The effects of oral garlic on vaginal candida colony counts: a randomised placebo controlled double-blind trial

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Accepted 21 August 2013. Published Online 6 December 2013.

Objective Garlic is effective against Candida species in vitro, and along with other alternative therapies, is used by women with vulvovaginal candidiasis. The objective of this study was to ascertain whether oral garlic reduced vaginal candida counts during the second half of the menstrual cycle in asymptomatic women colonised with Candida species.

Design A simple randomised double-blinded controlled trial.

Setting Melbourne, Australia.

Sample Sixty-three asymptomatic women who were culture-positive for Candida species at screening.

Methods Participants were randomised to three garlic tablets or placebo orally, twice daily, for 14 days.

Main outcome measures The primary outcome was the proportion of women with colony counts of candida >100 colony-forming units per ml in any given day during the last 7 days before menstruation, defined as a ‘case’. Secondary outcomes included the mean quantitative colony counts of candida over 14 days prior to menses.

Results There was no evidence of a difference between the proportion of cases in the garlic and placebo groups (76 versus 90%; relative risk, RR 0.85; 95% confidence interval, 95% CI 0.67 –1.08), in the mean colony counts in both groups (ratio of geometric means of candidal colony counts 0.63; 95% CI 0.39–10.03; \( P = 0.74 \)), or difference in the number of women reporting abnormal vaginal symptoms during the 2 weeks before menstruation (RR 1.03; 95% CI 0.67–1.58; \( P = 0.91 \)). The garlic group reported more adverse effects (83% compared 43% in the placebo group; difference in proportions 39%; 95% CI 17–%; \( P < 0.01 \)).

Conclusions This study provided data for sample size calculations in future studies on the antifungal effect of garlic, but provided no evidence to inform clinical practice regarding the use of garlic in vaginal candidiasis. Further studies might investigate longer courses or topical formulations.

Keywords Candida, colonisation, garlic, premenstrual, randomised controlled trial.

Introduction

Although uncomplicated vulvovaginal candidiasis (VVC) is usually easily managed, complicated VVC is more difficult to manage. For many women who suffer from repeated episodes of VVC, the recommended treatment of long-term suppression and maintenance therapy provides short-term relief; however, up to 50% relapse within months of finishing treatment. Women use a range of complementary and alternative therapies in an attempt to manage this condition. Garlic, a popular and widely accepted herbal supplement, is one of these choices; however, to date it has not been evaluated in women with VVC.
Allicin, a compound of garlic, is a potent antifungal agent against Candida species (spp.), and compares favourably with antifungal drugs in animal and in vitro studies.\textsuperscript{8–11} The fungicidal action of garlic may be mediated by blocking the lipid synthesis of the yeast and by the inhibition of nucleic acid and protein synthesis,\textsuperscript{12} or the inhibition of hyphae formation of Candida spp.\textsuperscript{7} Two animal studies using high doses of garlic demonstrated reduced Candida spp. colonisation when garlic was administered orally or intravenously.\textsuperscript{13,14} Unresolved issues regarding the potential use of garlic for VVC include lack of knowledge of its effect \textit{in vivo} and its bioavailability.\textsuperscript{15}

Although the available data are not conclusive, most studies concur that levels of candida colonisation and symptomatic episodes of VVC tend to rise in the second half of the menstrual cycle.\textsuperscript{16–20} Lower levels of vaginal colonisation with candida generally correlate with fewer symptoms of vaginitis.\textsuperscript{16,21–23} Symptomatic VVC is rare when vaginal colony-forming units per ml (CFU/ml) are below 100.\textsuperscript{22,23}

To explore the potential of garlic in VVC, the objective of this study was to examine the effect of women taking garlic tablets compared with placebo tablets on the vaginal colony count of candida in the 2 weeks prior to menstruation using a double-blind placebo randomised controlled trial (RCT), in a population of asymptomatic women colonised with Candida spp.

