



Austria



icseconf.com

٢١
١٣٩٥
International Conference on
**Science and
Engineering**
in the Technology Era
کنفرانس بین المللی
مهندسی
در عصر تکنولوژی
جوم ۹



Effect of drinking hydrogen rich water produced by "Alkaline Stick" for Skin care

Behrooz moraadi

MSc. of Microbiology, Diba Tejarat Khavarmianeh Co, Science and Research Unit
moraadi_behrooz@yahoo.com

Hamed Farahani

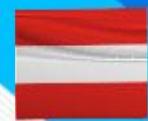
BA. Laboratory Sciences, Medical Sciences University of Arak
hamed_farahani_hdf@yahoo.com

Abstract

Antioxidant substances have the ability to bind free radicals, caused by oxidative stress, and may have significance in prevention and/or therapy of various skin diseases, as well as in slowing the skin aging process. Previous studies have shown that hydrogen exerts antioxidant, anti-apoptotic and anti-inflammatory properties that are beneficial to the cell.

Alkaline water stick is a portable filter whenever placed in a half liter bottle of water after 1-2 hours, give alkali metal ions such as Magnesium and Calcium to the water and making hydrogen rich water (HRW). Many articles demonstrate positive effect of hydrogen on the complications of dermatitis, skin aging, photo-damage and wound healing due to reduce free radicals, that's required daily use it to enhance the skin health in the society.

Keywords: hydrogen rich water, Alkaline Stick, Skin care, antioxidant



Austria



icseconf.com

٢١
١٣٩٥
11 March
2017

International Conference on
**Science and
Engineering**
in the Technology Era

کنفرانس بین المللی
مهندسی
در عصر تکنولوژی
۹۱



Introduction

Skin is the prime protector of living entity's body against environment, one of the most important reasons of skin aging is cellular destruction *via* free radicals. Free radicals that are very active, attack body's cellular structure and eliminate them. The most predominant resource producing free radicals is fuel cell that anytime is utilized by the entire body cells.

Even the environmental factors such as sun ray and air pollution are the producers of free radicals in skin. Besides, the stress producing factors such as diseases, cigarette smoke and high consumption of alcohol can cause free radical in the human skin. The high reactivity of these molecules can cause destruction of cells and cellular division. Such disorders can lead to premature aging and or skin cancer. Human skin strategy has created an advanced protection against the destructive enforcement of free radicals. The antioxidant material neutralizes the active reactive variants prior to enforcement of damaging effect. (Lademann et al. 2011)

The human body is approximately 60-80% water. The function of water in the body is mainly classified as follows. 30 minutes after drinking, water enters the different body tissues. Even water *via* bloodstream passes the brain barrier. If water itself could neutralize the free radicals, it could be an ideal antioxidant. Alkaline water is enriched with dissolved hydrogen molecules and has a negative Oxidation Reduction Potential (ORP) that cleanses the active oxygen radicals and *via* this route prevent the oxidative stress. (Kim, 2002)

Studies on the functions of ERW were initiated in Japan in 1931, and its application to agriculture was first attempted in 1954. In 1960, it was applied to medical care as a health-beneficial water, and in 1966, the Ministry of Health, Labour and Welfare of Japan admitted that ERW was effective for chronic diarrhea, indigestion, abnormal gastrointestinal fermentation, antacid, and hyperacidity, and it authorized an ERW-producing device for home-use. In 1994, to mainly promote electrolyzed water use in society, the Functional Water Foundation was established with the support of the Ministry of Health, Labour and Welfare of Japan. (Shirahata, et al. 2012)

Almost in all the studies the antioxidative effect of these waters has been related to the production of dissolved hydrogen in the water. For this reason in the scientific articles these waters are called as Hydrogen-Rich Water (HRW). The natural antioxidants such as glutamine, vitamin C and or antioxidative enzymes such as Superoxide Dismutase (SOD) with hydrogen donation cause neutralization of free radicals.

Shimouchi *et al.* in 2012 investigated hydrogen gas absorption rate in the body of five men and women and showed that after 20 minutes drinking approximately 40% of hydrogen existing in HRW is absorbed *via* body and carries out neutralization of free radicals. Therefore, hydrogen has been known as the smallest antioxidant molecule. Similarly, HRW provides the hydrogen required by antioxidants and even increases activity of antioxidants. (Shimouchi, et al. 2012)



Austria



icseconf.com

٢١
١٣٩٥
11 March
2017

International Conference on
**Science and
Engineering**
in the Technology Era

کنفرانس بین المللی
مهندسی
در عصر تکنولوژی



Accordingly, in the present study, the effect of drinking hydrogen-rich water produced *via* alkaline stick for skin care is investigated in three segments; anti-inflammatory effects, minimization of radiation side-effects and acceleration of wound healing.

