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# 피부 미백 평가 시 기미 병변 부위에서의 적색도 평가의 효용

이 정 아† · 김 주 연 · 이 선 화 · 김 보 라 · 김 남 수 · 문 태 기

(주)엘리드

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# Use of Redness Assessment in Melasma Lesions in Skin Whitening Evaluation

**Jung Ah Lee†, Ju Yeon Kim, Sun Hwa Lee, Bora Kim, Nam Soo Kim, and Tae Kee Moon**

Ellead co., Ltd., 325 Hwangsaeul-ro, Bundang-gu, Seongnam-si, Gyeonggi-do 13590, Korea

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**요 약:** 기미는 몇몇의 병인학적 요인을 갖고 있지만, 많은 연구가 멜라닌 형성에 집중되어 있다. 본 연구에서는 멜라닌 형성과 구별되는 혈관의 감소에 의한 기미의 개선을 보고자 하였다. 피부과 전문의의 육안평가를 통해 기미와 일광 흑자를 가진 한국 여성 20명을 대상으로 실험을 진행하였다. 연구 대상자는 8주 간 기능성 화장품을 사용하였다. Chromameter 기기로 측정한 연구 대상자의 기미 병변, 일광 흑자 병변 및 정상 피부 부위에서의 각 피부색 측정 결과를 분석하였다. 시료 사용 8주 경과 후, 기미 병변 부위의 피부색 밝기와 적색도가 정상 피부 부위에 비해 통계적으로 유의하게 개선되었다. 또한, 기미 병변 및 일광 흑자 병변 부위의 피부색 밝기의 개선 정도는 유사하였다. 그러나, 시료 사용 8주 경과 후 기미 병변 부위의 적색도가 일광 흑자 병변 부위에 비해 통계적으로 유의하게 개선되었다. 본 연구에서는 기능성 제품을 사용함으로써 기미 병변 부위에서 피부색 밝기 뿐만 아니라 적색도 또한 개선됨을 확인하였다. 이에 적색도가 기미 병변 부위의 평가를 위한 부가적이고 적합한 요인이 될 수 있음을 제시하고자 한다.

**Abstract:** Melasma has several well-recognized etiologic factors, but most researches focus on melanogenesis. The purpose of this study is to show improvement of melasma by reducing vascularity distinguished from melanogenesis. We examined 20 Korean women with both melasma and solar lentigo that were visually assessed by a dermatologist. The volunteers applied functional cosmetics for 8 weeks. We analyzed the results obtained using the chromameter, evaluating the skin color of three areas (melasma lesions, solar lentigo lesions, and non-lesional skin) on the face of volunteer. There was a statistically significant improvement in the brightness and redness of melasma lesions compared to those of non-lesional skin after 8 weeks. Also, we observed that the improvements in the brightness of melasma lesions and solar lentigo lesions were similar. However, the redness of melasma lesions improved more than that of solar lentigo lesions with statistical significance after 8 weeks. In this study, we have shown that brightness and redness in melasma lesions can be improved by functional cosmetics. Thus, we suggest redness to be an additional suitable parameter for the evaluation of melasma lesions.

***Keywords:*** *melasma lesions, lentigo lesions, non-lesional skin, redness, vascularity*

## 1. Introduction

Melasma is a common problem to Asians and Hispanics[1]. Many researchers have studied to investigate causes of melasma. According to the results, melasma has been associated with several well-recognized etiologic factors such as UV light exposure, hormone change, defective barrier function, increased vascularity, and inflammation, but its exact pathogenesis has not been fully understood[2-5].

† 주 저자 (e-mail: feelyolyo@hanmail.net)
call: 031)709-9070

Melanin is the key material that leads directly to melasma[6]. The value of $L^*$ has been frequently used in melasma lesions research to investigate improvement in brightness. Also, increment of vascularity in melasma is one of the represented histologic findings[5,7]. A recent study compared the difference in erythema as well as melanin index between melasma and normal skin, and the results showed that these factors in lesional skin were higher than in normal skin[8]. Moreover, an increase in the vascularity in the male melasma was higher than lentigo lesional skin in men and female[9]. Thus, we have to depict and analyze $a^*$ for redness, by investigating improvement in melasma and solar lentigo lesions through treatment.