**Methods**

This two-arm double-blind parallel group RCT (trial reg. no. ACTRN12610000744055) was preceded by a pilot study (\(n = 10\); trial reg. no. ACTRN12610000532000) that determined the acceptability of the methods for participants, the viability of candida in posted vaginal swabs, and laboratory techniques.\textsuperscript{24}

Oral therapy is preferred by women with VVC.\textsuperscript{25} We used Garlicin\textsuperscript{\textregistered} tablets (Nature’s Way, Lehi, UT, USA), which have been extensively studied in clinical trials.\textsuperscript{15,26,27} We found that Australian enteric-coated freeze-dried garlic tablets had a lower allicin yield than Garlicin\textsuperscript{\textreg} (unpubl. data). We found that two tablets twice daily were well tolerated in the pilot study, and we increased the dose to three tablets twice daily for the RCT to maximise the potential antifungal effect. Self-collected and posted swabs were used to ease participant burden. Our preliminary studies confirmed methods for self-collected swabs, postage of swabs for analysis of Candida spp, and stability of Candida spp. in swabs at room temperature (20–25°C) for 24 hours, which had successfully been demonstrated in previous studies.\textsuperscript{28–31}

**Recruitment of participants**

Recruitment occurred in Melbourne, in the State of Victoria, Australia, between October 2010 and July 2011. Printed and electronic advertisements for participants were distributed across two universities, a large tertiary referral hospital for women, women’s gymnasiums, online community notice boards, and social media. Interested participants contacted the researchers by email or telephone.

**Eligibility criteria**

Women were eligible if they reported at least one episode of VVC in the previous 12 months, had no current abnormal vaginal symptoms, were aged between 18 and 50 years, and had no allergy to garlic or tablet excipients, and had vaginal Candida spp. present at baseline screening.

Exclusion criteria included amenorrhoea or highly irregular cycles (because of the potential problems in calculating the 2 weeks before menses), impending surgery, pregnancy, breastfeeding, and use of anticoagulants.

Eligible women were sent a screening pack containing study information, swab, specimen bag, reply-paid envelopes, and an entry questionnaire. Women were asked to mail back written consent, questionnaires, and self-collected vaginal swabs placed in Amies transport medium.

To identify women with vaginal Candida spp., semi-quantitative cultures were performed at RMIT University, using Brilliance Candida agar (Thermo Fisher Scientific, Adelaide, SA, Australia) and Sabouraud Dextrose Agar (Thermo Fisher Scientific), both containing chloramphenicol (0.4 g/l). Each plate was incubated at 36°C for 24 and 48 hours, and cultured yeast were identified. Women with positive screening cultures were invited to participate.

**Outcomes**

The primary outcome was the proportion of ‘cases’, where ‘cases’ where defined as women with colony counts of candida >100 CFU/ml in any given day during the last 7 days before menstruation.

Secondary outcomes included the vaginal quantitative counts of Candida spp. determined by daily swabs taken 2 weeks prior to menstruation, itch (moderate to severe, compared with mild), and abnormal discharge (yes/no). In the exit interview, women were asked whether any symptoms of vaginitis experienced during their study menstrual cycle were the same, better, or worse than usual.

**Randomisation**

Blocked randomisation in block sizes of ten, with an allocation ratio of 1 : 1, was generated in \textit{Stata} 11 (College Station, TX, USA) by the biostatistician (P.C.), who was not involved in participant recruitment, or in data collection, entry, or management. This randomisation schedule was forwarded by the biostatistician to the Head of Pharmacy at Royal Women’s Hospital, Melbourne, whose only role in this study was to label, number, and seal the study inter-
ventions (garlic or placebo tablets). The intervention packages were allocated sequentially according to the schedule (C.W.).