1- Anti-inflammatory effects

Skin inflammatory appearances are investigable with increase of inflammatory factors. Manifestation of oxidative stress causes increase of inflammatory factors and rise of antioxidative capacity contributes in regulation of these factors. The preliminary studies in this field indicated that molecular hydrogen improves diseases under oxidative stress in the animal models. In the study of Itoh on mouse mast cell, molecular hydrogen caused phosphorylation reduction Fc ϵ RI as a signal transmitter and with NADPH oxidase deactivation the production of hydrogen peroxide can be reduced. Therefore, it was concluded that probably hydrogen acts as a gaseous signal in the control of inflammatory reactions. (Itoh, et al. 2009)

Atopic dermatitis or eczema is a type of allergic inflammation that intensifies with oxidative stress. In a study the effect of hydrogen-rich water was investigated on dermatitis in experimental mouse and demonstrated that serum level of inflammatory cytokines such as IL-10, TNF- α , IL-12p70 and GM-CSF of mouse treated with HW significantly reduced in relation to the control group. The results showed that HW dermatitis influences an allergic contact *via* modulation responses Th1 and Th2 in the mouse. These clinical results justify that drinking of hydrogen-rich water is a potentially hopeful treatment for the treatment of atopic dermatitis. (Ignacio, et al 2013).

Also, Yoon et al. in 2014 investigated effect of hydrogen-rich water on the experimental mouse and showed that use of water enriched with hydrogen increases activity of peroxidase glutathione enzyme. It is noteworthy that Th2 cytokine level, interleukin (IL-5)5, and pre inflammatory cytokines such as tumor necrosis factor IL-6 and α were significantly lower in the mice that drank hydrogen-rich water in relation to the control group. (Yoon et al. 2014)

Even the studies on human society have validated the positive effects of hydrogen-rich water consumption. In a double-blind clinical experiment, the effect of daily drinking of 1.5 to 2 liters of hydrogen-rich water on 8 women (40-60 years) for a period of 12 days was assessed. The evaluations indicated that neck skin melanin rate of case study group was significantly lower than the control group. The results of this experiment showed that consumption of hydrogen-rich water has a positive effect on neck skin aging. This study validates the anti-aging effects of skin *via* hydrogen that is assessable with evaluation of skin melanin, redness, fat, pH and moisture rate. This study has been included in the Korea Cosmetic Association Journal. (Kim & Gang 2016)

2- Topical use of hydrogen-rich water

One of the most important damaging factors that causes cutaneous side-effects are unwanted radiations such as ultraviolet ray. The unwanted radiations can cause cutaneous diseases such as dermatitis and in the advanced stages it can provide a base for cutaneous cancer manifestation. The secondary studies have validated hydrogen effects in gaseous or injection form to reduce radiation side-effects on tested mouse and cellular levels. (Mei, et al. 2014, Guo, et al. 2012, Watanabe, et al. 2014, Qian, et al. 2010)

Ignacio et al., investigated the effect of bath therapy with hydrogen-rich water to prevent the skin damage *via* UVB in the mouse. In this study, the effect of hydrogen-rich water on cytokine network on skin after UVB exposure was assessed and demonstrated that level of inflammatory cytokines such as IFN- γ , TNF- α , IL-6 and IL-1 β significantly reduces *via* hydrogen-rich water bathing. Finally, the electronic microscope information showed that hydrogen-rich water bathing protects the cells from UV damage. (Ignacio, et al. 2013)

Shin et al. in 2013 in a study on live tissue showed that hydrogen surrounded by water regulates the growth of cutaneous cells and expression of ultraviolet ray influenced genes. In this experiment in addition to evaluation of genome and inflammatory factors, the topical effects of hydrogen surrounded by water was used on skin of 11 young individuals (median age 31.7) to assess improvement of UV radiation side-effects, 7 aged individuals (median age 73.1), to assess skin aging improvement and 10



