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Original Article

Water Treatment by Magnetic Field Increases Bone Mineral Density of Rats

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Abstract

Water treatment using a magnetic field is an attractive but controversial issue with regard to its effects on human health. This study aimed to investigate the effects of water treatment using a magnetic field on the bone mineral density (BMD), bone mineral content (BMC), bone area (BA), bone resistance (BR), blood gas analysis, blood viscosity, and blood biochemical profile of rats. Forty-eight Wistar rats were divided into 2 groups: control (n = 24) and magnetic water-treated (n = 24). Each of these groups was subdivided into 3 groups to evaluate 3 consumption periods (15, 30, and 45 d). The animals were kept in metabolic cages throughout the experiment. A completely randomized design distributed to a 2×3 factorial arrangement was used. No significant difference was found in the water intake, dry matter intake, BA, or femoral head resistance between the groups. However, higher anion gap and lower $CHCO_3$ were found in the arterial blood of the magnetic water-treated group. There was significant interaction between the water consumption period and the BR, BMD, and BMC. With 15 d of consumption, there was no difference in the BMC and BR. With 30 d of consumption, the BR (midshaft), BMD, and BMC showed increases; the increases were greater with 45 d of consumption. In adulthood, every month of the animal is approximately equivalent to 2.5 human years. The consumption of water treated by magnetic field for 45 d provided an effective way to improve BMD, BMC and BR in rats.

Key Words: Blood biochemical; blood gas; blood viscosity; drinking water; magnetic field.

Introduction

Although magnetism is widely used in the fields of physics, industry, and commerce and its remarkable effects on metals have been known for centuries, there are no conclusive studies on the implications of magnetism on living organisms. However, the Earth is a giant natural magnet that transmits magnetic energy to all living organisms *(1)*. The development of life is linked to magnetic radiation. Therefore, plants and animals are affected, for better or for worse, by this inevitable phenomenon *(1)*. One of the applications of magnetism in living organisms is through magnetic water treatment.

Published data on magnetic water treatment are often contradictory, but a physically modified liquid with lower surface tension and higher electrical conductivity, solubility, coagulation, and crystallization has been found *(2,3)*.

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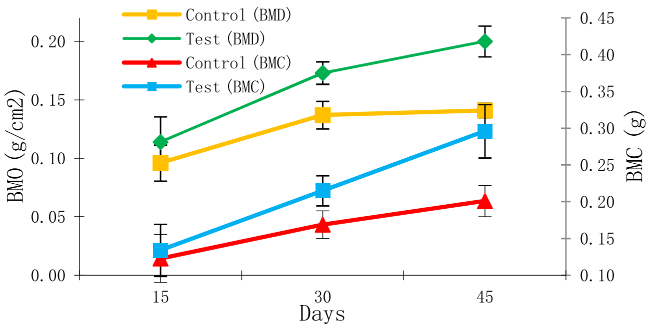

Fig. 1. Bone mineral density (BMD, g/cm^2) and bone mineral content (BMC, g) of rats drinking magnetically treated water.

From the biological point of view, according to Coey and Cass *(4)*, the influence of the treatment persists for more than 200 h. This persistence of the effects of magnetic treatment exerts effects on the body after water intake (WI) and is lighter, purer, and smoother compared with water in the normal state. These changes favorably affect the blood flow *(5)*. Tao and Huank *(5)* observed that after the blood was exposed to a magnetic field of 1.33 T parallel to the direction of flow for 1 min, the viscosity dropped from 5.7 cSt to 4.37 cSt (23.3%). They believed that this decrease in the viscosity could be beneficial for blood flow in all kinds of blood vessels. There has also been extensive experimental and theoretical research to determine the magnetic properties of red blood cells. It is generally accepted that red blood cells are paramagnetic with a magnetic susceptibility. Therefore, a strong magnetic field induces dipolar interaction, which causes the aggregation of red blood cells.

