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Changes in the electrical conductivity, infrared absorption, and surface tension of partially-degassed and magnetically-treated water

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ABSTRACT

Although the properties of magnetically-treated water (MTW) have received a great deal of interest in recent years, the physical changes exhibited by MTW remain controversial. During the magnetic treatment (MT) of distilled-deionized water, it was found that a significant amount of gas was lost. We suspected that the physical properties of water, including conductivity, infra-red (IR) absorption, and surface tension might be affected by this gas loss, and thus, experiments were performed using MTW made using water partially degassed by sonication in order to maintain low gas levels during the MT process. Real time measurements of conductivity, IR absorption, and surface tension of MTW made using partially-degassed water consistently showed lower conductivity, greater IR absorption, and less surface tension than MTW made using non-degassed water. These findings indicate that the MT of water molecules can be interfered by the levels of gas molecules in non-degassed water. Our findings suggest that the physical properties of MTW should be measured at low gas level similar to that after MT.

1. Introduction

All materials on earth, including living organisms, are exposed to the geomagnetic field, and recently, exposures to magnetic fields (MFs) have been increased by the advent of techniques, such as, magnetic resonance imaging [1,2]. Moreover, the effects of MFs on aqueous solutions and biomaterials have been competitively investigated in various disciplines [3–5].

Because water molecules are relatively sensitive to MFs due to the proton spin flipping [6,7], it has been established that the physicochemical properties of water are changed by exposure to MFs. Water is diamagnetic [8], and shows increases in the cluster size [9], refractive index, and evaporation rate [10,11] when exposed to a MF. These effects are consistent with the weakening of van der Waals bonding between water molecules, due to increase in hydrogen bond strength [12,13].

The MT of water is caused by proton transfer in the closed hydrogen-bonded chains as determined by infrared (IR) and Raman spectroscopy [14]. MFs affect the IR spectrum of water by changing water cluster, and these effects remain for a considerable time after the MF is removed [15]. The protracted nature of the effects of magnetic and electromagnetic radiation on the properties of water is intriguing, for example, water restructuring after exposure to infrared radiation persists for more than a day [16–19], and has given rise to the term 'memory' phenomenon.

Reported changes in the conductivity of water are controversial [5,14,17,20–27]. For example, some have reported that the conductivity of water is increased by MT [14,17,24–26], whereas others have reported converse findings [5]. These discrepancies appear to have been caused by the use of different methods of producing a MF, by the use of alternating MFs, and by using water containing different types and levels of impurities.

It was reported that the water structure can be disrupted by the polarizability of dissolved gasses, and that it will be recovered by degassing, thus more hydrophobic liquid droplets were dispersed into degassed water than non-degassed water [28]. We also found that the ability of MTW to solubilize gasses is lower than that of non-MTW as shown as shown elsewhere [29], suggesting that studies on the physical properties of water should always consider the possible effects of dissolved gasses. In the present study, we investigated the conductivity changes caused by MT of partially-degassed water to prevent dissolved gas levels interfering with the physical properties, that is, conductivity, infra-red absorption, and surface tension.

2. Experimental

2.1. Preparation of MTW

A pulsating 800 G (Gauss/Tesla meter, 4048F.W. Bell, Orlando, USA), 7 Hz electromagnetic field was produced by supplying a solenoid coil with rectangular direct current at 150 V (Fig. 1A and B). A preliminary study confirmed that a pulsating electromagnetic field produces MTW

