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Investigation of jewelry powders radiating far-infrared rays and the biological effects on human skin

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Synopsis

Far-infrared rays have certain kinds of effects on the human body, especially on skin, blood circulation, and skin cell vitalizing. Some jewelry powders radiate far-infrared rays. Jade has powerful far-infrared ray radiation, and tourmaline has pyroelectric and piezoelectric properties and radiated far-infrared rays. The jewelry powders (fine powdered jade and tourmaline powders) were screened by far-infrared rays for radiation properties and tested for the effects of far-infrared rays on the human skin by temperature observation using an infrared thermal analyzer.

INTRODUCTION

In recent years, jewelry powders have been applied in cosmetic formulations. Tourmaline powder has especially been a representative example, and crystalline jewelry has been used for the purpose of crystal therapy in Western countries. The main concept of this therapy has been related to oriental "ki" and "chakra," which refers to a flow of energy, and to wave energy, which has been researched for the new alternative therapy, wave therapy. Crystal therapy and wave therapy have the same concept as wave energy. Wave energy has very wide regions of wavelengths, but the most important regions are from 4 to 20 micrometers. These regions of wavelength are usually referred to as "far-infrared rays" or "biologically beneficial rays." In this study, the wavelength of far-infrared rays is in the region of 4 to 20 micrometers. Far-infrared rays have been applied in the cure of dermatologic diseases (1) such as psoriasis (2) and atopic dermatitis (3). They also have effects on living organisms and have growth-promoting effects in growing rats, sleep-modulatory effects in freely behaving rats and insomniac patients, and blood circulation-enhancing effects in human skin (4), especially in percutaneous skin blood circulation (5–7). Effects on the skin and perspiration have also been investigated (8,9). In addition, far-infrared rays affect the whole human body (10) and growth inhibition of mammary

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tumors (11). Some kinds of jewelry radiate far-infrared rays. Representatives employed in this study are jade and tourmaline. Jade radiates far-infrared rays, and tourmaline has pyroelectric and piezoelectric properties and radiates far-infrared rays (12). Far-infrared rays radiated from these jewelry powders were estimated, and skin temperature elevation induced by these jewelry powders was estimated by infrared ray thermal analyzer, thermography.

MATERIALS AND METHODS

MATERIALS

Jade powder (NEPHRITE®, Jungdo Chem. Co., Korea) and tourmaline powder (Tourmaline®, Adam Kozan Co., Japan) were used for the experiments. The jade was mined and powdered in Korea, and the tourmaline was mined in Brazil and powdered in Japan. All jewelry was powdered in Korea and Japan. The mean radius of each of the powders was 10 micrometers. Cetostearyl alcohol (Cognis Co., USA), glyceryl stearate and PEG-100 stearate (Arlacel 165®, Uniquema Americas, USA), sorbitan stearate (Arlacel 60®, Uniquema Americas), polysorbate 60 (Tween 60®, Uniquema Americas), cetyl 2-ethylhexanoate (Nikkol CIO®, Nikko Chemicals Co., Japan), liquid paraffin (Matsumura Chemical, Japan), meadowfoam seed oil (Crodapure MDF®, Croda Inc., USA), glycerine (Glycerine USP®, Lita Co., USA), and polyacrylamide–C13-14 isoparaffin–laureth-7(0.3:0.6:0.1) (Sepigel 305®, SEPPIC, France) were used for the O/W emulsion. All water was purified with a reverse osmosis membrane filter.

Formulation. An O/W cream type emulsion was prepared with the jade powder and the tourmaline powder. The formulation example is shown in Table I. J-cream contained 1%

Table I.
Exemplified Formulation for the O/W Emulsion

	Concentration (w/w %)		
Compounds	Control	J-Cream	T-Cream
Internal oil phase			
Cetostearyl alcohol	2.00	2.00	2.00
Arlacel 165	0.80	0.80	0.80
Arlacel 60	0.40	0.40	0.40
Tween 60	1.20	1.20	1.20
C.E.H.	5.00	5.00	5.00
Liquid paraffin	4.00	4.00	4.00
Crodapure MDF	6.00	6.00	6.00
Aqueous phase			
Glycerine	5.00	5.00	5.00
Sepigel 105	1.00	1.00	1.00
Nephrite	—	1.00	—
Tourmaline	—	—	1.00
D.I. water	To 100	To 100	To 100

jade powder, T-cream contained 1% tourmaline powder, and the control cream contained water and oils only.

