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Research Paper

Preclinical efficacy examination on healing practices and experiences of users for S4 bio-balls bed of loess bio-balls products

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ABSTRACT

This study deals with the various healing properties of S4 bio-balls beds using loess bio-balls. The loess, especially yellow loess, Hwangto in Korean, which has been excavated in Korea has been widely used for a long time as a generic powder that has contributed greatly to health promotion, housing, and environmental purification. Many healing effects have been shown when this loess powder is applied to various skin diseases such as atopy, frostbite, athlete's feet, face packs, and half body baths or systemic baths. In addition, many mental and physical healing cases such as sleep, fatigue, pain, and stress relief have been reported by the user. Considering the importance of healing methods using far-infrared rays, reports of many user healing cases, and user opinions on loess bio-balls products, three healing effects can be achieved: 1) Improvement of blood circulation in peripheral blood vessels by activating the movement of red blood cells in the blood, 2) Reducing or eliminating various pains due to muscle relaxation, and 3) Elimination of mental fatigue and stress through stabilization of the nervous system by rapid *in vitro* release of harmful toxic substances.

Key words: Loess, loess bio-balls, healing effect, far infrared rays, bio-balls products.

INTRODUCTION

It is well known that loess powders mined in Korea have long contributed to the basic mental and physical healing (about 1000 years). The loess powder contains various kinds of minerals including quartz and has a large specific surface area. It has long been known through many years of life and research that loess powder is naturally superior in far-infrared radiation properties such as uniform thermal effect, deodorization, good antibacterial and mildew prevention, natural cosmetics, and temperature and humidity control (KFIR, 2012; ENSEKI, 2012; Far-infrared rays, 2012). Yellow loess powder has been widely used to make loess bowls and to build houses. The loess houses are cool during the day and warm at night, so the body is naturally warm.

Both the United States and Russia have studied the conditions of human survival in harsh space environments in space development projects which started in the 1950s. In particular, researches on solar radiation by NASA have confirmed that far-infrared (FIR) wavelengths of 4.0 to 14.0 μm are essential for the survival of organisms (NASA, 2015). At the same time, German scientists who have studied biological resonance attempted to discover a so-called natural remedy, a new treatment that is linked to the mechanisms of restoring human health. In Japan, various ceramic materials such as FIR oscillators have attracted attention in the field of health and energy saving (Habil and Wetzel, 2011; Simon, 2007).

The Infrared (IR) radiation consists of wavelengths from 760 to 1 mm in the order of increasing wavelengths: Near-IR (0.76-1.40 μm), Mid-IR (1.40-3.00 μm), and Far-IR (3.00-1000 μm). Given that almost half of the solar energy reaching the Earth's surface is in the IR range, solar IR is expected to have significant biological effects on humans, especially on the skin (Cho et al., 2009).

Vatansever and Hamblin (2012) pointed out that the concept of nanostructured water layers would be useful in a review of the subheading, "The Hypothesis on the Mechanism of Action of FIR Effects on Molecules and Cells." These are thin nanometer layers formed on hydrophobic surfaces such as cell membranes and can be considered "concentrated water". It is reasonable to assume that a relatively small amount of vibrational energy delivered by the non-fired FIR can interfere with the structure of the cell membrane underneath a massive unheated nanoliter layer. If the cell membrane contains ion channels, small perturbations in the membrane structure can have a significant effect on the cellular level (Sommer et al., 2011, 2008).

Yamashita et al. (2010) developed an incubator that can continuously release FIR into cells. When the FIR was continuously radiated to cells of A431 (vulva), A549 (lung), HSC3 (tongue), MCF7 (breast) and Sa3 (gingival), FIR radiation effects were studied. Far-infrared radiation energy inhibited cell proliferation of ATF3 mRNA and suppressed the expression of cell proliferation-related and stress response genes in FIR sensitive cell lines, A549 (lung), HSC3 (tongue), and Sa3 (gingiva). In the analysis of gene expression induced by FIR energy radiation, it was made clear that gene expression of HSP (Heat Shock Protein) 70 was enhanced by FIR energy radiation.

In addition, basal expression levels of HSP70A mRNA were higher in A431 (vulva) and MCF7 (chest) cells than FIR sensitive HSC3 (tongue), Sa3 (genital), and A549 (lung) cells. Overexpression of HSP70 inhibited FIR induced growth arrest in HSC3 (tongue) cells, and HSP70 siRNA inhibited proliferation of A431 (vulva) cells by FIR radiation. This finding suggests that FIR may be a very effective medical treatment for some cancer cells with low HSP70 levels (Yu et al., 2006).