Blinding and intervention
Participants, researchers involved in the participant recruitment, and laboratory staff were blinded to the group allocation. Garlicin tablets contained 350 mg garlic powder, and had a reported allicin yield of 3200 mg. Placebo tablets contained lactose, povidone, maize starch, talc, and magnesium stearate, and were matched for weight and colour. Each DB capsule contained lactose, povidone, maize starch, talc, and magnesium stearate, and were matched for weight and colour with the garlic tablets by Sigma Pharmaceuticals (Rowville, Vic., Australia). DB caps, opaque gelatin capsule shells, were used to cover all tablets so that the two interventions looked identical, and were odourless.

Women were provided with all study interventions, materials, and the means to mail them to the investigators. Based on the last normal menstrual period and usual pattern, 14 days prior to the next menses was calculated (C.W.), and participants commenced taking tablets at that time, as instructed. They were requested to start collecting daily vaginal swabs on that date, place them in the Amies transport medium and specimen bag, and post them to the laboratory. To reduce the likelihood of fungal overgrowth, swabs obtained on Friday, Saturday, and Sunday were refrigerated and sent on Monday. Inhibition of candida growth has been demonstrated during refrigeration.

Daily text reminder messages (SMS) were used. Each participant was instructed to take three tablets morning and night after food. Each day, women were asked to record in a diary any vaginal itch (slight, moderate, or severe) and any abnormal vaginal discharge. Participants were advised to immediately report any side effects to C.W. using a designated telephone number. Additionally, in the telephone exit interview, women were asked: ‘did you experience any symptoms that you thought were caused by the tablets you took?’ The participants completed the study when menstruation occurred, or if vaginitis requiring treatment was experienced.

The validated laboratory technique for quantitative colony counts of Candida spp. was used, and has been previously described. In a capped sterile Wasserman tube, each swab was vortexed for 5 seconds in 0.9 ml of sterile physiological-strength saline. After spreading 100 μl of the saline suspension on the surface of a Brilliance Candida Agar (BCA) plate containing chloramphenicol (0.4 g/l), each plate was incubated at 36°C for 24 and 48 hours. The remaining suspension was capped and stored at 4°C for further dilutions if growth of yeast was seen after 24 hours of incubation. Using sterile saline, 100 μl of dilutions (from $10^{-1}$ to $10^{-5}$) were spread on the surface of Sabouraud’s Dextrose Agar (SDA) (Oxoid, Basingstoke, Hampshire, UK) containing chloramphenicol (0.4 g/l). If no yeast colonies were present on the BCA plate, 500 μl of the initial saline suspension was added to the surface of an SDA and a further 48 hours of incubation was performed. At 48 hours of plate incubation, the colony count was recorded as CFU per 100 μl and per 1 ml of saline suspension. If yeast were germ-tube positive and green colonies were present on BCA, they were identified as Candida albicans. Isolates that were germ-tube negative were stored at −80°C pending identification using API Candida (bioMérieux, Marcy-l’Étoile, France), and if the results were uncertain then ID 32C (bioMérieux) was used as a confirmatory ID.

Sample size
Based on a two-sample Student’s t-test of proportions, a total sample size of 56 was required to detect an absolute difference of 40% in the proportion of cases in the garlic group compared with placebo, given that 80% of the women were cases in the placebo group, with 90% power and 5% significance level. The sample size was inflated to 62 to allow for a conservative attrition rate of 8%.

Statistical methods
Descriptive statistics were used to compare the characteristics of the women in the two study groups. Analysis was based on intention-to-treat.

Logistic regression was used to compare the binary outcomes between the study groups. Relative risks (RRs) and odds ratios (ORs) were reported with 95% confidence intervals (95% CIs) and $P$ values. Multivariable regression was used to adjust for reported recurrent VVC and use of oral contraceptives (OCs). No adjustment was made for women with and without diabetes mellitus, as the numbers were too small. Colony counts of Candida spp. were transformed using the logarithmic scale because the distribution was skewed to the right. As candida was undetected in some swabs (recorded as 0 CFU/ml), 0.1 was added to the outcome measure prior to log transformation. To account for the correlation of repeated responses within women, the log-transformed colonisation counts were averaged across the 14 days before menses for each woman.