SCANNING ELECTRON MICROSCOPY (SEM)

The powders underwent a gold-palladium coating. The observations were realized with a Hitachi S4300 (Hitachi, Japan) scanning electron microscope.

FAR-INFRARED RAY ANALYSIS

Sample preparation. Each of the jewelry powders was formulated in a cosmetic O/W emulsion. The contents of the jewelry powder were from 0.1% to 7% (w/w). After formulation, they were completely dried in a vacuum oven for 48 hours at 60°.

Far-infrared ray analysis. Emissivity and emission energies were observed with an IR spectrometer (M2410-C, Midac Co., USA), and the observed wave ranges were 4 to 20 micrometers.

THERMOGAPHIC SKIN TEMPERATURE ANALYSIS

Preparation of O/W emulsions. The control cream was formulated with oil, surfactant, and water only, and contained no mineral compounds. Each of the sample creams was formulated with the jade powder and the tourmaline powder. The J-cream was the sample cream containing the jade powder, and the T-cream was that containing the tourmaline powder. The contents of the jewelry powder were 0.25%, 1.0%, 3.0%, and 7.0% (w/w).

Subjects and thermography. The subjects were five healthy females and five healthy males aged 26 to 35 years. Each subject washed his or her face using a liquid face-washing agent (Pacific Co.) and water. The subjects were thermographed (Thermovision 900, AGEMA, Sweden) in a room with a constant temperature of 25° and a constant relative humidity of 40% to 50%. Ten minutes after washing his or her face, each subject was seated on a chair. Five minutes after seating, the first thermograph was taken. Each subject treated his or her face with 0.5 g of control cream (right side) and 0.5 g of sample cream (left side). Immediately after application of the creams, the second thermograph was taken. The thermographs were all taken according to a pre-fixed schedule.

RESULTS AND DISCUSSION

The chemical composition of the tourmaline was $(Na,Ca)(Mg,Li,Al,Fe^{2+})_3Al_6B_3Si_6(OH)_4$. It had a fibrous structure and a hardness of 7 to 7.5, a specific gravity of 3.0 to 3.3, and a refractive index of 1.625 to 1.655. Tourmaline usually occurs as heavily striated, elongated, prismatic crystals, and less commonly as short, stubby, prismatic crystals. All tourmaline crystals have a rounded, triangular cross section. Tourmaline seldom occurs in tabular crystals, but it also occurs in columnar, radiating, and stalactitic forms, as well as in dense groups of tiny, elongated needles and in black, compact masses.