Researchers have developed medications and cosmetics that focus on the melanin for the treatment of melasma involving mechanisms such as inhibition of tyrosinase, melanin transfer, reducing tyrosine oxidation, and others[10]. A few agents include niacinamide and plant extracts has various effects on skin[11,12]. Previously, a study has shown that niacinamide inhibits melanosome transfer, suggesting that it reduces melasma[12]. *Glycyrrhiza glabra (G. glabra)* root extract has effects of whitening, antioxidant, and anti-erythema[13]. Therefore, we compared and analyzed whether there were any changes and differences in the level of skin brightness and redness among normal and hyper-pigmented skins with functional cosmetics.

## 2. Experimental

### 2.1. Subjects

Twenty healthy Korean females (aged 44.45 ± 5.29) who had melasma and solar lentigo simultaneously on the face were enrolled. Our inclusion criteria were women at least 18 years old without any clinical skin care investigation and dermatologist treatments on the face within the last three months. Women were excluded if they were pregnant, planning to be pregnant, nursing or had a history of hypersensitivity to any of the components of the study. Also, volunteers who take hormone-related medicine or had chronic diseases which could affect the results were excluded from this research. The protocol was reviewed and approved by the institutional review board (IRB) in Ellead Co., Ltd. and all volunteers provided inform consent.

### 2.2. Measurements

Each volunteer visited our facility, four times during two months (baseline, 2 weeks, 4 weeks, and 8 weeks) for measurement. No use of facial cosmetics was allowed on scheduled evaluation days. When they arrived at the laboratory, they washed their faces with the supplied cleansing foam, and then acclimated at 22 ± 2 ℃ and 50 ± 5% RH condition for 30 min before the evaluation. The skin brightness and skin redness (erythema) were measured three times by chromameter (CR-400, Minolta, Japan), on melasma lesions, solar lentigo lesions, and non-lesional skin. Total color difference (△E) was calculated from CIE $L^*a^*b^*$ as follows: $\triangle E = [(\triangle L^*)^2 + (\triangle a^*)^2 + (\triangle b^*)^2]^{1/2}$. Total color differences were calculated between solar lentigo lesions and non-lesional skin, melasma lesions and non-lesional skin, melasma lesions and solar lentigo lesions.

Volunteers applied three cosmetic formulations (toner, serum, and emulsion) which include niacinamide and *G. glabra* root extract to their whole faces in this order of twice a day (in the morning and evening) during the treatment phases, but they were not allowed to use other whitening cosmetics during the study. For outdoor activities, they applied their usual sunscreen product which did not include whitening material.

### 2.3. Statistics Analysis

All measurements were conducted three times and averages were obtained to evaluate correlations. The relationships between each measured area at baseline were analyzed using repeated measures of ANOVA ($p < 0.05$). All efficacy evaluation parameters were analyzed using descriptive statistics. The statistical software used was SPSS statistics (version 21.0, IBM, USA).

**Table 1.** The Statistical Analysis of Chromametric Mean Values between each Measured Area on the Face (Melasma Lesions, Solar Lentigo Lesions and Non-lesional Skin) at Baseline

| Factor | Melasma lesions vs. Non-lesional skin | Solar lentigo lesions vs. Non-lesional skin | Melasma lesions vs. Solar lentigo lesions | (Melasma lesions vs. Non-lesional skin) vs. (Solar lentigo lesions vs. Non-lesional skin) |
|---|---|---|---|---|
| $L^*$ | $< 0.001^{***}$ | $< 0.001^{***}$ | 0.117 | |
| $a^*$ | $< 0.05^{*}$ | 0.083 | 0.831 | |
| △E | | | | 0.266 |

Statistical analysis was performed by repeated measures ANOVA.
Significant differences between each measured area, $^{*}p < 0.05$, $^{***}p < 0.001$.

