# An analysis of the effects of aromatherapy abdominal massage on menstrual discomfort relief

Su-Jung Lee[1], Myung-Sun Lee[2]*
[1]Department of Beauty and Health Care, Daejeon University, South Korea; emailaddress@refiffmail.com (S.J.L).
[2]Department of Beauty Design, Daejeon University, South Korea; Laura2711@naver.com (M.S.L.).

**Abstract:** This study aimed to examine the effects of an aromatherapy-based intervention on relieving menstrual pain and discomfort in women suffering from premenstrual syndrome (PMS). Participants were divided into three groups: Experimental Group 1 received self-administered abdominal massage using a blend of essential oils (lavender, clove, black pepper, and clary sage) diluted in a carrier oil; Experimental Group 2 received massage with carrier oil only; and the control group applied a hot pack. The results showed that pain levels were lowest in Experimental Group 1, indicating that abdominal massage with aromatherapy can be an effective method for alleviating dysmenorrhea and menstrual discomfort. This intervention is expected to contribute to promoting the health and quality of life of women experiencing menstrual pain. The findings suggest that aromatherapy-based abdominal massage may serve as a practical approach for the management of dysmenorrhea and the enhancement of overall women's health.

**Keywords:** Aromatherapy, Complementary and alternative therapy, Dysmenorrhea, Premenstrual syndrome (PMS), Self-Abdominal massage.

## 1. Introduction

With the advancement of modern civilization, factors such as stress, poor dietary habits, lack of physical activity, and environmental influences have emerged as major contributors to the worsening of dysmenorrhea and menstrual discomfort. Consequently, health conditions related to menstrual pain among women have been on the rise [1, 2]. Many women prefer taking analgesics as the primary method for relieving menstrual pain, and it has been reported that 87.0% of unmarried women use painkillers for this purpose [3, 4]. However, frequent use of analgesics may lead to physical side effects such as gastrointestinal disturbances, kidney damage, cardiovascular complications, and drug tolerance, as well as psychological effects including anxiety and depression [5].

Due to these circumstances, dysmenorrhea and menstrual discomfort can significantly diminish an individual's quality of life, highlighting the need for appropriate responses and proactive interventions. Furthermore, greater attention at the societal and policy levels is warranted to address these issues effectively [6, 7]. In particular, when menstrual pain interferes with daily life, it is important to choose an appropriate treatment method to alleviate the pain and discomfort associated with the menstrual cycle [8]. To address this issue, non-pharmacological interventions with minimal side effects have been gaining attention as viable alternatives [9]. Among them, aromatherapy—a natural treatment method that utilizes essential oils extracted from plants—has been highlighted for its potential benefits. Essential oils are easily absorbed through the skin and may help relieve pain [10, 11]. Aromatherapy is considered a safe and fast-acting method for relieving menstrual discomfort and pain. It is also easy to self-administer, allowing for continuous and comfortable management of dysmenorrhea [12, 13]. In addition, massage has been shown to have positive effects on both physical and psychological well-

being, contributing to symptom relief during menstruation by promoting pain reduction, enhancing metabolism, and reducing tension and anxiety [14]. Previous studies have employed a variety of interventions to alleviate menstrual pain and discomfort in women, including massage therapy, abdominal thermotherapy, stone therapy, and traditional Korean herbal steam therapy (Joa-hun). However, there is a lack of research specifically examining the combined use of aromatherapy and self-administered abdominal massage as a method for relieving dysmenorrhea and menstrual discomfort. Therefore, the present study aims to investigate the effects of self-abdominal massage using essential oils—lavender, clary sage, black pepper, and clove—which possess calming properties and exhibit estrogen-like activity. This research is expected to contribute to the scientific validation of complementary and alternative therapies for the effective management of menstrual pain and discomfort.

## 2. Materials and Methods

### 2.1. Research Participants

Participants were initially recruited from women in their 20s and 30s who met the inclusion criteria of experiencing dysmenorrhea and menstrual discomfort. A screening questionnaire consisting of 16 items covering general and menstrual characteristics was distributed online. Among those who responded, 36 women who reported a pain intensity of 6.0 or higher on a numerical rating scale and expressed willingness to participate were selected for the study. The required sample size was calculated using G*Power software, assuming an effect size of 0.25, a significance level ($\alpha$) of 0.05, and a statistical power ($1-\beta$) of 0.95. Based on this calculation, a minimum of 36 participants was deemed appropriate. After excluding dropouts, the final number of participants included in the analysis was 29. Reasons for dropout were as follows: in Experimental Group 1, one participant withdrew due to discontinuation of self-administered abdominal massage; in Experimental Group 2 and the control group, participants withdrew due to personal reasons. Therefore, data from the remaining 29 participants were used for the final analysis.

