

Women with recurrent UTIs face challenges in managing persistent symptoms like urgency and discomfort, which may not always improve with antibiotics alone. Cranberry products, especially those rich in proanthocyanidins (PACs), offer a natural preventive option, appealing to individuals seeking non-antibiotic alternatives due to concerns about resistance and side effects. The products empower women to take control of their UTI management, with options to choose between formulations like juice or supplements based on personal preference. This review highlights the potential benefits of cranberry products, though their effectiveness varies with dosage and patient characteristics. Ongoing research and patient education are essential for optimizing their role in broader UTI management strategies.

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