The FIR effect on skin blood flow was noted further for 45 min and lasted 60 min for rats treated with FIR. This result implies that the non-thermal biological effects of FIR play an important role in skin microcirculation. Unfortunately, the mechanism by which FIR works remains unclear (Yu et al., 2006; Ishibashi et al., 2008).

In a recent review of Tsai and Hamblin (2017), several studies showed proliferation that IR can improve skin wound healing, photophobia, pain, stiffness, rheumatoid arthritis fatigue, ankylosing spondylitis, enhancing photodynamic therapy, ophthalmology treatment, IR stimulation, and mesenchymal stem cells and cardiac stem cells. They reported that the mechanism of action of IR radiation can be divided into two groups, which are related to energy transfer mechanisms and signaling pathway mechanisms. Further research is needed to study the mechanism of action of IR radiation in medical and biochemistry (Tsai and Hamblin, 2017).

Han-Ul Bio has developed a low-temperature drying process for loess bio-balls with 92.7% of far-infrared radiation (Choi et al., 2012; Choi et al., 2013a, b; Choi, 2012; Choi, 2015; Choi et al., 2015). The following series of studies were conducted to determine the basic physicochemical properties of loess and to monitor the movement of red blood cells in the blood to confirm the efficacy and safety of loess bio-balls products: (1) observation of the warmth of red blood cells using a Somatoscope microscope, observation of digital infrared image (DITI) data used for medical diagnosis, (2) a discussion based on the contrast between the oriental medical literature and the latest research papers, including the "Donguibogam", a classical Chinese medicine handbook (Choi et al., 2018), and (3) healing experience reports from many users of loess bio-balls products for detoxification, deodorization, air purification, redness mitigation, antifungal effects, body fatigue recovery, and stress relief or relief along with temperature and humidity control.

The purpose of this study is to evaluate the action mechanism and healing properties of loess bio-balls products for S4 bio-balls beds including bio-balls products such as mattresses, pillows, hot packs, and cushions.

EXPERIMENT METHODS

Details of the experimental items are described here. For detailed contents, refer to the table and figures in the Author's reference at the end of each section (Choi et al., 2012; Choi et al., 2013a, b; Choi, 2012; Choi, 2015; Choi et al., 2015).

Physical-chemical properties of loess powder

The qualitative analysis of XRD using Rigaku miniflex 600, measurement of particle size distribution using MT 3000 II MICROTRACK, evaluation of particle dispersion using Lumisizer 651, observation of surface morphology by SEM, and measurement of adsorption/desorption behavior by gas chromatography were performed. The measured physical-chemical properties of Korean loess powders are summarized in references (Park, 2012; KBSI, 2012).

FT-IR spectrum measurement

Far-infrared absorption spectra and far-infrared radiation characteristics by FT-IR measurements were evaluated (KBSI, 2012).

Blood test and DITI test

To evaluate the preclinical efficacy of loess bio-balls, two test methods were used: a Somatoscope microscopic observation and a DITI test using IRIS-XP as a thermal diagnostic device (Choi, 2015; KICM, 2003).

(A) (B)

Figure 1: (A) S4 bed, mattress divided into four sections of the surface of the bio-bed structure and (B) cross-sectional profile of the bed mattress.

Summary of healing experience reports by user

Clinical trials for loess bio-balls or loess bio-balls products have not yet been clinically confirmed. However, experience reports from users who have experienced the healing effects of loess bio-balls products in various situations can be used as a potential efficacy evaluation method. That is, it is still important to use a healing experience report on the degree of change in physical symptoms before and after using the product. In addition, various experience cases of loess bio-balls products have been published on the Hanu-Ul Bio website (Choi, 2015; Choi et al., 2015; Choi et al., 2018; Hur, 2005; Park, 2012; KBSI, 2012; Kamitani, 2016; KICM, 2003).

The manufacturing process of loess bio-balls based on particle design technology

The loess bio-balls are manufactured and managed by a series of unit processes called a low-temperature drying process. That is, natural loess powder is stored indoors for at least 6 months or more, and then subjected to a series of unit processes. A series of processes such as screening to remove other heterogeneous materials such as gravel and fiber matters, crushing of solidified powders, kneading with binders (incorporation of plant extracts), die extrusion, rounding by rotary pans, drying and sizing processes are performed (Choi et al., 2012, 2013).