### 2.2. Research Method

To achieve the objectives of this study, the experiment was conducted from June 1 to August 29, 2021. The intervention was applied daily for 10 minutes, starting 14 days before the onset of each participant's menstrual cycle and continuing until 3 days before menstruation. Participants in Experimental Group 1 performed self-abdominal massage using a blend of essential oils (lavender, clary sage, black pepper, and clove) mixed with almond oil as the carrier. Experimental Group 2 performed self-abdominal massage using almond oil only. The control group applied a hot pack to the abdominal area for the same duration.

The measurement tools used in this study to compare the results between the experimental and control groups included the Visual Analogue Scale (VAS) to assess the intensity of menstrual pain, and a modified version of the menstrual discomfort scale originally developed by Hwang [15] to measure physical and psychological discomfort related to dysmenorrhea. In addition, changes in menstrual symptoms—such as cycle length, menstrual volume, and duration—were measured using a revised scale based on the study by Jung, et al. [16]. Table 1 provides detailed information on the interventions applied to Experimental Groups 1 and 2 as well as the control group. Participants in Experimental Groups 1 and 2 were instructed to perform self-abdominal massage daily, with Group 1 using essential oils and Group 2 using only carrier oil. The control group applied a hot pack to the abdominal area for the same duration over the intervention period.

**Table 1.**
Clinical Experimental Design Comparing Experimental and Control Groups

| Group | N (Participants) | Intervention | Type of Treatment |
|---|---|---|---|
| Experimental Group 1 | 9 | Lavender, clove, black pepper, clary sage + carrier oil (almond oil) | Essential Oils |
| Experimental Group 2 | 10 | Carrier oil (almond oil) only | Carrier Oil |
| Control Group | 10 | Hot pack application | Hot pack |

### 2.3. Experimental Procedure

Participants in Experimental Groups 1 and 2 were instructed to perform daily abdominal massage using a blend of essential oils (lavender, clary sage, black pepper, and clove) mixed with almond oil, while participants in the control group applied a hot pack. These interventions were carried out daily from 14 days before the expected onset of menstruation until 3 days prior to menstruation. After the intervention period, participants completed a survey to assess menstrual pain, menstrual discomfort, and changes in menstrual symptoms.

### 2.3.1. Self-Abdominal Massage Method

Participants in Experimental Group 1 performed abdominal massage by gently rubbing the abdomen using a blend of essential oils and a carrier oil, based on previous studies indicating their effectiveness in relieving menstrual pain. The essential oils used were lavender, clary sage, black pepper, and clove, blended in a ratio of 2:1:1:1. The blend was diluted in almond oil at a total concentration of 5%. Participants in Experimental Group 2 performed the same massage technique using almond oil only. The massage method did not require any special technique; the use of oil prevented friction-induced irritation and allowed the oil to be smoothly absorbed along the muscle fibers, thereby promoting blood circulation and reducing discomfort.

### 2.4. Data Analysis

The collected data were analyzed using SPSS version 23.0. A two-way ANOVA was conducted to examine differences in menstrual pain and menstrual discomfort by group and time. To compare differences in menstrual characteristics among groups, ANCOVA was performed. In addition, the Quade nonparametric ANCOVA was used as a nonparametric alternative.

## 3. Results and Discussion

### 3.1. Changes in Menstrual Pain

Table 2 presents the results examining whether there were significant differences in menstrual pain among the groups over time following the intervention.