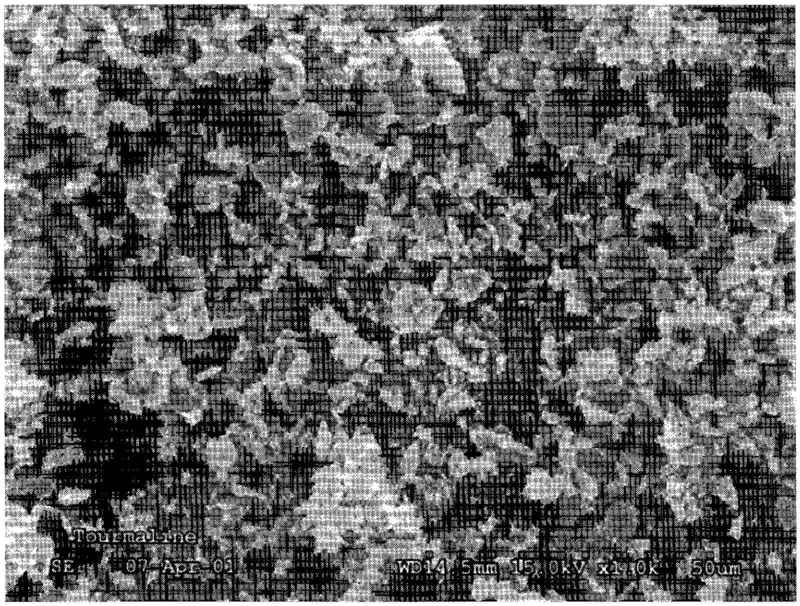

Figure 1. SEM observation of tourmaline powders (× 1000). The crystal structure used was a mixture of a round-type crystal and a plane-type crystal, and had a mean diameter of 10 micrometers.

The crystal structure used was a mixture of a round-type crystal and a plane-type crystal, and it had a mean diameter of 10 micrometers. The SEM image is shown in Figure 1. The chemical composition of the jade (nephrite) was $Ca(Mg, Fe)_5Si_8O_{22}(OH)_2$, and had a fibrous and planar structure. The hardness was 6 to 6.5, the specific gravity was 3.0,

Figure 2. SEM observation of jade powders (× 2000). The crystal structure was a mixture of a needle-type crystal and a plane-type crystal, and had a mean diameter of 10 micrometers.

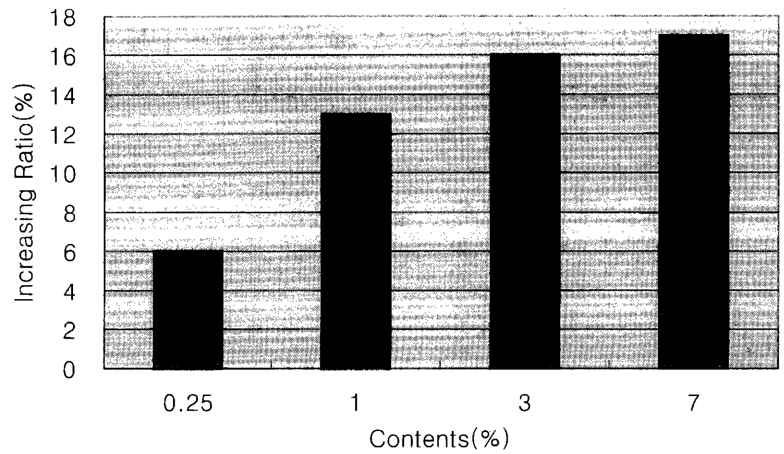

Figure 3. The increasing ratio of radiation energy (W/m^2) of the O/W emulsion containing the tourmaline powder. The y-axis is the increasing ratio (percentile) and the x-axis is the contents of the tourmaline powder.

and the refractive index was 1.62. The crystal structure was a mixture of a needle-type crystal and a plane-type crystal, and had a mean diameter of 10 micrometers. The SEM image is shown in Figure 2.

The O/W-type emulsion creams were prepared. Each of the creams contained the jade powder and the tourmaline powder. The contents of each powder were 0.25%, 1.0%, 3.0%, and 7.0% (w/w). The estimated emission energy of each cream is shown in Figure 3 for the tourmaline powder and Figure 4 for the jade powder. As shown in these figures, the emission energy increased exponentially. The increasing rate of emission energy was almost saturated at 1% content for both of the two jewelry powders. As a cosmetic ingredient, it was determined that the optimum content for each powder was 1%.