As a wide variation of colony counts between participants was expected following data obtained from the pilot study, a coefficient of variation (CV) was used in the analysis rather than the standard deviation, as it remains constant over a large range of measures. Geometric means are usually applied to log-transformed data.

The sample size of 56 individuals was also sufficient to detect a geometric mean ratio of 0.62 between the garlic and placebo groups for colony counts of Candida spp. (averaged across the 14 days) with 80% power, assuming the CV between women (that is, the standard deviation of
the untransformed counts divided by its mean) is 0.7. Table 1 gives the geometric mean ratio detectable for a range of CV, as there was no information available for the likely values of the CV between the women.

Linear regression on the log-transformed colonisation counts averaged for each woman was used to estimate the intervention effect. The estimated mean difference between study arms and 95% CI were back-transformed and reported as the ratio of the geometric means of the garlic group compared with the placebo group. Colonisation levels at the beginning and end of the 2 weeks were also compared between study groups, as well as the number of women in each group remaining free of candida colonisation. The two-sample Student’s t-test for proportions was used to compare the proportion of women reporting an improvement in their symptoms of vaginitis and the proportion of women with at least one side effect between the study groups. Missing data were not accounted for in analysis, as attrition was very small. Analysis was conducted in Stata 12.

Results

We received 375 enquiries about the study, from which 264 women were eligible and 192 returned a screening swab (Figure 1). Seventy (37%) were colonised with Candida spp., of which 63 eligible women were randomised. Seven eligible women were not randomised as the study quota was reached. Four women withdrew from the study (garlic n = 3, placebo n = 1), leaving a sample size of 59.

All participants completed the study according to the protocol. The median time between the screening sample and study commencement was 2.5 weeks (range 1–12 weeks); 2.1 weeks for those who tested culture-positive during the study (n = 54; range 1–8 weeks) compared with 2.2 weeks for those who remained culture-negative (n = 5; range 2–13 weeks).

The participants were more highly educated than other women of this age group from Victoria (ABS census 2006). The study groups were similar on their baseline characteristic, except for reported recurrent VVC (Table 2). In total, 75% (44/59) of participants reported recurrent VVC at baseline: 86% of women in the garlic group and 63% of women in the placebo group.

Most participants were colonised with C. albicans (n = 51, 86%) or Candida glabata (n = 6, 10%), and one woman (2%) was colonised with Candida lipolytica. The species was not recorded for one isolate.

Primary analysis

In the garlic group, 75.9% of women were cases (where ‘cases’ were defined as women with colony counts of candida >100 CFU/ml in any given day during the last 7 days before menstruation), compared with 89.7% in the placebo group. There was no evidence for a difference in the proportion of cases in the two study groups (difference in proportion 13.8%, 95% CI −5.3 to 32.9%), RR 0.85 (95% CI 0.67–1.08, P = 0.17), the unadjusted OR was 0.36 (95% CI 0.08–1.57, P = 0.16), and the OR adjusted for reported recurrent VCC and OC use at baseline was 0.66 (95% CI 0.14–3.16). There was no evidence to reject the null hypothesis of no difference between study groups (P = 0.32).

Secondary analysis

The geometric mean of the colony counts averaged across the 14 days was 1174 (95% CI 137–100 051) in the garlic group and 1872 (95% CI 292–12 009) in the placebo group. The estimated ratio of geometric means between the garlic and placebo groups was 0.63 (95% CI 0.39–10.03, P = 0.74). When adjusted for both recurrent VVC and OC use, the estimated geometric mean ratio was 0.43 (95% CI 0.024–7.6, P = 0.56).

Figure 2 shows the comparison of geometric mean colonisation colony counts for the garlic and placebo groups, and the variability of colony counts both between and within women on each of the 14 days before menses. The figures demonstrate considerable variability in the colony counts both between and within women, by as much as log10 6 over 24 hours.