**Table 2.**
Differences in Menstrual Pain Over Time by Group After Intervention.

| Time Point | Group | Mean (M) | Standard Error (SE) |
|---|---|---|---|
| 1 Day Before | Experimental Group 1 | 6.64 | 0.795 |
| | Experimental Group 2 | 7.39 | 0.479 |
| | Control Group | 7.95 | 1.170 |
| Day of Menstruation | Experimental Group 1 | 6.07 | 0.949 |
| | Experimental Group 2 | 6.69 | 0.692 |
| | Control Group | 7.63 | 1.106 |
| Day 2 | Experimental Group 1 | 4.64 | 1.040 |
| | Experimental Group 2 | 4.89 | 0.614 |
| | Control Group | 6.38 | 1.132 |
| Source | Type III Sum of Squares | | |
| | Wald Chi-Square | df (Degrees of Freedom) | Significance (p-value) |
| Intercept | 1.440 | 1 | 0.230 |
| Group | 5.328* | 2 | 0.040 |
| Time | 47.398*** | 2 | 0.000 |
| Group × Time Interaction | 17.939** | 4 | 0.001 |
| Age | .089 | 1 | 0.765 |
| Medication Dosage | 1.304 | 1 | 0.254 |

**Note:** $*p<.05, **p<.01, ***p<.001$

When examining the results from one day before menstruation, the mean pain score in Experimental Group 1 was 6.64 (SD = 0.795), while Experimental Group 2 reported a mean of 7.39 (SD = 0.479). The control group showed the highest mean pain score at 7.95 (SD = 1.170). On the day of menstruation, the mean pain score in Experimental Group 1 decreased to 6.07 (SD = 0.949), compared to 6.69 (SD = 0.692) in Experimental Group 2 and 7.63 (SD = 1.106) in the control group. By the second day, Experimental Group 1 reported a further decrease in pain, with a mean score of 4.64 (SD = 1.040), followed by Experimental Group 2 at 4.89 (SD = 0.614). The control group maintained a relatively high pain score of 6.38 (SD = 1.132). The chi-square value for the group variable was 5.328 with a p-value of .040, indicating a statistically significant difference between the groups. The time variable showed a chi-square value of 47.398 with a p-value of .000, also indicating a statistically significant difference over time. Furthermore, the interaction effect between group and time was statistically significant, with a chi-square value of 17.939 and a p-value of .001. These results suggest that there was a significant interaction between group and time, meaning that the changes in menstrual pain over time differed significantly among the groups. In addition, the results indicated that there were significant differences in menstrual pain between groups over time. Specifically, the analysis of group-by-time differences (1 day before menstruation, day of menstruation, and 2 days after) revealed statistically significant changes in pain levels across both time and group variables, as well as a significant interaction effect. More specifically, Experimental Group 1 reported the lowest pain level on the second day of menstruation. This finding is consistent with previous studies using essential oils such as lavender, clary sage, and rose [13] as well as research utilizing geranium and lavender essential oils [14]. The findings of this study indicate that aromatherapy is effective in relieving menstrual pain and that a variety of essential oils can be used for this purpose. Although both Experimental Group 2 and the control group also showed reductions in menstrual pain, the greatest reduction was observed in Experimental Group 1, which used essential oils. This confirms the soothing, analgesic, and antispasmodic effects of the essential oils used in this study. These results also highlight the potential for developing accessible and easy-to-use products incorporating lavender, clove, clary sage, and black pepper essential oils for menstrual pain management.

### 3.2. Changes in Menstrual Discomfort
Table 3 presents the results examining whether there were significant differences in menstrual discomfort among the groups over time following the intervention.

**Table 3.**
Differences in Menstrual Discomfort by Group and Time After the Intervention

| Group | Time | Mean | | Standard Error |
|---|---|---|---|---|
| Experimental Group 1 (Essential Oil Group) | 1 Day Before | 86.18 | | 10.683 |
| | Day of Menstruation | 81.14 | | 10.683 |
| | Day 2 | 60.05 | | 10.683 |
| Experimental Group 2 (Carrier Oil Group) | 1 Day Before | 87.30 | | 7.118 |
| | Day of Menstruation | 83.20 | | 7.118 |
| | Day 2 | 65.80 | | 7.118 |
| Control Group (Hot Pack Group) | 1 Day Before | 89.92 | | 8.225 |
| | Day of Menstruation | 87.04 | | 8.225 |
| | Day 2 | 75.47 | | 8.225 |
| Source | Numerator df | Denominator df | F | Significance (p-value) |
| Intercept | 1 | 19.900 | 1.769 | .199 |
| Group | 2 | 20.155 | 3.716* | .012 |
| Time | 2 | 26.411 | 27.147*** | .000 |
| Group × Time Interaction | 4 | 26.411 | 18.210*** | .000 |
| Time | 1 | 19.890 | 1.005 | .328 |
| Medication Dosage | 1 | 19.890 | .086 | .773 |