Austria



icseconf.com

٢١
١٣٩٥
March
2017

International Conference on
**Science and
Engineering**
in the Technology Era

کنفرانس بین المللی
مهندسی
در عصر تکنولوژی



middle-aged individuals (median age 54.1) to assess improvement of sun burn. These results showed that topical use of hydrogen-rich water could prevent skin inflammation due to ultraviolet ray and even limit skin aging and its internal processes. Therefore, the results show that use of hydrogen surrounded by water could be a new route to regulate skin inflammatory factors or skin aging. (Shin, et al. 2013)

Likewise, in a clinical study the effect of hydrogen-rich water on wrinkles inhibition due to ultraviolet ray, fibroblast oxidative stress inhibition and keratinocyte cell damage inhibition was evaluated. In this experiment, electrolyzed hydrogen-rich warm water (at 41 °C) was used. HW significantly reduced UVA side-effects due to inner cellular superoxide radicals in experimented cellular levels. Besides, daily bathing of 6 Japanese for a period of 3 months using hydrogen-rich water was studied. Hydrogen-rich water bathing significantly reduced the wrinkles at nape in 90 days in relation to the first day. So, it was concluded that daily use of hydrogen-rich water has beneficial effects for skin care and reduces UVA skin damage *via* control of free radical and raise of collagen type I synthesis in the skin. (Kato, et al. 2012)

3- Acceleration of wound healing

One of the most important effects of antioxidants use is their effect on reperfusion in different tissues via skin. In 2001, study of Hanaoka and associates exhibited that alkaline water is able to reduce free radical in cell culture. In this study, antioxidative properties of alkaline water were related to hydrogen production in the water. Active hydrogen can with attachment to hydrogen donating antioxidants (enzymatic and non-enzymatic) cause increase of antioxidative capacity. (Hanaoka, 2001)

In 2007, in the most validated International Journal of Medical Sciences *viz.* Nature Medicine, a study on the cells under oxidative stress and animal model i.e. laboratory rat, the effects of hydrogen therapy on reperfusion was assessed and it demonstrated that hydrogen molecule can with neutralization of oxygen free radicals causes an interference in the lower messaging network of cellular necrosis and apoptosis and leads to reperfusion in the damaged tissues. (Ohsawa, et al. 2007) Zhao *et al.* (2013) investigated the effect of hydrogen-rich serum injection on reperfusion of cutaneous grafting in the mouse and showed that hydrogen-rich serum with reduction of inflammatory reactions causes alleviation of reperfusion damages. Therefore, it can be adopted potentially as a therapy for cutaneous grafting improvement. (Zhao, et al. 2013)

The effects of drinking hydrogen-rich water on wound healing have also been assessed. In an experimental study, the effect of drinking hydrogen-rich water on acceleration of oral wound healing through antioxidative defense activation by activation of NRF2 route was assessed in mouse and it was observed that hydrogen-rich water drink accelerates the process of oral wound healing in relation to the control group. (Tamaki, et al. 2015)

Researches in this field have also been conducted on the human society. Li *et al* in 2013 investigated the effect of using hydrogen rich water *via* feeding tube for bedsore patients and its remedial effects on the human skin cells. In this study, bedsore patients with the age range of 71 to 101 years daily drank 600ml of hydrogen-rich water. At the end of this study, it was demonstrated that use of hydrogen rich water *via* feeding tube, by elderly bedsore patients caused reduction of sore size and its speedy healing. In cellular tissue studies, these effects due to construction ability in collagen type I in the cutaneous fibroblast cells and acceleration of oxygen free radicals neutralization *via* mitochondria system was diagnosed in epidermal keratinocyte. (Ostojic, et al. 2014)

Considering the above studies, use of hydrogen-rich water can be considered as a novel strategy to improve and accelerate the repair of cutaneous damages.

Production of hydrogen-rich water with Alkaline Stick

One of the simple, cost-effective and safe routes for the production of hydrogen-rich water is use of alkaline sticks or magnesium stick. Fujita *et al.*, in 2009 showed that whenever stick containing magnesium beads is nestled in a half liter bottle, after 2 hours with production of 0.8 ppm hydrogen in water creates a similar antioxidative properties in relation to hydrogenated water systems containing



Austria



icseconf.com

٢١
١٣٩٥
International Conference on
**Science and
Engineering**
in the Technology Era

11
March
2017

کنفرانس بین المللی
مهندسی
در عصر تکنولوژی



1.5 ppm dissolved hydrogen in water. Meantime, the stability of hydrogen in water containing stick is relatively higher than the hydrogen bubble blower. (Fujita, et al. 2009)