**Table 2.** The Chromametric Mean Values and Statistical Analysis with Melasma Lesions, Solar Lentigo Lesions and Non-lesional Skin at Baseline and after 8 Weeks

| Factor | Site | Baseline | 8 Weeks |
|---|---|---|---|
| $L^*$ | Melasma lesions | 62.66 ± 2.71 | $63.37 \pm 2.63^{***}$ |
| | Solar lentigo lesions | 61.95 ± 1.89 | $62.65 \pm 1.79^{***}$ |
| | Non-lesional skin | 65.37 ± 2.26 | $65.62 \pm 2.29^{**}$ |
| $a^*$ | Melasma lesions | 13.14 ± 2.00 | $12.06 \pm 1.67^{***}$ |
| | Solar lentigo lesions | 13.03 ± 1.64 | $12.66 \pm 1.43^{*}$ |
| | Non-lesional skin | 12.21 ± 2.14 | $11.85 \pm 2.08^{*}$ |
| △E | Melasma lesions vs Non-lesional skin | 3.71 ± 1.70 | $3.31 \pm 1.53^{*}$ |
| | Solar lentigo lesions vs. Non-lesional skin | 4.28 ± 1.78 | $3.96 \pm 2.01^{*}$ |

Results are given as mean ± S.D. Statistical analysis was performed by repeated measures ANOVA.
Significant differences between baseline and after 8 weeks, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

## 3. Results and Discussion

### 3.1. Comparison of $L^*$, $a^*$ and △E Values between each Measured Areas on the Face with Melasma Lesions, Solar Lentigo Lesions and Non-lesional Skin at Baseline

Mean values for the melasma lesions, solar lentigo lesions, and non-lesional skin at baseline, were compared in Table 1. For $L^*$ representing brightness, both melasma and solar lentigo lesions showed lower values than non-lesional skin with statistical significance at baseline ($p < 0.05$). For $a^*$ representing redness, melasma lesions showed higher values than non-lesional skin with statistical significance of $p < 0.05$, but there was no statistical significance between solar lentigo lesions and non-lesional skin. Significant differences of both $L^*$ and $a^*$ values between melasma lesions and solar lentigo lesions were not found. Also, △E was calculated between non-lesional skin and other areas such as melasma lesions and solar lentigo lesions. There was no statistical significance between the two △E at baseline.

### 3.2. Improvement of $L^*$, $a^*$, and △E Values on each Measured Site by Using Cosmetic Formulation for 8 Weeks

In Table 2, the brightness and redness were improved in melasma lesions, solar lentigo lesions and non-lesional skin with statistical significance at 8 weeks ($p < 0.05$). After 8 weeks, it showed a greater reduce of $a^*$ values in melasma lesions compared to other lesions. Each △E between non-lesional skin and melasma lesions was decreased with statistical significance at 8 weeks ($p < 0.05$).

### 3.3. Comparison of $L^*$, $a^*$, and △E Values between each Measured Areas on the Face after 8 Weeks

The statistical analyses of chromametric values among three lesions on the face were shown in Table 3. The val-

**Table 3.** The Statistical Analysis of Chromametric Values between each Measured Area on the Face (Melasma Lesions, Solar Lentigo Lesions and Non-lesional Skin) after 8 Weeks

| Factor | Melasma lesions vs. Non-lesional skin | Solar lentigo lesions vs. Non-lesional skin | Melasma lesions vs. Solar lentigo lesions | (Melasma lesions vs. Non-lesional skin) vs. (Solar lentigo lesions vs. Non-lesional skin) |
|---|---|---|---|---|
| $L^*$ | $< 0.001^{***}$ | $< 0.001^{***}$ | 0.854 | |
| $a^*$ | $< 0.01^{**}$ | 0.982 | $< 0.01^{**}$ | |
| △E | | | | 0.665 |

Statistical analysis was performed by repeated measures ANOVA.
Significant differences between each measured area, $^{**}p < 0.01$, $^{***}p < 0.001$.

ues of $L^*$ in melasma lesions and solar lentigo lesional skin improved more than in non-lesional skin with statistical significance at 8 weeks ($p < 0.05$), and $L^*$ and △E values between melasma lesions and solar lentigo lesions did not significant differences. However, $a^*$ values of melasma lesions improved significantly improved than those of solar lentigo lesions and non-lesional skin ($p < 0.05$), but on the other hand, there was no significant difference of $a^*$ value between solar lentigo lesions and non-lesional skin.