**Note:** *$p<.05$, **$p<.01$, ***$p<.001$.

For Experimental Group 1, the mean menstrual discomfort score was 86.18 (SD = 10.683) one day before menstruation, 81.14 (SD = 10.683) on the day of menstruation, and 60.05 (SD = 10.683) on the second day. In Experimental Group 2, the mean score was 87.30 (SD = 7.118) one day before menstruation, 83.20 (SD = 7.118) on the day of menstruation, and 65.80 (SD = 7.118) on the second day. In the control group, the mean score was 89.92 (SD = 8.225) one day before menstruation, 87.04 (SD = 8.225) on the day of menstruation, and 75.47 (SD = 8.225) on the second day.

The analysis showed that the group variable was statistically significant, with an F-value of 3.716 and a p-value of .012. The time variable also demonstrated a statistically significant effect, with an F-value of 27.147 and a p-value of .000. Furthermore, the interaction between group and time was statistically significant, as indicated by a chi-square value of 18.210 and a p-value of .000. These results suggest that the effect of time on menstrual discomfort varied significantly across the groups. An analysis of menstrual discomfort across groups and time points following the intervention revealed statistically significant differences by both group and time (1 day before menstruation, the day of menstruation, and the second day). A significant interaction effect between group and time was also observed. More specifically, Experimental Group 1 reported the lowest level of menstrual discomfort on the second day after the intervention. These findings suggest that abdominal massage using essential oils is effective in reducing symptoms of menstrual discomfort. This result is consistent with previous studies in which abdominal massage with rose oil led to reductions in stress indices and emotional scores in both the left and right hemispheres of the brain, demonstrating the massage's effectiveness in relieving stress and stabilizing psychological states [17]. Among the various approaches in aromatherapy, massage-based treatment appears to be the most efficient and rapid method for maximizing the therapeutic effects of essential oils, thereby promoting holistic health and preventing related disorders.

**Table 4.**
Differences in Menstrual Characteristics After the Intervention by Group

| | | | Group | | | Total | $X^2$ (p) |
|---|---|---|---|---|---|---|---|
| | | | Experimental Group 1 | Experimental Group 2 | Control Group | | |
| Changes in Menstrual Cycle After Intervention | Yes | N | 8 | 7 | 3 | 18 | 14.485* (.026) |
| | | % | 88.9% | 70.0% | 30.0% | 62.1% | |
| | No | N | 1 | 3 | 7 | 11 | |
| | | % | 11.1% | 30.0% | 70.0% | 37.9% | |
| Satisfaction with the Effects After the Intervention | Very Satisfied | N | 4 | 3 | 2 | 9 | 20.959*** (.000) |
| | | % | 44.4% | 30.0% | 20.0% | 31.0% | |
| | Somewhat Satisfied | N | 3 | 2 | 2 | 7 | |
| | | % | 33.3% | 20.0% | 20.0% | 24.1% | |
| | Neutral | N | 1 | 3 | 5 | 9 | |
| | | % | 11.1% | 30.0% | 50.0% | 31.0% | |
| | Somewhat Dissatisfied | N | 1 | 2 | 1 | 4 | |
| | | % | 11.1% | 20.0% | 10.0% | 13.8% | |
| | Very Dissatisfied | N | 0 | 0 | 0 | 0 | |
| | | % | 0.0% | 0.0% | 0.0% | 0.0% | |
| Degree of Helpfulness | Very Helpful | N | 3 | 2 | 2 | 7 | 20.241*** (.000) |
| | | % | 33.3% | 20.0% | 20.0% | 24.1% | |
| | Somewhat Helpful | N | 3 | 3 | 1 | 7 | |
| | | % | 33.3% | 30.0% | 10.0% | 24.1% | |
| | Neutral | N | 2 | 4 | 5 | 11 | |
| | | % | 22.2% | 40.0% | 50.0% | 37.9% | |
| | Not Very Helpful | N | 1 | 1 | 2 | 4 | |
| | | % | 11.1% | 10.0% | 20.0% | 13.8% | |
| | Not Helpful at All | N | 0 | 0 | 0 | 0 | |
| | | % | 0.0% | 0.0% | 0.0% | 0.0% | |
| Intention to Reuse | Will Continue to Use | N | 5 | 3 | 2 | 10 | 18.074** (.004) |
| | | % | 55.6% | 30.0% | 20.0% | 34.5% | |
| | Will Use Occasionally | N | 3 | 5 | 2 | 10 | |
| | | % | 33.3% | 50.0% | 20.0% | 34.5% | |
| | Undecided | N | 1 | 1 | 4 | 6 | |
| | | % | 11.1% | 10.0% | 40.0% | 20.7% | |
| | Will Not Use | N | 0 | 1 | 2 | 3 | |
| | | % | 0.0% | 10.0% | 20.0% | 10.3% | |