Structure of S4 bio-balls bed and cross-sectional profile of bed mattress

The surface of the S4 bio-balls bed is divided into four sections vertically and horizontally, and the temperature of each section can be set independently according to the user's physical condition or taste. As can be seen from the cross-sectional profile of the bed mattress, several measures are taken to ensure safety from overheating and moisture (Figure 1). The S4 bio-balls bed is designed based on the traditional Korean 'ONDOL' heating culture, and it has long been known to Koreans how to improve their health by keeping their head cool and their feet warm. Therefore, the temperature of the surface of the S4 bio-balls bed can be adjusted by lowering the set temperature of the upper part and by warming the body by raising the set temperature of the lower part (Choi et al., 2015).

The main features of the S4 bio-balls bed are as follows: (1) Pleasant human workability through temperature control, that is, improve blood flow, and promote metabolism by improving hypothermia. (2) Warmth like the mother's arms: far-infrared radiation heat is heated not only on the skin surface but also deep inside the body. (3) Comfortable satisfaction throughout the four seasons through temperature and humidity control: Deep sleep even on rainy days, dry days and above 40°C. (4) Independent section temperature control of four bio-balls bed surfaces: It is independently adjusted in four sections: the left, right, upper and lower according to the user's physical condition and taste. (5) Systemic baths during sleep: You can enjoy systemic bath effects such as blood circulation and immune-boosting during sleep.

EXPERIMENT RESULTS AND DISCUSSION

Physical-chemical properties of loess powder

The qualitative analysis of the XRD results for two different high temperature treated samples is shown in Figure 2. The XRD pattern of the powder sample prepared by the heat treatment process at different heating temperatures is shown along with the pattern of the raw loess powder. This pattern shows that the supernatant powder is halloysite ($Al_2SiO_2(OH)_4$) and the precipitated powder is quartz (KBSI, 2012; Kamitani, 2016). In addition, the peak of the halloysite in the as-received sample disappeared in the high-temperature treatment, and it was confirmed that the low-temperature drying process was useful.

The measured particle size distribution and particle shape of the loess powder are shown in Figure 3A and B,

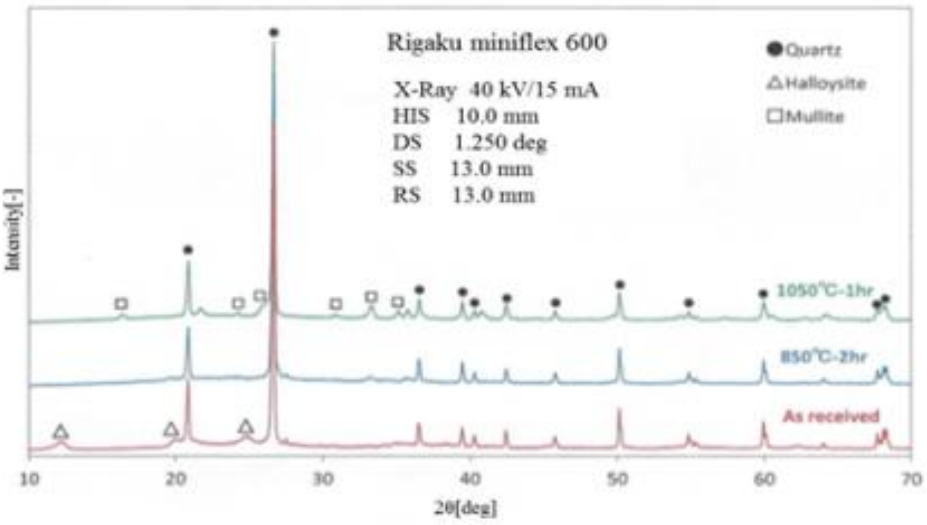

Figure 2: X-ray diffraction profiles and mineral phase detection of two heat-treated samples of Korean loess measured with Rigaku miniflex 600.