Levy et al *(6)* observed lower levels of fat in the meat from calves consuming magnetic water. On the other hand, Al-Mufarrej et al *(2)* did not observe any differences in the composition of the carcass of broilers that were made to consume magnetic water. Patterson and Chestnutt *(7)* observed a reduction in dry matter intake (DMI) and poorer feed conversion in lambs, whereas Sargolzehi et al *(8)* did not find any significant differences in the ions and metabolites of blood in lambs.

There are many relationships among blood gas, biochemical profile, viscosity, and other parameters, which help elucidate the mechanisms underlying the effects of magnetic water on bone densitometry. The purpose of the present study was to investigate the effects of magnetic water treatment on the bone mineral density (BMD, g/cm^2), bone mineral content (BMC, g), bone area (BA, cm^2), bone resistance (BR, kN/m), blood gas analysis (bicarbonate, mmol/L; anion gap, mOsm/kg), blood viscosity, and blood biochemical profile of rats (Fig. 1).

Materials and Methods

This study was carried out at the São Paulo State Agency Agribusiness Technology, Secretary of Agriculture and Food Supply (APTA-SAA-SP), Department of Basic Science and Department of Veterinary Pathology, São Paulo State University (UNESP), SP—Brazil.

Forty-eight Wistar male rats were divided into 2 groups: control (n = 24) and magnetic water-treated group (n = 24). Each of these groups was further subdivided into 3 subgroups (n = 8) and paired by body weight to evaluate 3 consumption periods (15, 30, and 45 d) in 8 replicates. All the animal experiments were performed under approved conditions in accordance with protocols approved by the Institutional Animal Care and User Committee from APTA-SAA (CEEA/IZ 0178/2013). A completely randomized design with 2 treatments and 3 consumption periods, distributed to a 2×3 factorial arrangement, was used.

The animals were fed with the same ration during the experimental period (Table 1). The water treatment was performed using a commercial magnetic conditioner (Sylocimol; Timol, Uberlândia, Brazil) designed to generate a strong magnetic monopole field of 32,000 Gauss. These devices were inserted into the water troughs of the metabolic cages. The water chemical composition was analyzed according American Public Health Association *(9)*, and dissolved oxygen was analyzed according to the Winkler method *(10)* (Table 2). The samples were collected after pumping the wells for 15–20 min and by subsequent filtering through 0.45 µm membranes. The analyzed parameters include the activity of hydrogen ion concentration (pH), turbidity, total hardness (TH) and important cations like Calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+) and anions like carbonate, Chloride (Cl^-), Nitrate (NO^{3-}), Sulfate (SO_4^{2-}) and Fluoride (F^-). The pH were measured using pH meters. Calcium (Ca^{2+}) and magnesium (Mg^{2+}) were determined titrimetrically using standard EDTA. Chloride (Cl^-) was analyzed by standard AgNO3- titration, carbonate by titration with HCl, sodium (Na^+) measured by flame photometry, sulfate (SO_4^{2-}) by systronics spectrophotometer. Nitrate and fluoride by Consort C933 electro chemical analyzer. A photometric method was used for the determination of Fe. The Determination of the Dissolved Oxygen is based on the addition of manganese II tetraoxosulphate vi solution followed by a strong alkali-iodide solution. In the presence of iodide ions in an acidic solution, the oxidized manganese reverted to the divalent state and librated iodine is equivalent to the original oxygen content.

The rats were kept in individual steel metabolic cages throughout the experiment. The initial average weight of the animals was 286 g; the weights of the animals increased to 357–390 g by the end of the experimental period. The rats were randomly assigned to individual steel metabolism cages equipped with stainless steel feeders and individual troughs. The average room temperature during the trial ranged between 22.8 ± 1.0°C (minimum) and 29.2 ± 2.4°C (maximum).

The BMD (g/cm^2), BMC (g), and BA (cm^2) of the right femur were measured using the DPX-Alpha Lunar®