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The therapeutic effect of magnetized and alkaline water intake on Ehrlich solid carcinoma in mice

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ABSTRACT

This study aimed to investigate the effect of magnetized and alkaline water on Ehrlich solid carcinoma (ESC) in mice. In addition to assess their antioxidant and anti-inflammatory activities. Twenty-eight CD1 mice were used, seven of them served as a control group (Gp1). The remaining mice were inoculation with Ehrlich ascites carcinoma (EAC) cells (2x10^6/mouse). Then, EAC bearing mice were divided into three groups (7 mice/each), as follows; a positive control (Gp 2), drunk the magnetized water (Gp3), and drunk alkaline water (Gp4). The results showed that the magnetized water significantly improved the lipid profile, liver, and kidney functions compared to the positive control. On the other hand, alkaline water decreased the serum levels of total triglycerides and alanine transaminase. However, it increased the serum levels of total cholesterol, low-density lipoprotein cholesterol, and serum urea. Regarding antioxidant activity, both waters decreased malondialdehyde and carcinoembryonic antigen while increasing reduced glutathione. Additionally, magnetized water significantly increased superoxide dismutase, whereas alkaline has no effect compared to positive control. The results showed that both magnetized and alkaline water significantly decreased the volume of the Ehrlich tumor in mice.

Key words: Alkaline water, Ehrlich solid carcinoma, Lipid profile, Liver functions, Magnetized water.

1. Introduction

Cancer is a group of malignant cell diseases that cannot be controlled. It is responsible for about 13% of all deaths worldwide (Hassan et al., 2023). Conventional cancer drugs have many side effects. The resistance of malignant cells to toxic and anticancer drugs has created a new problem, resulting in poor and unpredictable outcomes. As a result, we can return to natural remedies and use fruits and vegetables as cancer treatments. Ehrlich's ascites carcinoma (EAC) is one of the most common tumors. These tumors grow and multiply until they reach the stage of ascites. EAC resembles human malignant tumors. It is believed that using natural resources as an alternative treatment for cancer is of great value in combating it (Hemdan, 2022). Water is the most essential nutrient for growth and development. It is usual to search for beneficial foods, but few people realize that drinking water also has physiological reasons and some health benefits. According to food science and technology, water is vital for normal digestion and the development of healthy gut flora, which helps absorb all the required nutrients. Magnetization occurs when water is exposed to a magnetic field, and its microscopic composition and macroscopic properties change (Ibraheim and Khater., 2018). Magnetized water is made by passing water through a specially designed permanent magnet. The magnet may ionize and activate water molecules, changing their structure into a hexagonal shape, similar to the water in our bodies. The pH of magnetic water is 9.2, while the pH of regular water is 7. Water minerals change when exposed to a magnetic field, but how they change depends on the magnet's strength and exposure time.

Using magnets to improve water quality is more beneficial than chemical and physical treatments. Regularly drinking magnetized water will affect blood flow within the human body (Aboulfotoh et al., 2022). It is effective in treating various chronic conditions, including diabetes (caused by oxidative stress). It is worth noting that the study of the effects of magnetic fields on living organisms has increased in recent decades, especially in physics, biology, medicine, and agriculture (Hasaballah and Mabrouk, 2020). Many studies have shown that magnetized water has antioxidant properties, possibly due to the increased concentration of glutathione peroxidase in the blood (Zayed et al., 2018). It has also been shown that magnetized water can lower blood sugar levels while improving lipid levels and antioxidant status in streptozotocin-induced rat hearts, spleens, and lungs. Furthermore, magnetized water has been used to reverse the nephrotoxic effects caused by cisplatin, ferric acid, and gentamicin. The density of water varies in the presence of magnetic fields, depending on physics. More hydroxyl ions (OH) are generated to produce alkaline molecules (Jassim and Aqeel., 2017). Alkaline water is a type of water that has gentle, energetic, and combining characteristics of water as a cleaning agent. Most research on its potential health benefits has focused on digestive problems, and patients with gastric acidosis are advised to use it. The evidence has led to Japan approving alkaline water devices as medical devices. Much talk has been about how alkaline water affects tumor formation, but no meaningful research has been done in human or animal models. Fenton and Huang (2016) found no evidence for or against an acid load in the diet or alkaline water for cancer prevention or treatment. In addition to treating various conditions, such as stomach and intestinal problems common in Japan and Korea, alkaline water also serves as a treatment for blood pressure, diabetes, and cancer.