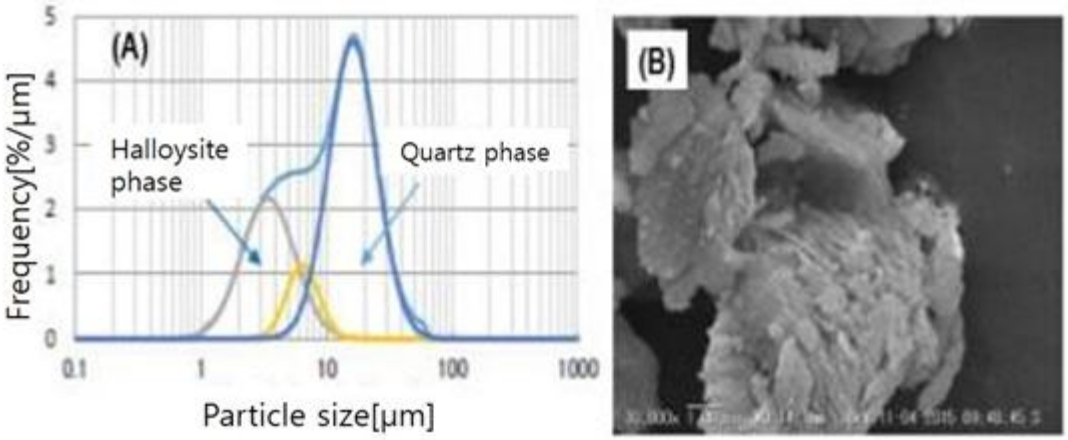

Figure 3: (A) Particle size distribution of loess powder and (B) particle shape of loess powder.

respectively. In Figure 3A, the three particle size distribution curves obtained by separating the original distribution with the peak separation method assuming the original particle size distribution as the logarithmic normal distribution function are shown together below the original particle size distribution curve. The loess is composed of quartz phase particles and halloysite particles, and the halloysite phase may be a secondary form of agglomerated particles. Figure 3B shows the shape of the loess particles observed with the microscope. Samples for particle size distribution measurements in Figure 3A were measured by dispersing in sample particles in ion-exchanged water with 0.5wt% sodium hexametaphosphate as dispersant under ultrasonic irradiation (Kamitani, 2016).

A plot of isothermal curves as a series of adsorption and desorption processes is shown in Figure 4. The BET specific surface area was 61.65 m^2/g for powders and 25.466 m^2/g for granules, indicating a type II adsorption isotherm with typical type III hysteresis. The amount of water vapor adsorption was 69.8 cm^3-STP/g for powders and 48.6 cm^3-STP/g for granules. It is considered that the loess particles have high porosity, and slit-like pores are observed between the plate-shaped particles, so that water adsorption and desorption can be easily performed. The characteristics of the measured loess powders and granules are summarized in Table 1 (Kamitani, 2016).

Far infrared radiation characteristics of loess particles

The far-infrared emissivity of loess powder was measured at 40°C using an FT-IR spectrometer in the Korea Institute of Construction Materials. As a result, the emissivity was 0.927 and the radiation power at 40°C was 374 W/(m^2·μm)

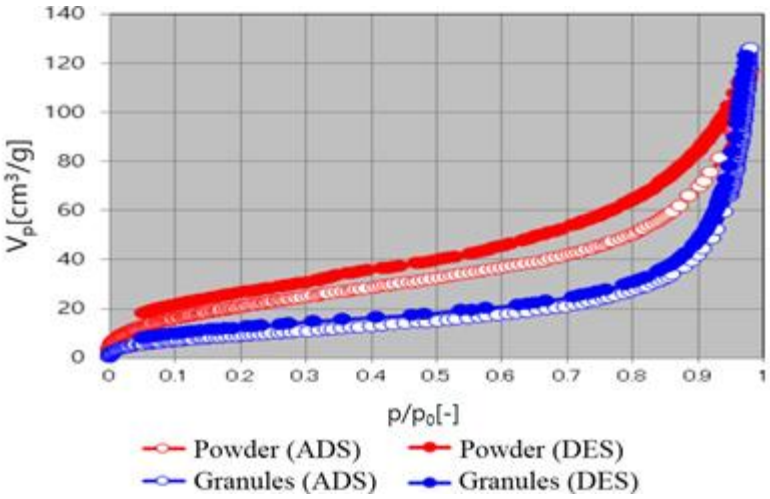

Figure 4: Adsorption and desorption isothermal curves of loess powder and granule samples.

Table 1: Summary of characteristics of adsorption and desorption Isotherms of Korean loess bio-balls powders and bio-balls granules.