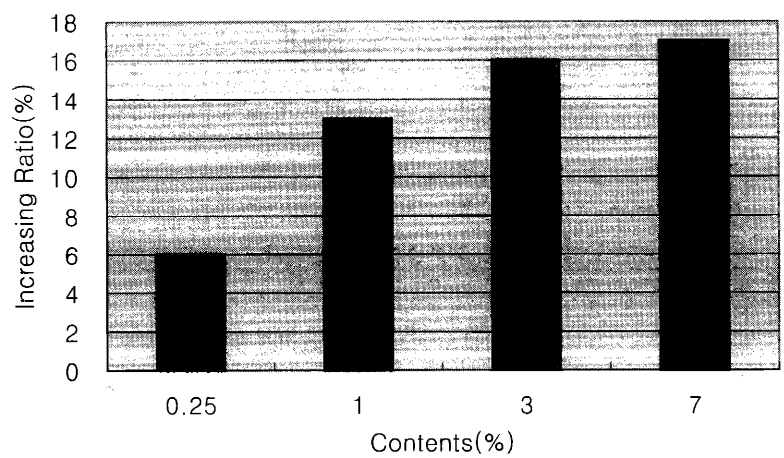

Figure 4. The increasing ratio of radiation energy (W/m^2) of the O/W emulsion containing the jade (nephrite) powder. The y-axis is the increasing ratio (percentile) and the x-axis is the contents of the jade (nephrite) powder.

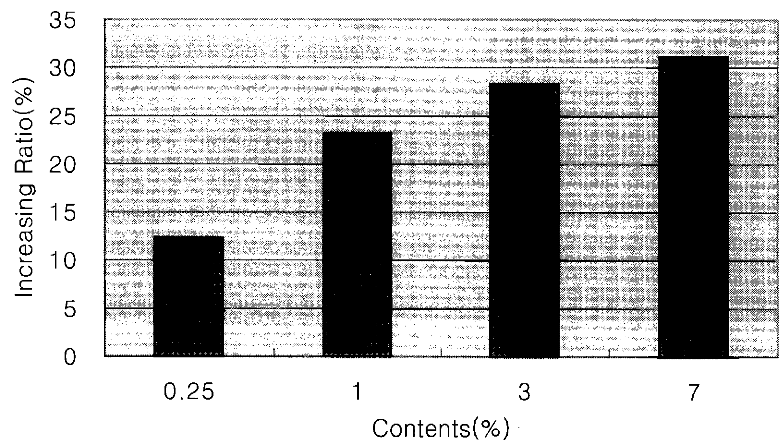

Figure 5. The increasing ratio of emissivity of the O/W emulsion containing the tourmaline powder. The y-axis is the increasing ratio (percentile) and the x-axis is the contents of the tourmaline powder.

These results of saturation at 1% content were confirmed from the results of emissivity estimation. The emissivity results are shown in Figure 5 for the tourmaline powder and Figure 6 for the jade powder. The emissivity was saturated at 1% of the contents of both of the jewelry powders. From the results of emissivity and emission energy estimation, the content of each powder was determined to be 1% of the total amount as a cosmetic ingredient.

The sample creams were prepared, and the contents of each powder were fixed at 1% (w/w). The skin temperatures of all the subjects were raised about one degree, as shown in Table II. The thermographic analysis data are shown in Figure 7 for the tourmaline 1% cream (T-cream), and Figure 8 for the jade 1% cream (J-cream). The T-cream and

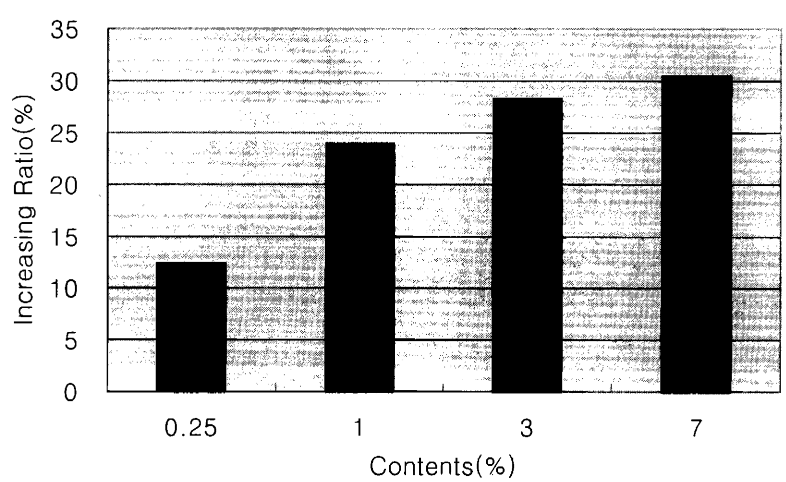

Figure 6. The increasing ratio of emissivity of the O/W emulsion containing the jade powder. The y-axis is the increasing ratio (percentile) and the x-axis is the contents of the jade powder.