Magnetic water is an example of this type of water, which uses a similar mechanism and has many medical benefits to Zamzam water. It is also inexpensive, safe, and works well in preventing the activity of pathogens (Al-Janabi et al., 2016). A recent study discovered alkaline water can prevent a cultured breast cancer cell line from growing and multiplying (Gómez et al., 2021). This study aimed to assess the effects of magnetized and alkaline water on mice suffering from ESC and its related complications.

2. Materials and Methods

Chemicals

All chemicals and biochemical analysis kits were purchased by Sigma-Aldrich Company (Cairo, Egypt).

Ehrlich solid carcinoma induction

Viable Ehrlich solid carcinoma cells were obtained from the National Cancer Institute in Cairo, Egypt, to be injected intramuscularly about 2×10^6 viable Ehrlich tumor cells (200 µl) to induce ESC (Calixto-Campos et al., 2013; Abd-Alhaseeb et al., 2014; Mansour and Ibrahim, 2022). All treated animals showed palpable tumor growth ten days after the implant. The ESC animals were then divided into three cohorts (n = 7) in addition to the untreated control group of mice with no tumors.

Magnetized and alkaline water

A magnetization water device with magnetic strengths of 2500 gauss was obtained from the National Research Centre (NRC), Egypt. The device consists of an internal magnet covered outside by a steel shield with internal and external water channel openings. Tap water samples were taken from the study site before and after exposure to the magnetic field. 2.1.3

The alkaline water was sourced from a local market in Cairo, Egypt with a pH level ranging from 7.6 to 8. The electrolytes contents, measured in mg/L, were as follows: Calcium (Ca) 24, Magnesium (Mg) 0.84, Sodium (Na) 2.6, Potassium (K) 14, Bicarbonate (HCO_3) 29, Sulfate (SO_4) 0.4, Chloride (Cl-) 45, and Silica (Si) 1.0.

Animals and experimental design

Twenty-eight healthy adult male mice weighing (17-22g) were purchased from the National

Cancer Institute in Cairo, Egypt. Animal treatments were subjected to the ethical standards approved by the Scientific Research Ethics Committee of Mansoura University (No: 33-13/1/2022). The mice were housed for one week in rodent cages under standard environmental conditions (a vast, ventilated room with a 12-h light/dark cycle and a temperature of 25 ± 2 °C). During the acclimatization period of seven days, the mice were provided with a standard basal diet and had access to tap water *ad libitum*. Seven mice continued eating the basal diet and drinking tap water during the experiment, serving as a normal control (group 1). The remaining mice were administered the line of Ehrlich's solid carcinoma (ESC) cells by injecting about 2×10^6 viable Ehrlich tumor cells (200 µl) intramuscularly into each mouse's left thigh of the hind leg.

On the 10th day after transplantation, a solid tumor appeared, and the mice were then randomly divided into three groups, each containing seven mice. One group continued to drink tap water, which served as the positive control (Gp 2). Another group drank magnetized water instead of tap water (Gp 3), while the third group drank alkaline water instead of tap water (Gp 4). Over 28 days, weekly body weight and feed intake variations were registered. Body weight gain percentage (BWG%) and feed efficiency ratio (FER) were calculated (Chapman et al., 1959). The volume of each tumor was measured using the equation described by Goto et al. (2000)as follows: Volume (cm^3) = a x b^2 /2 where a is the length of the tumor (cm) and b is the width (cm). Twenty-eight days after the treatment, all mice were sedated with ether, and blood samples were taken by heart puncture after a night of fasting. According to Drury and Wallington (1980), serum samples were separated by centrifuging the blood at 5000 rpm for 10 min to collect serum. The samples were then kept frozen for subsequent processing. After that, all mice were sacrificed, and tissue samples were collected for further analysis and histopathology analysis.