Parameter	Unit	Powder	Granule
V_m	[cm^3/g]	18.358	7.5827
BET specific surface area	[m^2/g]	61.654	25.466
Total void volume (p/p_0 = 0.98)	[m^3/g]	0.094572	0.1016
Average pore diameter	[nm]	6.1357	5.962

(KBSI, 2012; Kamitani, 2016).

Figure 5 shows the IR absorption spectra of Korean loess samples according to the wavenumber or the wavelength. Two important peaks were observed here. The small absorption peak near the 2.6-2.7 μm infrared wavelength, which was the subject of Nobel physiology in 1998, is a peak associated with nitric oxide and NO, which has been pointed out as a signal molecule in the cardiovascular system. Another large absorption peak with 9.5 μm of infrared wavelength is mainly attributed to the resonance oscillation of water molecules and is associated with thermal energy and detoxification (KICM, 2003). Here, the peak indicated by the red circle is the peak of the mineral component of Portland cement used as a binder for preparing granules, and the peak due to OH-stretching at the short-wavelength disappears at high-temperature samples fired at 850 and 1050°C. Thus, the usefulness of the selected low-temperature drying process could be reaffirmed.

Preclinical review by in vivo blood test and DITI test

The Somatoscope images taken from a live blood test showed that the movement of red blood cells in the live blood irradiated on the mattress for 20 minutes was observed and then red blood cells were separated one after another and activated more than before exposure to radiation. After 20 min of radiation exposure on the mattress, the blood circulation was observed to be improved not only in the large vessels but also in peripheral small vessels, so that the cold hands of the subject felt warm within minutes. Furthermore, even in the mattress at room temperature, these movements of red blood cells were observed as in the photograph at 40°C. In the DITI photographs, a non-invasive diagnostic technique that does not require exposure to epigastric radiation, a red zone of the epigastrium of the upper abdomen were observed after exposure to the bio-balls products. It has been confirmed that the far-infrared rays of loess bio-balls products are larger than other products, and the far-infrared rays of loess bio-balls products can increase the skin temperatures (Choi et al., 2013, 2015).

Loess powder and its healing effects

Table 2 shows the healing experience case reports of loess Bio Bowl S4 bed users from 2014 to 2018, including gender, age, occupation, pre-bedtime syndrome, and the improved physical condition after use.

The main symptom improvement of the users can be summarized as follows: (1) Moist feeling of skin and the

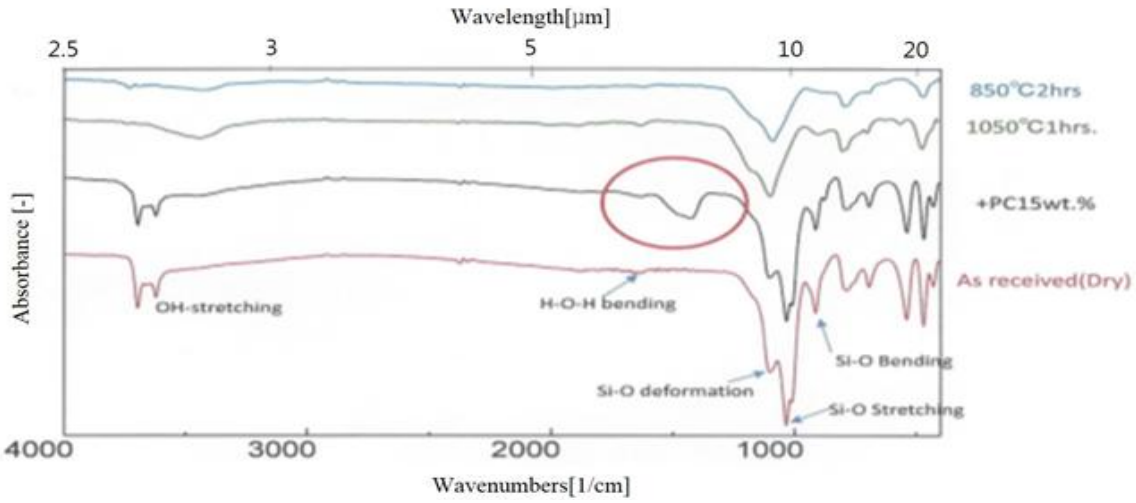

Figure 5: IR absorption spectrum at various heating temperatures of loess powder according to the wavenumber or the wavelength.

Table 2: A summary of healing experience case reports of users of loess bio-balls S4 bed since 2014.