Table II.
Temperature Elevation Induced by Jewelry Powders

	Before application			After application		
	Right	Left	ΔT_1	Right	Left	ΔT_2
T-cream	31.2	31.3	0.1	31.3	32.5	1.2
	32.3	32.4	0.1	32.6	33.6	1.0
	32.0	32.0	0	32.9	33.8	0.9
	32.5	32.5	0	32.8	33.7	0.9
	33.5	33.3	0.2	32.9	33.7	0.8
$T_{T,mean}$			0.08 ± 0.08			1.0 ± 0.2
J-cream	29.7	30.0	0.3	31.0	32.3	1.3
	33.6	33.8	0.2	33.3	34.4	1.1
	31.4	31.4	0	31.9	33.0	1.1
	32.2	32.3	0.1	32.1	32.9	0.8
	32.2	32.3	0.1	33.1	33.9	0.8
$T_{J,mean}$			0.1 ± 0.1			1.0 ± 0.2

ΔT_1: skin temperature differences on the subject's face before application.
ΔT_2: skin temperature differences on the subject's face after application.
$T_{T,mean}$: mean skin temperature differences in T-cream.
$T_{J,mean}$: mean skin temperature differences in J-cream.

the J-cream were applied to the left side of the subject's face and the control cream was applied to the right side. Representative thermographs are shown. The control cream was applied to the right side and the powder-containing cream was applied to the left side of each subject's face. The skin temperature elevation rate was different in each subject, and some subjects showed rather late temperature elevation, while others showed very fast temperature elevation. These results might be induced by the sensitivity of each subject to far-infrared rays. Right after the treatment, the skin temperature was cooled down by the water evaporation and then increased. The skin temperature elevation rate was mainly due to blood circulation in capillary blood vessels, and far infrared rays might be helpful in accelerating the blood circulation below the skin layer. As shown in Figures 7 and 8, before the treatment the temperature of both side of a subject's face was almost same, and the temperature differences of both sides were not significant and did not exceed ± 0.3° for all the subjects in controlled measurement conditions.

CONCLUSION

In this study it was demonstrated that the jade and the tourmaline powders radiated far-infrared rays and that the intensity of the wave energy was proportional to the contents of the jewelry powders. As a cosmetic ingredient, the optimum content of the jewelry powders was 1% (w/w). After the O/W emulsion formulations containing the jewelry powders were applied to the face, the radiation energy from the jewelry powders elevated the skin temperature. It is thought that the measured skin temperature elevation might be the result of the acceleration of percutaneous blood circulation. Depending on the subject's sensitivity to far-infrared rays, the skin temperature elevation varied

(a) (b)