Biochemical analysis

The total cholesterol (TC), triglycerides (TG), and high-density lipoprotein cholesterol (HDL-c) levels were determined using the methods outlined by Allain et al. (1974), Fassati and Prencipe (1982), and Lopes et al. (1977), respectively. Low-density lipoprotein cholesterol (LDL-c) and very low-density lipoprotein cholesterol (VLDL-c) were calculated according to Friedewald et al. (1972). Aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were measured according to the method described by Burtis et al. (1999). Serum creatinine and urea levels were determined colorimetrically using the methods outlined by Young (2001) for creatinine and Young (2000) for urea. Superoxide Dismutase (SOD), Glutathione Reduced (GSH) and Malondialdehyde (MDA) were determined by colorimetric methods using the kits of the Biodiagnostic company (Giza, Egypt) at 560, 405 and 534 nm according to Nishikimi et al. (1972), Beutler et al. (1963), and Ohkawa et al. (1979), respectively. Carcinoembryonic antigen (CEA) level was measured by the Roche Diagnostic kits (Gmbh, Mannheim) using Cobase 601 immunoassay analyzer as reported by Guder *et al*. (1996).

Data analysis

The collected data were presented (means ± S.D.), and statistical analysis was performed using one-way analysis of variance (ANOVA). The means between groups were compared using (LSD) statistic test at 5%, using the computer program (Costate), according to Gomez and Gomez (1984).

Statistical analysis

Means ± SD and percentages were among the descriptive statistical analyses carried out with Microsoft Excel 2023 (Microsoft Corp., USA). The Statistical Package for Social Sciences (SPSS v. 26, USA) software was used to perform additional statistical analyses. To determine the significances, a one-way ANOVA test was performed. P values below 0.05 were regarded as significant.

3. Results

Effect of magnetized and alkaline water on weight gain, feed intake, and efficiency ratio (FER) in mice

The data in Table (1) illustrates the initial weight, final weight, weight gain, feed intake and

FER in all the mice groups. No significant differences between the groups were observed concerning the initial body weight. Normal control recorded the highest final weight (28.88±1.65 g), weight gain percentage (44.27±14.22%), feed intake (2.63±0.15 g) and FER (0.119±0.025). In contrast, the positive control group showed significant decreases in the final body weight (20.48±1.60 g), weight gain percentage (11.69±9.41%), feed intake (1.86±0.15g), and FER (0.039±0.030) compared to the normal control. The magnetized water significantly increased weight gain percentage, feed intake, and FER. In contrast, the alkaline water group did not show significant differences in these parameters compared to the positive control, indicating that the magnetized water was more effective than the alkaline water.

Effect of magnetized and alkaline water on tumor volume in the mice with ESC

Table (2) shows that administering magnetized and alkaline water significantly decreased tumor volume in mice with ESC compared to the positive control for four weeks. Treatment of ESC mice with magnetized and alkaline water decreased the tumor volume gradually from the 2nd week to the fourth week. The reduction percentages in the tumor volume in mice treated with magnetized water were 40.68, 68.47 and 89.11% in the second, third and fourth week, respectively, while the reduction percentages in the mice treated with alkaline water were 25.77, 62.03 and 88.42 %, respectively compared to the positive control group. These results indicate that magnetized water is somewhat better than alkaline water at reducing tumor volume.

Effect of magnetized and alkaline water on lipid profile in the mice with ESC

Table (3) shows the results of blood total cholesterol (TC), triglyceride (TG), total low-density lipoprotein (LDL-c) and high-density lipoprotein (HDL-c) levels in the normal control, positive control and the treated groups. It was evident that the positive control group with ESC had significant increases in TC (208.75±5.62 mg/dl), TG (236.75±8.42 mg/dl), LDL-c (139.40±6.83 mg/dl) and lower concentration of HDL-c levels (22.00±2.94 mg/dl) compared to the normal control group. Whereas their levels were (96.50±4.38 mg/dl), (82.00±4.16 mg/dl), (43.35d±6.52 mg/dl) and (36.75b±4.19 mg/dl) in the normal control group, respectively. In the magnetized water group, the reduction percentages for TC, TG, and LDL-c levels were 44.43%, 42.77%, and 56.31%. In contrast, the increase percentage in HDL-c was 37.50 % compared to the positive control group injured with ESC. On the other hand, the group that consumed alkaline water exhibited a notable increase in TC levels, with an increase of 4.55%, a significant decrease in the levels of TG by 37.91% and a significant increase in the serum HDL-c level of 27.27% compared to the positive control group. The magnetized water was more effective than the alkaline water in improving the lipid profile in the mice with ESC.