No.	Gender	Age	Occupation	Main symptom before use	Condition improved after use
1	Woman	30	Housewife	Cancer operation	Feeling of light and quiet body
2	Man	50	Business	Tightness is tense & nap	Deep seep
3	Man	50	Self-employed	Heavy of foot	Heavy Foot becomes light.
4	Woman	40	Housewife	Slow maturing fatigue	Full of vigor & deep sleep
5	Woman	40	Dining room	Fatigue, lumbago	Sleep soundly with pain relief
6	Woman	50	Housewife	Nap for much agony	Asleep and sleep well
7	Woman	50	Housewife	Drying feeling of face	Moist feeling of face
8	Man	40	Office worker	Numbness of the foot	Disappeared neatly
9	Man	30	Business	Indigestion for stress	Pain relief with good meal
10	Woman	30	Office worker	Fatigue and lack of spirit	Good meal and full of vigor
11	Man	50	Self-employed	Fatigue until deep night	Deep sleep
12	Man	40	Office worker	Stress and insomnia	Deep sleep
13	Man	40	Office worker	Pains of shoulder & back	Sleep at different temperature
14	Man	60	Farming	Pains until over-night	Fatigue recovery and pain relief
15	Woman	60	Housewife	Knee and calf ache	Disappeared neatly
16	Man	40	Newspaper boy	Pains in the foot	Pain relief in different temp.
17	Woman	40	Mart calculator	Swell foot up	Pain relief in different temp.
18	Man	50	Self-employed	Lack of sleep time	Fatigue recovery in short time
19	Man	40	Business	Buttocks itch in other bed	Comfortable in different temp.
20	Woman	50	Housewife	Coldness of hands-feet	Refreshed by body's warmth

disappearance of itching, (2) Relieve pains such as head, shoulders, lower back, and calf, (3) Refreshing life through fatigue recovery, (4) Improving sleep quality by relieving insomnia and getting a good night's sleep, and (5) Relieving stress caused by relaxation of body and mind.

Notable effects of three loess bio-balls from users' healing experiences case including bed are followings:

·Bio-balls pillow relieves headaches and hangovers, neck disc coming from the uncomfortable posture.

·Bio-balls hot pack relieves joint pain in the shoulders, knees and lower back, and diet due to warming of abdominal on the hot pack,

·Bio-balls cushion Improves long term chair life in summer, and prevention of bedsores,

·S4 bio-balls bed makes a pleasant indoor environment and the smell control of the elderly room.

As described above, through many healing experience reports, when the use of three bio-balls products is

combined with the S4 bio-balls bed, it is considered to be useful to prevent lifestyle-related diseases and to prevent recurrence after surgery. For further details, please refer to the Proceedings of WCPT 8, organized by the American Institute of Chemical Engineers (AIChE) in Orlando, the USA in April 2018 (Choi et al., 2018).

The followings are an excerpt from the users' healing experience case report on how to use loess bio-balls products well. For more information, refer to the Han-Ul Bio website (Choi, 2015):

- Half body and whole body bath: Disperse 100 g of loess powder in hot water bath at 30 to 40°C. After sweating for 10-20 min, the body is washed with warm water. Excellent effects on a skin rash, rough skin, and acne were observed.
- Used for atopic dermatitis: Disperse 100g of loess powder in water, knead into creamy form and apply with brush or hand. After 10-20 minutes, wash with warm water. As a result, atopic dermatitis can be alleviated and improved.
- How to use it as a face pack: Add about 10 g of loess powder to 10 ml of water, mix well and apply to the face with a brush or hand. After 15-20 min, the loess powder is dried and then washed with warm water followed by cold water. When used as a face pack, milk or yogurt can also be mixed with water.

DISCUSSION

Survey study of Korean yellow loess room

Kim Y.K., professor of the College of Nursing at Pusan Catholic University, studied "The Perception of the Healing Effect after Using loess in Korea." Here, the loess used in the loess room investigated is different from the loess powder used in the present study. The results are summarized in five themes: (1) Promoting blood circulation, (2) Comfortable mind, (3) Restoration, (4) Moisturizing skin; (5) Itching disappears. Nearly half of the subjects, 41.35%, thought with the disease or disorder improved, and 58.65% did not reach the expected level of purchase but thought it was somewhat effective. Importantly, no one felt the side effects (Kim, 2001).