An analysis of group differences in menstrual characteristics revealed that changes in menstrual cycle, satisfaction with the intervention, perceived helpfulness, intention to reuse, and willingness to recommend to others were all significantly different in Experimental Groups 1 and 2 compared to the control group. These findings are consistent with the study by Son [18] which reported that participants who received abdominal massage with essential oils experienced more positive changes in menstrual characteristics than those who only inhaled the aroma [19]. The results of the present study further suggest that among various aromatherapy interventions, transdermal absorption through massage may have a more significant effect in alleviating menstrual discomfort. Table 4 shows the results of analysis of differences between group in menstrual characteristics.

## 4. Conclusion
This study examined the effects of self-administered abdominal massage using essential oils—lavender, clary sage, black pepper, and clove—on individuals experiencing dysmenorrhea and menstrual discomfort. Based on the findings, the following conclusions were drawn.

First, there was a statistically significant difference in menstrual pain across groups and time. In particular, the essential oil group reported the lowest pain levels on the second day after the

intervention, indicating the effectiveness of aromatherapy abdominal massage in alleviating dysmenorrhea.

Second, menstrual discomfort also showed significant differences depending on group and time. Specifically, the essential oil group demonstrated the lowest level of discomfort on the second day, confirming the intervention's effectiveness in reducing menstrual-related distress.

Third, participants in both essential oil groups showed more positive perceptions after the intervention in terms of changes in menstrual cycle, satisfaction with the treatment, perceived helpfulness, intention to reuse, and willingness to recommend the method to others. These results support the overall beneficial effects of aromatherapy-based abdominal massage.

This study confirmed that even in the absence of an external practitioner, self-administered aromatherapy using essential oils can effectively reduce symptoms of dysmenorrhea and menstrual discomfort due to the oils' inherent properties—including calming, analgesic, hormonal balancing, antispasmodic, and circulatory-enhancing effects. Moreover, by employing a controlled experimental design, the study demonstrated that the relief of menstrual pain was not merely the result of abdominal massage or heat application alone, but was significantly enhanced through the combined use of essential oils. These findings suggest that aromatherapy-based abdominal massage is a practical and accessible method for women to independently manage menstrual discomfort.

Based on these results, it is anticipated that further studies incorporating aromatherapy and abdominal massage will continue to advance the field of complementary and alternative therapies for women suffering from menstrual pain and discomfort.

## Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

## Copyright:

## References

[1]     S. Y. Cho and J. Y. Lee, "Heart rate variability (HRV) characteristics of patients with primary dysmenorrhea at the menstrual phase: A literature review and meta-analysi," *The Journal of Korean Obstetrics and Gynecology*, vol. 35, no. 3, pp. 122–136, 2022 https://doi.org/10.15204/jkobgy.2022.35.3.122

[2]     M. H. Sung, *Menstrual discomforts and coping in adult women*. South Korea: Korean Society of Public Health Nursing, 2005.

[3]     J. Lee, "The development and effect of therapeutic recreation program for relief of dysmenorrhea and premenstrual syndrome in female high school students," Dissertation, Graduate School, Daejeon University, 2009.

