## INTRODUCTION

The harmful effects of solar radiation on human skin are sunburn, skin pigmentation, premature aging, and the radiation possibly play a great role in the development of a skin malignancy[1,2,3]. Active ingredients which are able to absorb, scatter, or reflect the solar radiation on skin surface, namely sunscreen, could reduce the harmful effect[2]. For most Indonesian women beautiful-ideal skin is skin that is clean, smooth, light color and without any spotted hyperpigmentation[4]. UVA and UVB radiation could induce the damage of the skin which caused wrinkled, coarse texture and hyper and hypopigmentation[3,5] A good sunscreen must be able to protect the skin from any harmful effects of both solar spectra[5,6].

The use of active substances to protect the skin from solar radiation has been known since the era of old Indian, Tibet, and Europeans[7]. Long time ago, the ancestor of Indonesians used some face powders to keep their skin smooth, light, and healthy[8]. Based on a survey, among women in some parts of Indonesia are known to have lighter skin color compared with other subethnics. They commonly use special thick face powder during day time in order to protect their skin from daily sun exposure by its physical properties. Since the use of thick layer of the face powder is cosmetically unacceptable, improving the powder to be more cosmetically acceptable is necessary, at least by reducing its thickness. However, the effect of thin layer usage of those face powders is still questionable.

The skin color can be measured quantitatively by using the Chromameter[9]. In this method, the skin color is the result of the coordinate of chromatically tristimulus L* a* b* . L* is lightness which moves from black (L* = 0) to white (L* = 100); a* moves from negative value (green) to positive value (red); b* moves from yellow (positive value) to blue (negative value). In this study, the application effect of various traditional face powders in skin color to prevent specific dose of UVB and UVA radiation is reported.

## MATERIALS AND METHODS

### Materials

Five different traditional face powders from different areas of Indonesia were used in this study and the composition of rough substances in those powders are listed below:

Face powder 1 is composed of 1 kg rice (*Oryza sativa*), 0.25 kg *temu lawak* (*Curcuma xanthorhiza Roxb.*), 0.25 kg *kunyit* (*Curcuma domestica val.*), and *langereng* leaves quantum santis.

Face powder 2 is composed of 1 kg rice, 0.5 kg *temu lawak*, and *langereng* leaves *quantum santis*

Face powder 3 is composed of 0.25 kg rice, a handful of *menur* (*Jasminum sambac*) flower, a handful of *delima*'s young leaves (*Punica granatum*), and a handful of coffee leaves (*Coffea Robusta Linol ex de Willd*).

Face powder 4 is composed of 0.25 kg rice, a handful of *mangkokan's* leaves (*Nothopanax scutellarium Merr*), a handful of manuru pantais (*Jasminum sambac*) leaves and 1 finger size of *kunyit*.

Face powder 5 is composed of 0.25 kg rice, 10 nucleus of *langsat* (*Lansium domesticum corr.*) and 1 finger size of *kunyit*.

Face powder (FP) 1 and 2 originated from Ujungpandang, FP 3 was taken from the beach of Bajo, and FP4, and 5 were from Ternate.

The UVA compact studio - Phillips HP 3174/ A was used as UVA source (± 9.12 J/minutes) and Coerman solarium was used as UVB sources (± 8.04 mJ/minutes). Minolta CR-200 was used for measuring skin color.

### Subjects

Healthy subjects, 18-40 year old, with skin type III-IV and willing to participate in this study were involved. Users of any anti inflammatory drugs, photosensitizer agents, oral contraception, and those who used sunscreen in their back skin were excluded from the study. Informed consent was obtained from all subjects.

### Methods

Subjects eligible for this clinical trial were randomly allocated into two groups. The first group received UVB radiation and UVA irradiation. The back skin of each subject was covered with black plastic that had 6 holes of 2.5 x 10 $cm^2$. The other areas were covered with black linen. After measuring the skin color on every hole with Chromameter, 2 mg/$cm^2$ (50 mg/25

$cm^2$ diluted with 3 drop of sterile water) of each FP was applied into each hole. One hole which had been selected randomly, was free from application of any FP as the control.

After FP was dried, the hole was irradiated with either UVA for 20 minutes (182 J) in UVA group or UVB for 12 minutes (96.5 mJ) in UVB group. The determination of second skin color was done 6 days later for UVB exposure. For UVA irradiation, the determination was done in 30 minutes for immediate tanning and 6 days later for delayed pigmentation.