Calculation of FIR radiation energy in loess bio-balls bed

According to Fourier Transform Infrared Rays Spectroscopy (FT-IR) analysis data measured by the Korea Institute of Construction (KICM), the FIR radiation characteristic curve is warmed up to 40°C at the bottom of the loess bio-balls and radiated in one direction. Loess bio-balls had a maximum emission intensity of 33.0 W/(m^2·μm) at a wavelength of 11 μm (Kamitani, 2016). From this characteristic curve, the total radiant energy value of the loess bio-balls obtained by numerical integration over the wavelength range of 5 to 20 μm was obtained as 359.0 W/m^2 (96.0% of the KICM measurement data of the previous section 3.2). Some users who want to sweat in anticipation of fatigue recovery may set the temperature of the S4 bio-balls bed above 40°C (Choi, 2015). Thus, the total FIR radiation energy of the S4 bio-balls bed increases in proportion to the sleep time on the bed (Sommer et al., 2011; Yamashita, 2012).

Heat transfer problems with the human body, including FIR emissions of loess bio-balls, are related to some factors unknown under the circumstances of use, such as differences in permissible heat yields depending on the body region and FIR transmittance of the garment. To clarify these factors, it is necessary to take the actual clinical measurement.

Action mechanism for the healing effect of S4 loess bio-balls bed

S4 bio-balls bed is designed based on the Korean traditional 'ONDOL' indoor heating system. The bed surface is divided into four sections, left, right, upper and lower, as shown in Figure 1. The temperature of each section can be set independently according to the user's health condition or habitual taste as shown in Figure 4. In addition, synergistic effects are expected when other bio-balls products such as the bio-balls pillow, bio-balls hot pack and bio-balls cushion are used with the S4 bio-balls bed.

The results of the research so far are summarized as follows: (1) Measurement and analysis of basic physical-chemical properties of loess powder, observation of skin temperature rise by DITI photograph, and observation of erythrocyte movement in living blood by Somatoscope microscope, (2) Literature survey of recent research studies on oriental and Korean traditional medicine including the book 'Donguibogam' edited by Hur Jun, (3) Data on detoxification, deodorization, deodorization, air purification and antifungal effects of loess powder, and (4) Pre-clinical examination of the effects on healing experience cases of users of S4 bio-balls bed and other loess bio-balls products.

In a short time, the user has been able to recover from fatigue, alleviate headaches, and relieve various pains and stresses.

Figure 6 shows the estimation of the action mechanism of the healing in the human body in S4 bio-balls beds based on literature research, including the basic characteristics of loess bio-balls, the healing of the human body in bio-balls products, and research papers of FIR.

Energy sources include the sunlight, electric lamps or heating wires, body temperature and mineral components of loess. When this energy is irradiated to the loess bio-balls, infrared light is emitted from the bio-balls and acts on human cells. The first active site of the human body is the skin. Then, by improving blood circulation in the blood

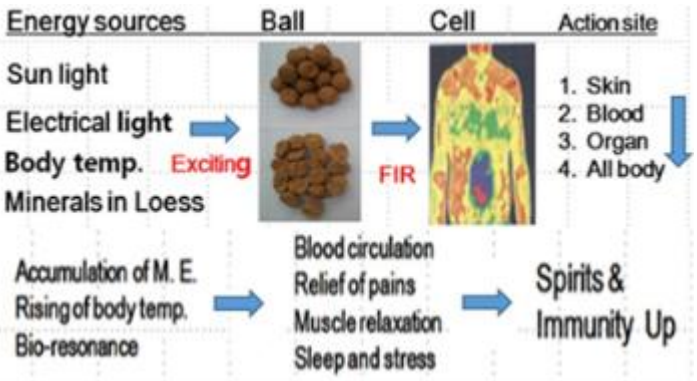

Figure 6: Estimation of the action mechanism of healing in humans for the S4 bio-balls bed through a recent literature review, including the healing experience cases users of loess bio-balls products, and research papers of FIR.

vessels, IR radiation has a healing effect on the living organisms of various organs, including peripheral blood vessels and the brain. As summarized below in this figure, the body induces healing such as increased body temperature, improved blood circulation by vibration and resonance of cells in vivo by infrared, pain and muscle relaxation, insomnia and stress relief. Therefore, it is assumed that both body and mind are restored to a healthy state (Choi et al., 2013, 2015, 2018).