There was no difference in symptoms between the groups, with 71% (20/28) and 69% (20/29) of participants in the garlic and placebo group, respectively, reporting moderate to severe itching or abnormal discharge during the 2 weeks before menstruation (RR 1.03, 95% CI 0.67–1.58, P = 0.91). There was a trend showing that more women in the garlic group 62% (18/29) reported that their symptoms of vaginitis were improved compared with 43%...
in the placebo group (difference in proportions was 19%, 95% CI -6.0 to 44%, $P = 0.14$; Table 3).

The first day and last day colony counts for both the garlic and placebo groups are shown in Figure 3. For women in the garlic group, counts rose in eight women and fell in 14 women. For the women in the placebo group counts rose in 12 women and fell in 14 women, with the remaining participants’ counts unchanged.

Despite all participants having candida detected in the screening swab, 13 (45%) women in the garlic group and 11 (37%) in the placebo group were no longer colonised by the time of their first specimen after randomisation; furthermore, four in the garlic group and one in the placebo group remained culture-negative throughout the study.

The proportion of women reporting at least one side effect attributed to the intervention was 83% (24/29) in the garlic group, compared with 43% (13/30) in the placebo group, with a difference in proportions between the two study groups of 39% (95% CI 17–97%, $P < 0.01$). The most prevalent reported side effect in the garlic group was gastrointestinal symptoms (e.g. gastric pain, garlic odour, and nausea; Table 4). No participants withdrew because of side effects from the study intervention.

**Discussion**

**Main findings**

In this first study of its kind, we found no impact of three Garlicin™ tablets taken twice daily in the 2 weeks prior to menstruation on vaginal candida colonisation.

**Strengths and limitations**

The strengths of this study include rigorous preliminary work and piloting of methods to ensure that tools were acceptable to participants and study methods were appropriate, including the obtaining and processing of microbiological specimens. There was good participant retention and compliance with the protocol.
Demographically the study sample, although better educated, was otherwise representative of non-pregnant, premenopausal women.

We chose a 40% difference in the proportion of cases on the assumption that this would be clinically significant. Using the evidence available at the time and expert advice, this study had sufficient power to rule out a significant difference between the cases in garlic and placebo groups. This work had no precedent upon which to base our calculations, but does provide information on which to base future sample-size calculations.

A limitation was our reliance on women’s self-reported VVC in the previous year, which is unreliable. This did not impact on primary outcomes, however, as asymptomatic candida colonisation was confirmed by screening swab. Diagnosis of recurrent VVC usually requires four or more microbiologically and clinically proven episodes in a 12-month period; however, we found that reported recurrent VVC was associated with positive screening culture.

Despite this limitation, 75% of our sample reported four or more episodes of VVC in the previous year, compared with 5% generally. Our research appeared to attract a group of women for whom therapies for recurrent VVC had failed.

Table 2. Characteristics of participants by study group

<table>
<thead>
<tr>
<th></th>
<th>Garlic (n = 29)</th>
<th>Placebo (n = 30)</th>
<th>χ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years—mean (SD)</td>
<td>31.2 (7.0)</td>
<td>31.6 (7.6)</td>
<td>0.96</td>
</tr>
<tr>
<td>Country of birth*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia/New Zealand</td>
<td>18 (62)</td>
<td>21 (70)</td>
<td>0.84</td>
</tr>
<tr>
<td>Employed</td>
<td>24 (80)</td>
<td>22 (73)</td>
<td>0.70</td>
</tr>
<tr>
<td>Level of education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University</td>
<td>22 (73)</td>
<td>23 (77)</td>
<td>0.94</td>
</tr>
<tr>
<td>TAFE</td>
<td>2 (7)</td>
<td>2 (7)</td>
<td>0.97</td>
</tr>
<tr>
<td>Secondary</td>
<td>6 (20)</td>
<td>5 (17)</td>
<td>0.95</td>
</tr>
<tr>
<td>Smoker**</td>
<td>1 (2)</td>
<td>4 (7)</td>
<td>0.19</td>
</tr>
<tr>
<td>Known allergies</td>
<td>24 (80)</td>
<td>21 (70)</td>
<td>0.28</td>
</tr>
<tr>
<td>Self-reported recurrent VVC</td>
<td>25 (86)</td>
<td>16 (63)</td>
<td>0.07</td>
</tr>
<tr>
<td>Sexually active</td>
<td>21 (72)</td>
<td>26 (87)</td>
<td>0.47</td>
</tr>
<tr>
<td>Use of oral contraceptive</td>
<td>9 (32)</td>
<td>12 (40)</td>
<td>0.34</td>
</tr>
<tr>
<td>Use of intrauterine device</td>
<td>2 (7)</td>
<td>0 (0)</td>
<td>0.14</td>
</tr>
<tr>
<td>Use of douching</td>
<td>2 (7)</td>
<td>3 (10)</td>
<td>0.65</td>
</tr>
<tr>
<td>Medical conditions***</td>
<td>6 (21)</td>
<td>3 (10)</td>
<td>0.30</td>
</tr>
<tr>
<td>Dermatitis</td>
<td>2 (7)</td>
<td>0 (0)</td>
<td>0.14</td>
</tr>
<tr>
<td>Diabetes</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>NA</td>
</tr>
</tbody>
</table>