The skin color was determined by defining L*, a*, and b*, and the changing of skin color was counted by the following formula:

$$(\Delta E = V (\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}).$$

The difference of skin color between controlled skin and FP applied skin before the application and UV radiation was analyzed by using analysis of variance, and the difference of Δ E between controlled skin and FP applied skin after irradiation was analyzed by using student t test. The higher Δ E means the darker skin color after irradiation.

## RESULTS

Forty-two volunteers were recruited for this study which consisted of 30 males and 12 females. They were randomly allocated into two groups. One group (with the mean age of 29.85 ± 4.79 year old) received UVB irradiation and another group (mean age of 28.70 ± 5.33 year old) received UVA irradiation. During this study, one volunteer from UVB group was excluded since he had a sunburn reaction after receiving 3 times of MED of UVB exposure. One subject in UVA group was excluded due to error of reading skin color procedure.

TABLE 1 shows that chromometrically (L a* b*) there was no skin color difference before irradiation among several locations of UVB irradiated group ($p>0.05$).

TABLE 2 shows that there was no skin color difference (L a* b*) before irradiation among several locations of UVA irradiated group ($p>0.05$).

TABLE 3 shows that 6 days after UVB irradiation the skin color in FP protected skin have lighter skin color compared with control, which is shown by lower Δ E compared with controlled skin. Statistically this difference is highly significant and from the same table it could also be seen that skin protected with FP3 shows the lightest skin color.

It is shown in TABLE 4, that there was no skin color difference (Δ E ) between FP protected skin and controlled skin after 30 minutes of UVA irradiation ($p>0.05$).

TABLE 1. – The comparison of skin color of UVB group before treatment among several location

| Location | | Mean of L* | Statistical analysis | Mean of a* | Statistical analysis | Mean of b* | Statistical analysis |
|---|---|---|---|---|---|---|---|
| Control | | 50.84 | | 13.63 | | 16.16 | |
| FP | 1 | 50.81 | F=0.0025 | 13.63 | F=0.048 | 16.01 | F=0.111 |
| FP | 2 | 50.96 | $p$=1.00 | 13.63 | $p$=0.999 | 15.97 | P=0.989 |
| FP | 3 | 50.68 | | 13.80 | | 15.82 | |
| FP | 4 | 50.88 | | 13.82 | | 15.92 | |
| FP | 5 | 50.78 | | 13.65 | | 16.03 | |

TABLE 2. – The comparison of skin color of UVA group before treatment among several locations

| Location | | Mean of L* | Statistical analysis | Mean of a* | Statistical analysis | Mean of b* | Statistical analysis |
|---|---|---|---|---|---|---|---|
| Control | | 49.69 | | 14.69 | | 15.99 | |
| FP | 1 | 49.78 | F=0.108 | 14.89 | F=0.424 | 15.75 | F=0.317 |
| FP | 2 | 50.35 | $p$=0.990 | 14.335 | $p$=0.8311 | 16.02 | P=0.902 |
| FP | 3 | 49.76 | | 14.745 | | 15.90 | |
| FP | 4 | 49.95 | | 14.730 | | 16.04 | |
| FP | 5 | 50.01 | | 14.510 | | 16.17 | |

TABLE 3. - The comparison of the difference of skin color (Δ E) between controlled skin and FP applied skin after 6 days of UVB irradiation

| Face powder | | Mean of Δ E FP applied Skin | Mean of Δ E Controlled Skin | Satistical analysis | |
|---|---|---|---|---|---|
| FP | 1 | 2.14 ± 1.21 | 3.92 ± 1.83 | t=3.6329, | P=00004 |
| FP | 2 | 2.24 ± 1.56 | | t=3.1272, | P=000016 |
| FP | 3 | 1.97 ± 0.86 | | t=4.3173, | P=000005 |
| FP | 4 | 2.23 ± 1.09 | | t=3.5382, | P=00005 |
| FP | 5 | 2.17 ± 1.45 | | t=3.3545, | P=0.0009 |