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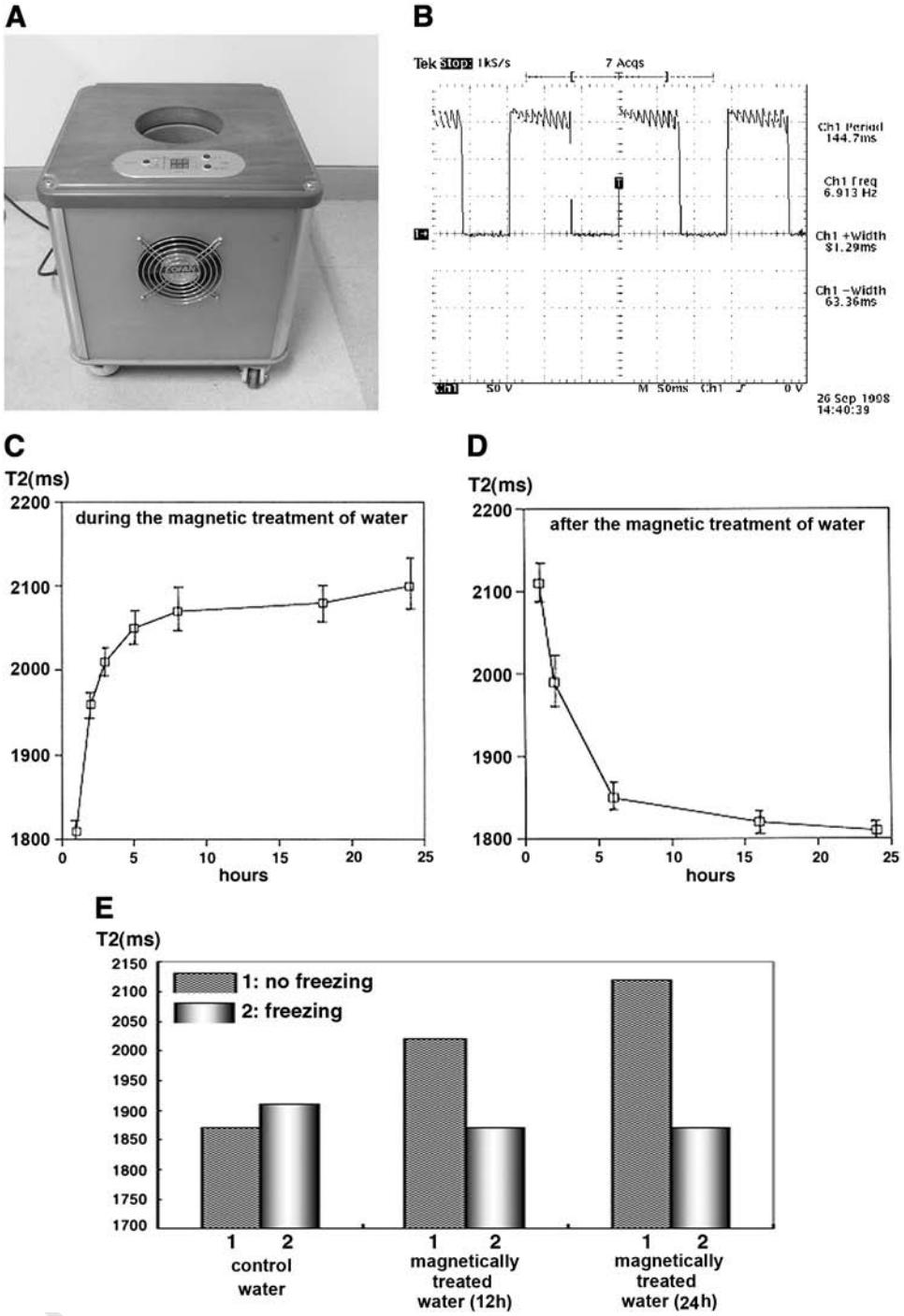

Fig. 1. Electromagnetic apparatus (A) used to produce MTW and the NMR effect of MTW (C–E). B: Oscilloscopic data obtained from the MT apparatus revealed a 7 Hz unipolar electric current at ~150 V. C: Gradual increase of T2 relaxation time during magnetic treatment of water for 24 h. D: When MTW stood at 25 °C for 24 h, the T2 relaxation times gradually relapsed to the normal range. E: The increase in T2 relaxation time shown by MTW depended on MT time, and was abruptly reduced to the normal range by freezing.

more efficiently than a static electromagnetic field [22,23]. The chamber of the field generating unit maintained at 25 °C with a cooling fan.

Before the experiment distilled–deionized water was produced using a water purification system (Aqua 312N, Young-Lin Co. Korea, and Millipore, Bedford, MA, USA) and then partially-degassed using an ultrasonic unit (3510R-DTH, BRANSONIC, USA) for 30 min. The partially-degassed water which had a dissolved oxygen (DO) level (7.40–7.45 mg/L) was poured into a 500 mL glass bottle such that the bottle was completely filled, and then the bottle was closed and exposes to a MF for 24 h. Whereas the non-degassed water as a control was also poured into a 500 mL glass bottle such that the bottle was completely filled, and then the bottle was closed. Both of magnetically-treated and control water samples were equilibrated in a water bath at 25 ± 0.01 °C under precise microprocessor control, and immediately used for the following experiments.

2.2. Spin–spin (T2) relaxation time changes caused by magnetic treatment of water

Because the T2 relaxation time of water is sensitive to dissolved O_2 concentration and temperature, the partially-degassed water was used to prepare MTW. The water samples were equilibrated at 25 ±