Effect of magnetized and alkaline water on liver and kidney functions in the mice with ESC.

Data in Table (4) revealed the effect of Magnetized and alkaline water on liver and kidney function parameters in mice injured with ESC. The serum levels of ALT and AST increased significantly in the positive control group (359.25±12.76 and 375.00±6.98 U/L), as compared to the normal control (62.75±10.21 and 113.75±8.26 U/L), respectively. This means that the positive control group injured by ESC revealed impaired liver and kidney functions, as shown in the serum levels of creatinine and urea, which increased significantly in the positive control group compared to the normal control group. The group treated with magnetized water demonstrated significant decreases in ALT and AST levels, with reductions of 46.97% and 41.60%, respectively. Conversely, the group using alkaline water exhibited a significant decrease in serum ALT levels of 4.31% but showed no significant difference in AST levels compared to the positive control group. In the positive control mice, there were notable increases in the levels of serum creatinine and urea, which are indicators of kidney function. Their values reached 1.18±0.06 and 134.25±5.38 mg/dl, respectively, compared to the normal group (0.58±0.05 and 62.75±3.86 mg/dl, respectively). However, their levels decreased in the group treated with magnetized water. In terms of serum creatinine, the most important indicator of kidney function, the results revealed that the mice with cancer treated with magnetized water showed a significant decrease in serum creatinine level (0.72±0.09 mg/dl). In contrast, the serum creatinine level in the alkaline water group showed no significant change compared to the positive control group. The group treated with magnetized water showed a significant decrease in serum urea by 23.65% compared to the positive control group. In contrast, the alkaline water group showed a significant increase of 7.45%.

Table 1. Effect of magnetized and alkaline water on weight gain, feed intake, and efficiency ratio (FER) in mice.

Groups		Initial weight	Final weight	Weight gain (g)	Weight gain %	Feed intake	FER
Gp1		20.10^{a}±1.51	28.88^{a}±1.65	8.78^{a}±2.24	44.27^{a}±14.22	2.63^{a}±0.15	0.119^{a}±0.025
Gp2		18.48^{a}±2.69	20.48^{e}±1.60	2.00^{c}±1.58	11.69^{c}±9.41	1.86^{e}±0.15	0.039^{b}±0.030
Gp3		19.23^{a}±1.65	23.65^{cd}±1.80	4.43^{bc}±1.98	21.91^{bc}±10.72	2.15^{cd}±0.16	0.073^{ab}±0.029
	*	**4.06**	**15.51**	**121.25**	**87.39**	**15.51**	**85.36**
Gp4		19.28^{a}±2.38	21.68^{de}±1.86	2.40^{c}±1.67	13.03^{c}±8.97	1.97^{de}±0.17	0.044^{b}±0.029
	*	**4.33**	**5.86**	**20.00**	**11.45**	**5.86**	**11.13**

Results are presented as means ±SD. Values with different superscript letters in each column indicate significant differences at $p < 0.05$. (*): % of change related to positive control group (Gp2). Gp1: normal control, Gp2: ESC-bearing mice, Gp3: ESC-bearing mice/ drunk magnetized water, Gp4: ESC-bearing mice/ drunk alkaline water, FER: feed efficiency ratio

Table 2. Effect of magnetized and alkaline water on tumour volume in ESC-bearing mice.

Groups		Tumor volume (cm3)			
		1st week	**2nd week**	**3rd week**	**4th week**
Gp1		-	-	-	-
Gp2		0.087^{a}±0.064	2.864^{a}±0.625	3.600^{a}±0.653	4.326^{a}±0.815
Gp3	**Mean±SD**	0.120^{a}±0.091	1.699^{b}±0.307	1.135^{b}±0.235	0.471^{b}±0.242
	*	**37.93**	**-40.68**	**-68.47**	**-89.11**
Gp4	**Mean±SD**	0.116^{a}±0.063	2.126^{b}±0.256	1.367^{b}±0.199	0.501^{b}±0.097
	*	**33.33**	**-25.77**	**-62.03**	**-88.42**

Results are presented as means ±SD. Values with different superscript letters in each column indicate significant differences at $p < 0.05$. (*): % of change related to positive control group (Gp2). Gp1: normal control, Gp2: ESC-bearing mice, Gp3: ESC-bearing mice/ drunk magnetized water, Gp4: ESC-bearing mice/ drunk alkaline water.