In a study on the athletes *via* Ostojic and associates in 2014, the effect of two weeks consumption of hydrogen-rich water produced *via* alkaline stick by 26 athletes having soft tissue damage was assessed and showed that drinking of water produced *via* alkaline stick with reduction of soft tissue inflammation and improvement of reperfusion causes healing acceleration of tissue damages. Besides, nil side-effects were reported in the users. Accordingly, it can be concluded that alkaline stick *via* reperfusion could even be effective in healing of cutaneous damages. (Ostojic, el. 2014)

Rheumatoid arthritis is a chronic inflammatory disease with destruction of bone and cartilage. Although its cause is unknown, but free radicals have a role in its pathogenesis. In a study that was carried out *via* Ishibashi and associates in the Rheumatology and Orthopedic Surgery Department in the Haradoi Hospital of Japan, twenty patients suffering from rheumatism for a period of 4 weeks daily drank 530 ml of hydrogen-rich water. The hydrogenated water was produced *via* chemical reaction of stick containing alkaline metals with water:



The results showed that hydrogen-rich water effectively reduces the oxidative stress in the patients suffering from this disease. The rheumatoid arthritis symptoms significantly improved with the consumption of water produced *via* alkaline stick. (Ishibashi, et al. 2012) Thus, these anti-inflammatory effects can even be used in the cutaneous inflammations.

As it was mentioned earlier the unwanted radiations cause oxidative stress and hydrogen-rich water with reduction of free radicals reduces the destructive effects of radiation. In a study *via* Kang *et al.*, in 2011, the protective effect of radiation therapy using hydrogen-rich water was assessed on the life quality of liver cancer patients. In this study, 49 patients having malign liver tumor were treated with alkaline water produced *via* stick containing alkaline metals and at the end it was concluded that use of hydrogen-rich water for a period of 6 weeks caused reduction of active oxygen metabolites in the blood besides maintenance of blood oxidation potential. The life quality scores during the radiation therapy in the patients' treated with hydrogen-rich water significantly improved in relation to the patients that received radiation with drug. Finally it was concluded that daily use of hydrogen-rich water produced *via* stick containing alkaline metals, is a novel potential therapeutic strategy for the improvement of life quality after the exposure to radiation. (Kang, et al. 2011) considering the protective effect of alkaline stick against the unwanted radiations side-effects this product can as well be used for the reduction of cutaneous side-effects created *via* UV radiation.

Conclusion

Review of this information by searching for key words Alkaline Water, Ceramic Ball, Skin Care, Hydrogen Rich Water, Reduced Water published in scientific resources, such as databases, Science Direct, Springer Link, IEEE, Wiley Inter science, ACS, ACM, ASCE done. Alkaline water with active hydrogen and mineral nanoparticles has a high antioxidant power. Hence, in some papers referred to as hydrogen-rich water.

The entire studies have stressed on its effectiveness and safety. Whenever alkaline stick is positioned in a half liter water bottle, after 1 to 2 hours ionizes the water and produces active hydrogen. The produced hydrogen in the form of bubbles is observable surrounding the stick. Alkaline sticks have a simple usage and is produced and supplied *via* several valid companies in the world.

In all the above studies, the positive and salutary effects of hydrogen-rich water on skin tissue have been stressed. These effects take place *via* reduction of unwanted inflammations with direct action on the routes of messaging and regulation of inflammatory factors. Similarly, these effects can accelerate reperfusion in the skin tissue and increase the speed of cutaneous lesions repair. The anti-aging experiments of hydrogen-rich water on skin that was conducted *via* Korea Cosmetic Association, the most validated skin cosmetic association in Asia, was a confirmatory stamp on the salutary effects of this product. Therefore, use of the above product seems imperative for skin health and esthetic.



Austria



icseconf.com

٢١
١٣٩٥
11 March
2017

International Conference on
Science and
Engineering
in the Technology Era

کنفرانس بین المللی
مهندسی
در عصر تکنولوژی
۹



Acknowledgment

Thanks to the **Neutron Health Groups** for collecting of articles, “**Alkaline Stick**” is a portable filter supplied by the neutron health group that is approved according scientific studies, (Moradi and Farahani, 1394) have been prepared, when place it in water to give alkaline metal ions (Ca, Mg, ...) to the water raise the pH and can be effective according lots of the studies. Also, that is a good alternative to produce alkaline water in future studies.