 Counts and percentages presented, unless otherwise stated; SD, standard deviation; TAFE, Technical and Further Education.
*One woman in the intervention group did not respond to country of birth.
**Two women did not provide information on their smoking status.
***Medical conditions are not mutually exclusive.

Figure 2. (A) Comparison of mean vaginal colony counts in garlic and placebo groups. (B) Variation of individual colony counts (grey lines) and mean colonisation across women (solid black lines) up to 14 days in the luteal phase of the menstrual cycle for garlic (n = 29) and placebo (n = 30) groups.

Table 3. Symptoms reported by study group

<table>
<thead>
<tr>
<th>Perceived symptoms</th>
<th>Garlic (n = 29)</th>
<th>Placebo (n = 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better</td>
<td>18 (62)</td>
<td>13 (43)</td>
</tr>
<tr>
<td>Same</td>
<td>8 (28)</td>
<td>14 (47)</td>
</tr>
<tr>
<td>Worse</td>
<td>3 (10)</td>
<td>3 (10)</td>
</tr>
</tbody>
</table>

Women were asked, in an exit interview, whether this menstrual cycle was better regarding symptoms, worse, or the same as in most cycles. Difference in proportions, 19%; 95% CI −0.60 to 44%; P = 0.13.

Our study was not powered to detect a difference in symptoms between the groups and differences in the other secondary outcomes described. These secondary outcomes are of an exploratory nature, and our findings must be interpreted in this light.
Interpretation

We designed our study with a 90% power to detect a difference of 40% in the proportion of cases in both groups with colony counts of >100 at least once in the last 7 days before menstruation, but in the actual study we found a 14% difference. Given that this is the first RCT investigating the effect of garlic on vaginal candida colonisation, future researchers will need to power their studies to detect a smaller effect of 14% between intervention and control groups. A total sample size of 224 in each group would be required to detect a difference of 14% between garlic and placebo with 80% power.

Our study does not support that garlic was effective in reducing candida colonisation in susceptible women; however, larger studies are needed to preclude smaller intervention effects. In both our pilot study and this main study there was no single ‘trigger point’ of colonisation beyond which symptoms occurred. It is possible that the mean colony counts of candida as an objective outcome did not reflect sufficiently the actual cases of candidiasis, as colonisation without having symptoms has uncertain clinical significance. The high degree of variability in the levels of Candida spp. both within and between participants may also contribute to the difficulty in interpreting the results.

The clinical value of self-reported symptoms may be questioned, as many participants reported symptoms on days when they were culture-negative. It is possible that, as found in our pilot study, symptoms may persist despite falling levels of colonisation. The significance of women who were not colonised yet reported symptoms is unclear. It may be that symptoms persist after colonisation levels have dropped to undetectable as a result of host response, and that symptoms may in fact result from VVC despite negative cultures. Furthermore, symptoms may have resulted from other conditions: as we tested only for candida and no physical examination was conducted, it is impossible to surmise whether symptoms were caused by yeast, by another pathogenic organism, or by other vulval conditions.