[4]     M. H. Ahn, S. H. Jeon, and Y. Yoon, "The effect of stonetherapy and hydrotherapy on dysmenorrhea and premenstrual syndrome of unmarried women in their 20s-30s," *Kor Journal Aesthet Cosmetol*, vol. 11, no. 1, pp. 85-92, 2013.  https://doi.org/G704-SER000010442.2013.11.1.002

[5]     B.-D. Suh and E.-H. Choi, "Dysmenorrhea and Relief Methods in Woman Nursing Students," *Research in Community and Public Health Nursing*, vol. 17, no. 2, pp. 235-241, 2006.  https://doi.org/10.12799/jkachn.2006.17.2.235

[6]     Y. S. Jeong and M. H. Lim, "Study on coping method for dysmenorrhea of female high school students," Master's Thesis, Daejeon University, Graduate School, Department of Alternative Medicine, 2019.

[7]     K. O. Lee, S. Kim, S. B. Chang, and J. S. Yoo, "Effects of Artemisia a. smoke (ssukjahun) on menstrual distress, dysmenorrhea, and prostaglandin F2α," *Korean Journal of Women Health Nursing*, vol. 15, no. 2, pp. 150-159, 2009. https://doi.org/10.4069/kjwhn.2009.15.2.150

[8]     S. Park, D.-J. Kim, and Y.-R. Choi, "Comparison of postural alignment and foot pressure balance according to the dysmenorrhea degree in women in their 20s," *The Journal of the Korea Contents Association*, vol. 22, no. 3, pp. 576-585, 2022.  https://doi.org/10.5392/JKCA.2022.22.03.576

[9]     S. J. Kim and Y. H. Kim, "The effect of lumbar sacral meridian massage on premenstrual syndrome, dysmenorrhea, and body temperature in college women," *Journal of the Korean Society of Cosmetology*, vol. 22, no. 4, pp. 644–652, 2016.

[10] J. S. Park, J. E. Park, J. S. Yang, H. W. Kwak, and J. A. Han, "Analysis of experimental researches in Korea on the effects of aromatherapy to relieve pain," *The Korean Journal of Hospice and Palliative Care*, vol. 14, no. 1, pp. 8-19, 2011. https://doi.org/10.14475/kjhpc.2011.14.1.8

[11] M. Hong, "A study on the health effects of adolescents using aromatherapy: Focusing on high school girls' pain," *Korea Entertainment Industry Association*, vol. 13, no. 2, pp. 187-195, 2019. http://dx.doi.org/10.21184/jkeia.2019.2.13.2.187

[12] M. Jeong and E. Choi, "The effect of aromatherapy massage and meridian massage on premenstrual syndrome, dysmenorrhea, and change of abdominal temperature of female university students," *Asian Journal Med Health Science*, vol. 6, no. 11, pp. 327–337, 2016 http://dx.doi.org/10.35873/ajmahs.2016.6.11.029

[13] H.-K. Lee, "The effect of self-aromatherapy massage on depression and satisfaction with life in depressed college students," *Korean Journal of Health Education and Promotion*, vol. 31, no. 3, pp. 63-72, 2014. https://doi.org/10.14367/kjhep.2014.31.3.63

[14] Y. Myung-Sook, "Effects of Aroma hand massage on state anxiety depression, quality of sleep and blood pressure of palliative patients in hospice," *Journal Korean Acad Social Home Care Nurs*, vol. 26, no. 3, pp. 309-318, 2019. https://doi.org/10.22705/jkashcn.2019.26.3.309

[15] L. Hwang, "Development and validation of a menstrual discomfort scale," *Journal of Women's Health*, vol. 14, no. 6, pp. 560-568, 2005.

[16] E. H. Jung *et al.*, "Efficient, stable and scalable perovskite solar cells using poly (3-hexylthiophene)," *Nature*, vol. 567, no. 7749, pp. 511-515, 2019.

[17] S. Cho, "Study on the effect of self-application with aromatherapy upon menstrual pain and inconvenience in women," Master's Thesis Department of Health, Chung-Ang University, Seoul, South Korea, 2003.

[18] G. Y. Son, "The effect of aromatherapy on high school girls' stress and blood cortisol: focused on inhalation and massage," Master's Thesis, Department of Cultural Industry, Major in Skin Obesity Management, Sungshin Women's University, Seoul, South Korea, 2009.

[19] S. Choi, K. Jang, and Y. Won, "The relaxing effect of abdominal massage using rose aroma essential oil on psychological and physiological responses of middle-aged," *Asian Beauty Cosmetics Journal*, vol. 5, no. 1, pp. 91-106, 2007.