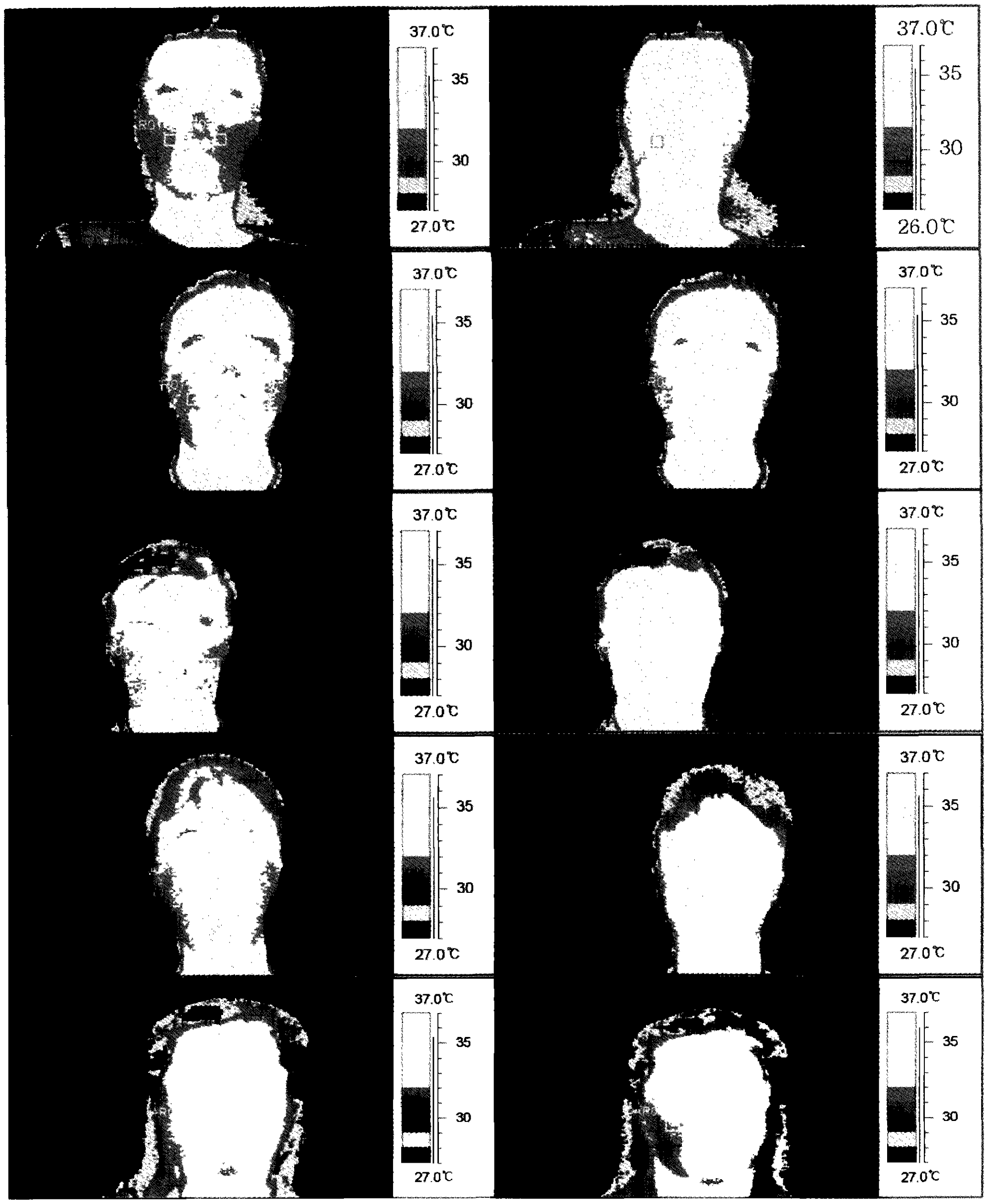

Figure 7. Thermograph of the tourmaline powder-containing cream. Thermographs were taken at a constant room temperature of 25°. (a) Thermographed before treatment; temperatures of both sides of subjects' faces were almost the same. (b) Thermographs taken 210 seconds after treatment.

from 0.6° to 1.5°. It is suggested that far-infrared rays play a key role in the skin temperature elevation. These results provide a clue for the understanding of wave crystal therapies. Among the jewelries, jade and tourmaline are very effective materials for skin temperature elevation and the acceleration of skin blood circulation, and they show great potential for utilization as cosmetic raw materials.