Reference

- Fujita, Kyota, Toshihiro Seike, Noriko Yutsudo, Mizuki Ohno, Hidetaka Yamada, Hiroo Yamaguchi, Kunihiko Sakumi et al. (2009). Hydrogen in drinking water reduces dopaminergic neuronal loss in the 1-methyl-4-phenyl-1, 2, 3, 6-tetrahydropyridine mouse model of Parkinson's disease. *PLoS One*, Vol. 4, No.9, e7247.
- Guo, Ze, Bingrong Zhou, Wei Li, Xuejun Sun, and Dan Luo. (2012) "Hydrogen-rich saline protects against ultraviolet B radiation injury in rats." *Journal of biomedical research* Vol. 26, No. 5: 365-371.
- Hanaoka, K. (2001). Antioxidant effects of reduced water produced by electrolysis of sodium chloride solutions. *Journal of Applied Electrochemistry*, 31(12), 1307-1313.
- Ignacio, Rosa Mistica C., Hyun-Suk Kwak, Young-Uk Yun, Ma Easter Joy V. Sajo, Yang-Suk Yoon, Cheol-Su Kim, Soo-Ki Kim, and Kyu-Jae Lee. (2013). "The drinking effect of hydrogen water on atopic dermatitis induced by Dermatophagoïdes farinae allergen in NC/Nga mice." *Evidence-Based Complementary and Alternative Medicine* 2013
- Ignacio, Rosa Mistica, Yang-Suk Yoon, Ma Easter Joy Sajo, Cheol-Su Kim, Dong-Heui Kim, Soo-Ki Kim, and Kyu-Jae Lee. (2013) "The balneotherapy effect of hydrogen reduced water on UVB-mediated skin injury in hairless mice." *Molecular & Cellular Toxicology* Vol. 9, No. 1: 15-21.
- Ishibashi, Toru, Bunpei Sato, Mariko Rikitake, Tomoki Seo, Ryosuke Kurokawa, Yuichi Hara, Yuji Naritomi, Hiroshi Hara, and Tetsuhiko Nagao. (2012) "Consumption of water containing a high concentration of molecular hydrogen reduces oxidative stress and disease activity in patients with rheumatoid arthritis: an open-label pilot study." *Medical gas research* Vol. 2, No. 1: 27.
- Itoh, Tomohiro, Yasunori Fujita, Mikako Ito, Akio Masuda, Kinji Ohno, Masatoshi Ichihara, Toshio Kojima, Yoshinori Nozawa, and Masafumi Ito. (2009) "Molecular hydrogen suppresses FcεRI-mediated signal transduction and prevents degranulation of mast cells." *Biochemical and biophysical research communications* 389, No. 4: 651-656.
- Kang, Ki-Mun, Young-Nam Kang, Ihil-Bong Choi, Yeunhwa Gu, Tomohiro Kawamura, Yoshiya Toyoda, and Atsunori Nakao. (2011) "Effects of drinking hydrogen-rich water on the quality of life of patients treated with radiotherapy for liver tumors." *Medical gas research* Vol. 1, No. 1: 11.
- Kato, Shinya, Yasukazu Saitoh, Keizou Iwai, and Nobuhiko Miwa. (2012) "Hydrogen-rich electrolyzed warm water represses wrinkle formation against UVA ray together with type-I collagen production and oxidative-stress diminishment in fibroblasts and cell-injury prevention in keratinocytes." *Journal of Photochemistry and Photobiology B: Biology* Vol. 106: 24-33.
- Kim Eun Joo, & Gang Sang Mo. (2016) "The Effect of Hydrogen Rich Water intake on 40's ~ 60's Women's Neck Skin." *journal of the korean society of cosmetology* Vol. 22, No. 6: 1352-1360.
- Kim, H. W. (2002). *The Reason of Every Disease, Definition of Active Oxygen, "The Best Water for Human Body"*, 60-62, Seoul.
- Lademann, J., S. Schanzer, M. Meinke, W. Sterry, and M. E. Darvin. (2011). Interaction between carotenoids and free radicals in human skin. *Skin pharmacology and physiology*, Vol. 24, No. 5, 238-244.
- Li, Qiang, Shinya Kato, Daigo Matsuoka, Hiroshi Tanaka, and Nobuhiko Miwa. (2013) "Hydrogen water intake via tube-feeding for patients with pressure ulcer and its reconstructive effects on normal human skin cells in vitro." *Medical gas research* 3, No. 1: 20.
- Mei, Ke, Sanhu Zhao, Liren Qian, Bailong Li, Jin Ni, and Jianming Cai. (2014): "Hydrogen protects rats from dermatitis caused by local radiation." *Journal of Dermatological Treatment* Vol. 25, No. 2 182-188.
- Moradi, Behrooz and Farahani Hamed, (1394) Antioxidant properties of Alkaline Stick, International Conference on Research in Engineering, Science and Technology, Istanbul, Institute of Modiran ideh-pardaz paytakht vira, , http://www.civilica.com/Paper-RSTCONF01-RSTCONF01_662.html
- Ohsawa, Ikuroh, Masahiro Ishikawa, Kumiko Takahashi, Megumi Watanabe, Kiyomi Nishimaki, Kumi Yamagata, Ken-ichiro Katsura, Yasuo Katayama, Sadamitsu Asoh, and Shigeo Ohta. (2007) "Hydrogen acts as a therapeutic antioxidant by selectively reducing cytotoxic oxygen radicals." *Nature medicine* Vol. 13, No. 6: 688-694.