TABLE 4. - The comparison of the difference of skin color (Δ E) between controlled skin and FP applied skin after 30 minutes of UVA irradiation

| Face powder | | Mean of Δ E FP applied Skin | Mean of Δ E Controlled Skin | Satistical analysis | |
|---|---|---|---|---|---|
| FP | 1 | 1.83 ± 0.98 | 1.76 ± 0.76 | t=-0.2518, | P=0.4013 |
| FP | 2 | 1.69 ± 0.80 | | t= 0.2572, | P=0.3992 |
| FP | 3 | 1.48 ± 0.77 | | t= 0.1647, | P=0.1257 |
| FP | 4 | 1.72 ± 0.88 | | t= 0.1711, | P=0.4325 |
| FP | 5 | 1.68 ± 0.88 | | t= 0.3152, | P=0.3772 |

TABLE 5. - The comparison of the difference of skin color (Δ E) between controlled skin and FP applied skin after 6 days of UVA irradiation

| Face powder | | Mean of Δ E FP applied Skin | Mean of Δ E Controlled Skin | Satistical analysis | |
|---|---|---|---|---|---|
| FP | 1 | 1.51 ± 0.84 | 1.57 ± 0.96 | t=0.2316, | P=0.4090 |
| FP | 2 | 1.48 ± 0.72 | | t=0.3445, | P=0.3662 |
| FP | 3 | 1.62 ± 0.86 | | t=0.1768, | P=0.4303 |
| FP | 4 | 1.39 ± 0.73 | | t=0.6510, | P=0.2595 |
| FP | 5 | 1.31 ± 0.81 | | t=0.9285, | P=0.1795 |

TABLE 5 shows that there was no difference of skin color (Δ E) between FP applied skin compared with controlled skin after 6 days UVA irradiation ($p$>0.05).

## DISCUSSION

Normal human skin color is produced by four skin pigments[3]: in epidermis by exogenously produced carotene (yellow) and endogenously melanin (brown); in dermis by oxygenated hemoglobin (red) in capillaries and reduced hemoglobin in venules. The majority of difference of skin color among people is determined by melanine. Based on melanin pigmentation, human skin color is divided into two components, constitutive and facultative skin color. The constitutive skin color depends on the generation of cutaneous melanin pigmentation according to cellular genetic programs, without any direct effect from radiation of solar origin, and it is usually acquired in those parts of body habitually shielded from light[3]. In this study, the back skin is chosen in order to reach skin color free from sunlight influence.

Among solar spectra, UVB light is the most effective for stimulation of pigmentation[1,3,5] since pigmentation is started 72-120 hours after irradiation and gradually disappeared after 2-3 weeks after irradiation[1,3]. Therefore, in this study to have maximal UVB pigmentation the measurement of skin color was taken in 6 days after irradiation. Immediate pigmentation of UVA light is started a few minutes after irradiation and gradually disappeared 1-2 hours later and then followed by delayed pigmentation 1. Based on the UVA nature, measurement of skin color was taken twice, 30 minutes after irradiation for immediate pigmentation and 6 days later for delayed pigmentation.

Since the skin color between controlled and FP treated skin before UVB or UVA radiation was not different ($p$>0.05, TABLE 1 and 2), therefore the comparison of difference of skin color could be analyzed by comparing skin color after irradiation minus before irradiation between

FP applied and controlled one. Furthermore, it appeared that all face powders had protective effect against UVB irradiation even when they were applied in thin layer and the most potent is FP 3 (TABLE 4). Unfortunately, all face powders do not have significant protection against UVA irradiation, either in immediate or delayed pigmentation, as presented on TABLE 4 and TABLE 5. It seems that the ability of all face powder to prevent skin darkening must be in thick layer as in the original use. Further study of active ingredient is, therefore, necessary to provide better protective effect of traditional face powder.

All of these face powders are basically composed of rice and amylum orizae in rice which is well known as a physical sunscreen due to its opaque particle[10,11]. Physical sunscreen is well known to have photoprotection capability against UVB, UVA, visible light, and even infrared ranges[2]. Temulawak and kunyit contain essence oil that composed of various active substances and one of them is camphor[12], which is known as a chemical sunscreen[11] with the capability to protect against UVB radiation. Furthermore, FP 3 is the best UVB protector and probably this is due to the complexity of its composition compared with other FP.

## CONCLUSION

All thin layer of face powders have protective effect for harmful UVB irradiation. However, they do not protective effect against UVA irradiation. In addition, the best UVB protection is found in face powder collected from Bajo beach probably due to its complex composition. Further studies are needed to clarify this matter.

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