In 1800, a scientist William Herschel first discovered the heat of infrared ray radiation. This fever has been used for thousands of years to cure or alleviate certain diseases and discomforts.

Literature consideration on biological healing activity of infrared rays

NIR has been reported to penetrate the epidermis and skin layers, reaching the subcutaneous tissue without significantly increasing skin temperature. On the other hand, most of the mid-infrared and far-infrared rays are absorbed by the epidermal layer and the skin temperature increases significantly (Schieke et al., 2003). Exposure to infrared radiation generates heat, and biochemical actions are affected by temperature regardless of whether or not favorable (Cho et al., 2009).

The biological effects of far-infrared rays on all organs are yet to be well known. However, Toyokawa et al. (2003) of the FIR study on skin wound healing suggested that FIR investigations may be clinically useful for wound healing. Far-infrared rays' radiation has been recognized to have some warming effect on blood circulation problems in the limbs. It also suggests the possibility of mitigating the mental workload or the possibility of further awakening (Konomi et al., 2002). Increasing peripheral circulating blood flow and muscle relaxation by far-infrared irradiation is suggested to create physical conditions favorable to the onset of sleep and maintenance of deep sleep (Kotori et al., 1988).

In studies of the biological effects of far-infrared therapy on increased skin microcirculation in rats, the facilitating effect of FIR radiation on skin microcirculation is closely related to nitric oxide (NO). NO released by endothelial cells acts as a kind of endothelial-dependent agent. Muscle relaxation is induced by controlling vasodilation effects and activating bio-tissues. Muscle relaxation relieves pain and dilates blood vessels, reducing blood flow resistance and increasing local perfusion (Ishibashi et al., 2008).

According to the user's healing experience cases report, Korean yellow loess, a kind of bio-ceramic, can control various biological effects. This is related to the hydrophobic bond of water. As the hydrogen bonds weaken, the inherent properties of water, such as adhesion, cohesion, surface tension, and viscosity decrease, while the density, diffusion coefficient, and solubility of solids increase, and the skin permeability of the drug depends on the water properties (Lin et al., 2013).

Vatansever and Hamblin (2012) suggest that fibers spun with FIR spun ceramic nanoparticles will benefit from the health benefits of FIR spun when used in apparel and wrapping.

Yamashita (2012) developed the FIR radiation system and FIR animal breeding equipment and conducted a variety of physicochemical and biological experiments using Japanese rhyolite as a sample. Here, the rhyolite powder had a crystal structure similar to that of Korean loess powder (Hwang et al., 2000). FIR radiation energy concluded that the activation of blood circulation *in vivo* as well as the movement of water molecules. It is also expected to be related to the development of healing therapies for the regeneration of tissues and organs as useful preventatives for skin, bone, and cancer.

Tsai and Hamblin (2017) suggest that the infrared radiation can perform optical stimulation and photo-biological control effects, especially for nerve stimulation, wound healing and cancer treatment. In recent years, the application of IR treatment is rapidly progressing. A better understanding of the new developments and biological effects of IR may be of great help in improving the

therapeutic effects of IR as well as the development of new therapies and bio-products using IR (Tsai and Hamblin, 2017).

Based on what has been found in the literature considered, most reports on user experiences of loess bio-balls products can be explained basically, but many healing symptoms remain unexplained. Therefore, there is an urgent need for clinical studies with hospital physicians to further improve the performance of current loess bio-balls products and fully explain the healing symptoms of unexplained.

This is also important for the development of FIR-release loess bio-balls products impregnated with Korean loess bio-materials based on clinical trial data and particle design techniques (Vatansever and Hamblin, 2012; Choi et al., 2018; Loturco et al., 2016).

CONCLUSION

By measuring the physicochemical and related properties of the loess powder, it was possible to characterize the useful properties of the loess bio-balls applicable to bio-products. Considering the importance of healing methods using far-infrared rays, reports of many experiences of healing experiences, and user opinions about loess bio-balls products, we can suggest that three healing effects are obtained.

1) Activation of the activity of red blood cells in the blood to improve blood circulation in peripheral blood vessels.
2) Relief or elimination of various pains caused by muscle relaxation.
3) Elimination of fatigue and stress through stabilization of the nervous system with rapid in vitro release of harmful toxic substances.

This healing effect on the human body is thought to be caused by the emission of infrared (medium and far infrared) radiation emitted from yellow loess bio-balls products at room temperature or heated temperature.

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