Although we chose the last 2 weeks of the menstrual cycle for our study because of premenstrual elevated candida colonisation, previous research on antifungal pharmaceuticals used the follicular phase (first 2 weeks) for their studies. The timing of our study may have affected the results; however, the value of the eradication of fungal burden immediately following menstruation in order to reduce the incidence of later symptomatic episodes has not been proven.

Another factor that may have affected the outcome and should be considered in future studies is the duration of treatment with garlic. Given the large variation in candida burden within and between individuals over the 2 weeks of this study, a longer duration of study, for two to six complete menstrual cycles, may have captured a better picture of colonisation patterns as well as cyclical symptoms. However, probable reduced participant retention and compliance would need to be considered.

This study indicates that if oral garlic has an effect on vaginal candida colonisation, it is modest. It is evident that allicin is a potent antifungal agent in vitro; however, it is likely that poor bioavailability reduces its efficacy against candida when used orally. As its direct antifungal effect cannot be disputed, it is also possible that a topical preparation may have therapeutic potential in VVC. The burning properties of organosulphur compounds necessitate the cautious use of allicin in tissues already compromised by chronic conditions such as recurrent VVC. It is possible that using a gelatin pessary containing allicin may prove to be beneficial without increasing morbidity among sufferers of recurrent VVC.

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Conclusion

This study investigated, for the first time, whether oral garlic tablets may reduce the colonisation of vaginal *Candida* spp. and symptoms of candidiasis in women reporting VVC in the previous 12 months, who were culture-positive for *Candida* spp. at screening. This study provides a foundation for planning future studies investigating the effect of garlic on candida colonisation. The antifungal effect of allicin, a compound of garlic, is evident *in vitro*, but the bioavailability of allicin after oral consumption is poor. Although we cannot recommend oral garlic tablets taken 2 weeks before menstruation for the management of vaginal candidiasis, future research might focus on a longer period of treatment or on topical preparations.

Disclosure of interests

The authors declare no financial, personal, political, intellectual, or religious conflict of interests.

Contribution to authorship

C.W. and M.P. initiated the study and wrote the grant application, and together with D.G., C.F., S.G., and S.M. developed the study design. D.G. and S.G. designed and approved the laboratory protocol. D.G. conducted and supervised the laboratory work. C.W. conducted the literature search and data collection. P.C. and C.W. worked on statistical analysis. All authors contributed to data interpretation and manuscript preparation.

Details of ethics approval

Ethics approval was granted through the University of Melbourne’s Health Sciences Human Research Ethics Committee (HREC; 9 September 2010; ref. no. 0932243.1), the Royal Women’s Hospital Human Research Ethics Committee (3 May 2010; ref. no. 0933026.1), and the University of Melbourne HREC for the pilot (ref. no. 0933026.1). All participants gave informed consent before taking part in the study. Clinical trial registration number and URL: ACTRN1261000744055; www.ANZCTR.org.au/ACTRN1261000744055.aspx.

Funding

This work was supported by The Shepherd Foundation, which provided funding for the study, and the University of Melbourne, which provided the student stipend. Australian Sexual Health and HIV Nurses Association/Commonwealth Scientific and Industrial Research Organisation provided funding for garlic tablet analysis. The funding bodies had no further role or influence on the study.

Acknowledgements

The women in this study are gratefully acknowledged. The authors would also like to acknowledge the assistance of Swee Wong and Huda Ishmael at the Royal Women’s Pharmacy, and Helen Williams and Ruby Beizen and laboratory staff at RMIT University. Dr Larry Lawson at Silliker Laboratories Utah is gratefully acknowledged for sharing his expertise with garlic. Garlicin™ tablets were purchased from Nature’s Way USA and placebo tablets were purchased from Sigma Pharmaceuticals (Australia).

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