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Short Communication

Efficacy of a novel pH-buffering tampon in preserving the acidic vaginal pH during menstruation☆

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The vagina of a reproductive-age woman has a pH between 4 and 5. During menstruation, the vagina becomes less acidic due to the presence of menstrual fluid and diminished population of lactobacilli [1]. If the vagina becomes less acidic, the protective barrier provided by the normal acidic condition of the vagina becomes less effective and colonization by pathogenic microorganisms tends to appear [2]. The antimicrobial activity of the vaginal fluids is correlated with low pH and high lactic acid content [3]. This clinical trial, the first in humans, was designed to test the ability of a unique new bifunctional tampon (Rostam Ltd. Caesarea, Israel) to preserve the acidic pH of the vagina during menstruation.

The tampon contains a polymeric delivery system (strips) that upon absorption of menstrual fluid gradually releases lactic acid and citric acid. The safety of the formulated novel tampon has been established in two animal studies using external approved GLP facilities (Harlan Biotech Israel Ltd. Rehovot, Israel). No skin sensitization was observed in guinea pig maximization test and no significant irritation was noted in rabbit vaginal irritation test.

The study was a randomized, double blind, placebo-controlled, crossover study, in which healthy volunteers, with regular menstrual cycles, used test tampons and identically looking regular tampons during two consecutive menstrual cycles according to random allocation. The study consisted of a screening\baseline visit, a menstruation visit (day 3 or 4 of the menses), and a follow-up visit (4–7 days prior to the next period). The same sequence of visits was performed for the subsequent menstrual cycle. Subjects who had abnormal vaginal discharge or abnormal growth of pathogenic microorganism in the initial vaginal culture were excluded from the study. Each visit the subjects were evaluated for vaginal pH and tampon pH (when applicable) and microbiologic cultures (using a standard sterile swab) were obtained. Subjects were instructed to use/change the tampons according to their individual habits and needs.

☆ The study was partially presented at the annual meeting of the Society for Gynecologic Investigation (SGI) Washington DC March 2003.

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Table 1
Vaginal pH and tampon pH in the regular tampon group vs. the test-tampon group

	Regular tampon ($n=14$)			Test-tampon ($n=14$)		
	Baseline	Intra-menstrual	Difference	Baseline	Intra-menstrual	Difference
Tampon		6.51 ± 1.01			4.70 ± 0.78	1.81*
Vaginal	4.6 ± 0.73	5.58 ± 1.02	0.98**	4.76 ± 0.86	5.08 ± 0.818	0.32**

(Values are mean ± S.D.). *$P<0.001$; **$P=0.0011$.

The vaginal pH was measured using a handheld pH meter (IQ 150, IQ Scientific Ltd). The measurements were performed on the lateral and contralateral vaginal walls at the middle of the vagina. The evaluation of the tampon pH was based on four different measurements in the middle/center surfaces of the tampon. Any complaint by the subject or unusual finding upon vaginal inspection was documented during each visit.

A *t*-test was used to compare the difference of the changes in vaginal pH and the difference in mean tampon surface pH values between the test tampon and the regular tampon. This analysis was further refined to determine the presence of a sequence effect, using analysis of variance for a two period crossover study. The association between vaginal and tampon pH and cycle days, duration of tampon insertion, and tampon weight, were assessed via linear regression models using SAS PROC GLM. An evaluation of the possible existence of a sequence effect was then conducted using analysis of variance for a two period crossover study.

Twenty-eight women completed the study and two were withdrawn prior to application of the tampons due to abnormal vaginal cultures upon screening (growth of candida albicans). The vaginal pH (Table 1) at the premenstrual visit varied from 3.75 to 5.95 (mean 4.60) when using the regular tampon and from 4.4 to 6.25 (mean 4.76) when using the test tampon. No significant difference was detected between the baseline values of the regular vs. the test tampon ($P=0.3294$). As expected, in the regular tampon cycles ($n=14$), the mean (±S.D.) vaginal pH increased from 4.6 (±0.73) at baseline to 5.58 (±1.02) during menstruation. This increase (by 0.98) was statistically significant ($P=0.0011$). In the test-tampon cycles ($n=14$), an insignificant increase ($P=0.0518$) was noted in the mean (±S.D.) vaginal pH, from 4.76 (±0.86) at baseline to 5.08 (±0.81) intramenstrualy.

Comparison of the mean intramenstrual vaginal pH values between the regular and the test tampon cycles using a paired *t*-test revealed a statistically significant difference ($P=0.0025$, mean pH regular tampon = 5.58, mean pH test tampon = 5.08). The difference in the changes of vaginal pH in the regular vs. test tampon group (0.98 vs. 0.32) was highly statistically significant ($P=0.0011$). The test-tampon surface pH was lower by 1.81 as compared to the regular tampon (4.70 vs. 6.51, $P<0.001$).

For both the vaginal pH and tampon surface pH there was no significant sequence effect with respect to vaginal pH ($P=0.1240$) and tampon surface pH ($P=0.1035$). The estimated treatment effect was 1.85 pH units with a *P*-value of < 0.0001. There was no significant difference between the two groups with respect to menstrual day, tampon insertion duration, and tampon weight. The bacteriological cultures of the vagina and tampon surface revealed normal vaginal flora and no colonization of pathogenic microorganism were detected in any of the subjects. There were no complaints of vaginal irritation or unusual discharge.

These results indicate that the test tampon can effectively reduce the elevation of vaginal pH during menstruation to the values present during the non-menstruating period. This effect is probably due to the continuous release of lactic acid. Vaginal acidity is thought to be produced by the anaerobic metabolism of glycogen to lactic acid [4]. The concurrent release of citric acid further contributes to the reduction of the vaginal pH. One

of the hallmarks of bacterial vaginosis is reduction in vaginal acidity leading to an overgrowth of a variety of mostly anaerobic bacteria [2]. Based on our preliminary results, it seems prudent to test (by large scale clinical trials) the efficacy of the new tampon in reducing the risk of vaginosis and perhaps other types of vaginitis.

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