Austria



icseconf.com

٢١

١٣٩٥

11
March
2017

International Conference on
**Science and
Engineering**
in the Technology Era

کنفرانس بین المللی
مهندسی
در عصر تکنولوژی



- Ostojic, Sergej M., Boris Vukomanovic, Julio Calleja-Gonzalez, and Jay R. Hoffman. (2014) "Effectiveness of oral and topical hydrogen for sports-related soft tissue injuries." Postgraduate medicine Vol. 126, No. 5: 188-196.
- Qian, Liren, Fei Cao, Jianguo Cui, Yuecheng Huang, Xiaojian Zhou, Shulin Liu, and Jianming Cai. (2010) "Radioprotective effect of hydrogen in cultured cells and mice." Free radical research Vol. 44, No. 3: 275-282.
- Shimouchi, Akito, Kazutoshi Nose, Mikiyasu Shirai, and Takaharu Kondo. (2012). Estimation of molecular hydrogen consumption in the human whole body after the ingestion of hydrogen-rich water. In Oxygen Transport to Tissue XXXIII (pp. 245-250). Springer New York. Chicago
- Shin, Mi Hee, Raeeun Park, Hideo Nojima, Hyung-Chel Kim, Yeon Kyung Kim, and Jin Ho Chung. (2013) "Atomic Hydrogen Surrounded by Water Molecules, H (H₂O)_m, Modulates Basal and UV-Induced Gene Expressions in Human Skin In Vivo." PloS one Vol. 8, No. 4: e61696.
- Shirahata, Sanetaka, Takeki Hamasaki, and Kiichiro Teruya. (2012). Advanced research on the health benefit of reduced water. Trends in Food Science & Technology, Vol. 23, No. 2, 124-131.
- Tamaki, Naofumi, Rita Cristina Orihuela-Campos, Makoto Fukui, and Hiro-O. Ito. (2015) "Hydrogen-rich water intake accelerates oral palatal wound healing via activation of the Nrf2/antioxidant defense pathways in a rat model." Oxidative medicine and cellular longevity 2016.
- Watanabe, Sadahiro, Masanori Fujita, Masayuki Ishihara, Shoichi Tachibana, Yoritsuna Yamamoto, Tatsumi Kaji, Toshio Kawauchi, and Yasuhiro Kanatani. (2014) "Protective effect of inhalation of hydrogen gas on radiation-induced dermatitis and skin injury in rats." Journal of radiation research Vol. 55, No. 6: 1107-1113.
- Yoon, Yang-Suk, Ma Easter Joy Villarosa Sajo, Rosa Mistica Coles Ignacio, Soo-Ki Kim, Cheol-Su Kim, and Kyu-Jae Lee. (2014) "Positive Effects of hydrogen water on 2, 4-dinitrochlorobenzene-induced atopic dermatitis in NC/Nga mice." Biological and Pharmaceutical Bulletin Vol. 37, No. 9: 1480-1485.
- Zhao, Ling, You-bin Wang, Shi-rui Qin, Xue-mei Ma, Xue-jun Sun, Ming-lian Wang, and Ru-gang Zhong. (2013) "Protective effect of hydrogen-rich saline on ischemia/reperfusion injury in rat skin flap." Journal of Zhejiang University Science B. Vol. 14, No. 5: 382-391.