### 3.4. Discussion

Most middle aged women are concerned about hyperpigmentation such as melasma and solar lentigo. A few pathogenesis of melasma such as UV light exposure, hormone change, increased vascularity, defective barrier function, and inflammation have been identified[2,5,14]. In this study, we considered solar lentigo. The pathogenesis of solar lentigo is commonly known to relate to UV light exposure[15,16]. According to the previous studies, pathogenesis of melasma is more varied and complex than pathogenesis of solar lentigo. Although most of the clinical studies showed increased melanin in both lesions, alteration of vascularity was referred another pathogenesis in case of melasma. In this study, we compared and analyzed the results obtained by the chromameter in evaluating the skin color of three areas on the face where the females applied cosmetic formulations in order for 8 weeks.

In our study, the brightness of melasma lesions, solar lentigo lesions, and non-lesional skin increased by 1.14%, 1.13%, and 0.37% after 8 weeks, respectively (data not shown). According to the result, we observed that the brightness of melasma lesions and solar lentigo lesions increased more than that of non-lesional skin with a statistical significance ($p < 0.05$). However, after 8 weeks, the increased rates of brightness between melasma lesions and lentigo lesions did not have statistical significance (Table 3). Also, both total color differences (△E) calculated between each lesional skin and non-lesional skin decreased after 8 weeks with statistical significance ($p < 0.05$). This shows that the brightness of melasma lesions and solar lentigo lesions improved by similar degrees.

We also measured value of $a^*$ as the erythema index. At baseline, the value of $a^*$ in the melasma lesions was higher than in non-lesional skin with statistical significance ($p < 0.05$). In a previous study, it is considerable different from non-lesional skin in the vessel size and area in female melasma skin[9]. Therefore, it suggested that higher value of $a^*$ in the melasma lesions compared to the non-lesional skin is due to increased vascularity in melasma lesions[5]. After 8 weeks, the redness of melasma lesions, solar lentigo lesions, and non-lesional skin decreased by 8.19%, 2.81%, and 2.96%, respectively (data not shown). We observed that the redness of melasma lesions decreased more than that of solar lentigo lesions and non-lesional skin with statistical significance ($p < 0.05$). It is possible to speculate that decreasing redness by improving vascularity in melasma skin is more effective than solar lentigo lesional and non-lesional skin.

The volunteers applied the functional cosmetics including niacinamide and *G. glabra* root extract. Niacinamide has a strong anti-inflammatory effect for acne which is a

chronic inflammatory disease[17,18]. Among the symptoms, damaged stratum corneum barrier function caused by UV light exposure increased vascularity related to vasoactive amine and inflammation by melasma - all of which are involved with redness[17-19]. It also decreases redness by altering of vascular characteristics in melasma[5] or by improving of stratum corneum barrier function and hydration in rosacea[2,5,19]. Moreover, glabridin from licorice extracts has the effects on melanogenesis and inflammation. Skin color of UVB-induced pigmentation was brighter in glabridin group than control group, and UVB-induced erythema was reduced compared to control *in vivo*[20]. In another study, the value of $a^*$ was reported to have no significant difference even though the values of $L^*$ changed considerably[11]. So, we suggest that the combination of niacinamide and *G. glabra* provides the synergy on improvement of brightness and redness, and the difference with the previous study comes from different study conditions such as concentration, skin type and comparison method. This study has limitations such as having no control group and active ingredients are simultaneously present in the formulations. Further study is needed with the control group, and to confirm whether the results come from the synergy of the combination of the materials or from specific individual material.

## 4. Conclusion

In this clinical study, we measured that the improvement of brightness and redness by using functional cosmetics in females who have pigmented skin. Brightness in both melasma lesions and solar lentigo lesions was improved compared with non-lesional skin. In contrast, the degree of improvement of redness in melasma lesions was particularly higher than in solar lentigo lesions and non-lesional skin. Thus, we propose that redness may be a considerable parameter in the evaluation of melasma lesions.

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