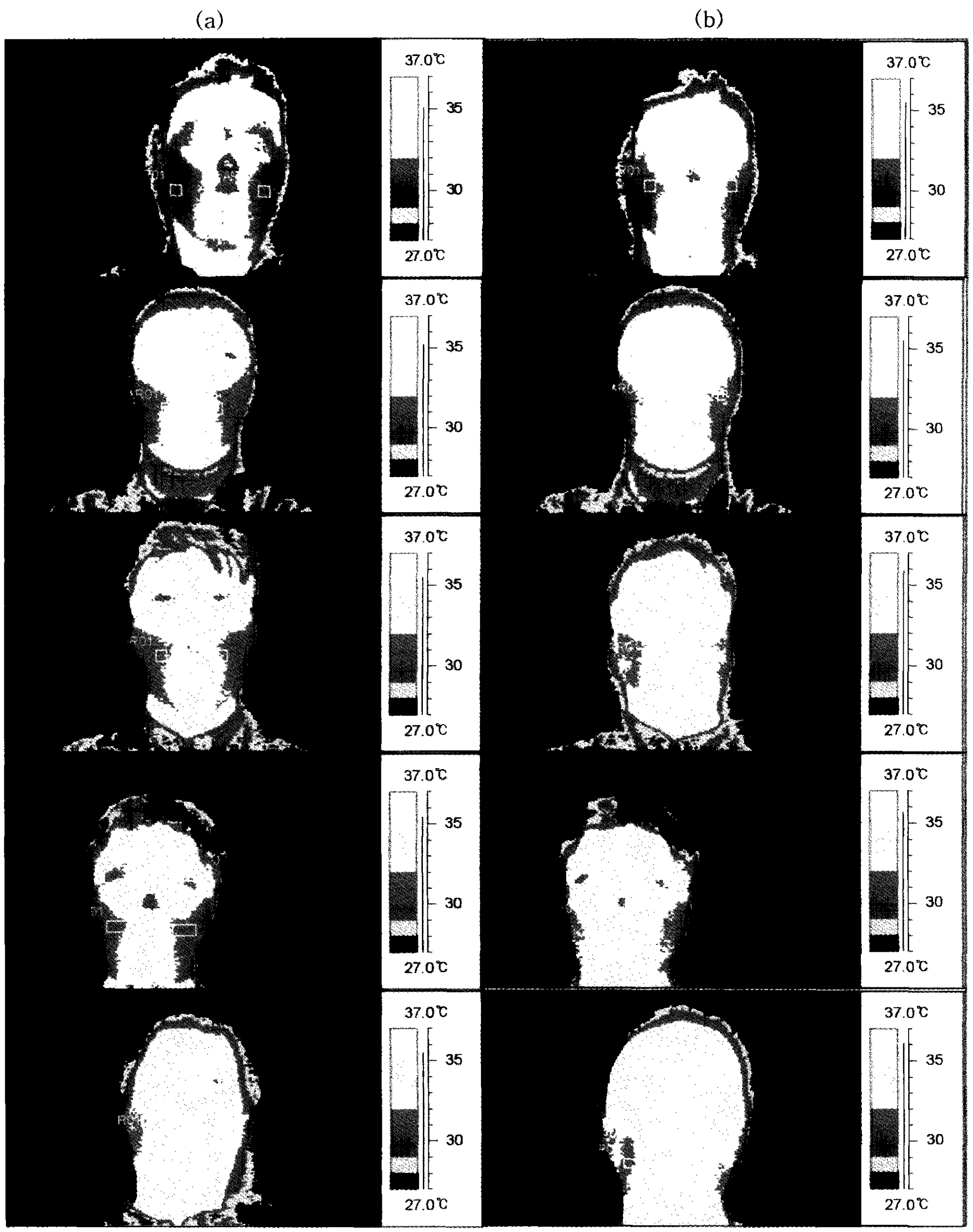

Figure 8. Thermograph of the jade powder-containing cream. Thermographs were taken at a constant room temperature of 25°. (a) Thermographed before treatment; temperatures of both sides of the subjects' faces were almost the same. (b) Thermographs taken 330 seconds after treatment.

ACKNOWLEDGEMENT

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