Table 3. Effect of magnetized and alkaline water on lipid profile in ESC bearing mice.

Groups	TC (mg/dl)	TG (mg/dl)	HDL-c (mg/dl)	LDL-c (mg/dl)	VLDL-c (mg/dl)
Gp1	96.50^{d}±4.38	82.00^{d}±4.16	36.75^{a}±4.19	43.35^{d}±6.52	16.40^{d}±0.83
Gp2	208.75^{b}±5.62	236.75^{a}±8.42	22.00^{c}±2.94	139.40^{b}±6.83	47.35^{a}±1.68
Gp3	116.00^{c}±5.29	135.50^{c}±5.32	30.25^{b}±2.99	60.90^{c}±9.95	27.10^{c}±1.06
Gp4	218.25^{a}± 4.57	147.00^{b}±4.97	28.00^{b}±3.92	158.60^{a}±6.65	29.40^{b}±0.99

Results are presented as means ±SD. Values with different superscript letters in each column indicate significant differences at $p < 0.05$. (*): % of change related to positive control group (Gp2). Gp1: normal control, Gp2: ESC-bearing mice, Gp3: ESC-bearing mice/ drunk magnetized water, Gp4: ESC-bearing mice/ drunk alkaline water.TC: total cholesterol, TG: triglycerides, HDL: high density lipoprotein, LDL: low density lipoprotein, VLDL: very low-density lipoprotein.

Table 4. Effect of magnetized and alkaline water on liver and kidney functions in ESC bearing mice

Groups	ALT (U/L)	AST (U/L)	Creatinine (mg/dl)	Urea (mg/dl)
Gp1	62.7^{d}±10.2	113.5^{c}±8.2	0.58^{c}±0.05	62.7^{d}±3.6
Gp2	359.2^{a}±12.7	375.0^{a}±6.9	1.18^{a}±0.06	134.2^{b}±5
Gp3	190.5^{c}±8.1	219.0^{b}±11	0.72^{b}±0.09	102.5^{c}±5.9
Gp4	343.7^{b}±12.1	377.0^{a}±10	1.20^{a}±0.10	144.2^{a}±8.2

Results are presented as means ±SD. Values with different superscript letters in each column indicate significant differences at $p< 0.05$. Gp1: normal control, Gp2: ESC-bearing mice, Gp3: ESC-bearing mice/ drunk magnetized water, Gp4: ESC-bearing mice/ drunk alkaline water

Effect of magnetized and alkaline water on oxidative stress and CEA levels in mice with ESC.

The results in Table (5) showed the antioxidant parameters; Superoxide dismutase (SOD), reduced glutathione (GSH), and Malondialdehyde (MDA), in addition to carcinoembryonic antigen (CEA) in mice with ESC. The results indicated lower blood SOD activity in the positive control group (119.00±5.89 U/ml) compared to the normal control (259.50±10.25 U/ml). On the other hand, a significant decrease in serum GSH activity in the positive control group (1.83±0.09 mmol/l) was observed compared to the normal control (4.89±0.10 mmol/l). The treatment groups revealed significant increases in serum SOD and GSH with percentages of 31.30% and 31.69% in the magnetized water group and 8.61% and 29.78% in the alkaline water group, respectively, compared to the positive control group. The findings indicated a significant increase in blood MDA concentration level in the positive control (10.10±0.62 umol/L) compared to the normal control (2.93±0.46 umol/L). In the context of the carcinoembryonic antigen (CEA), a tumor biomarker, the results demonstrated that the positive control group exhibited a significant increase in its value (12.33±0.36 ng/mL) compared to the normal control group (2.45±0.24 ng/mL). The two ESC groups treated with magnetized water and alkaline water showed significant reductions in blood levels of MDA and CEA compared to the positive control group. Specifically, the magnetized water group experienced decreases of 56.31% in MDA levels and 46.00% in CEA levels, while the alkaline water group had reductions of 13.86% in MDA and 22.11% in CEA.

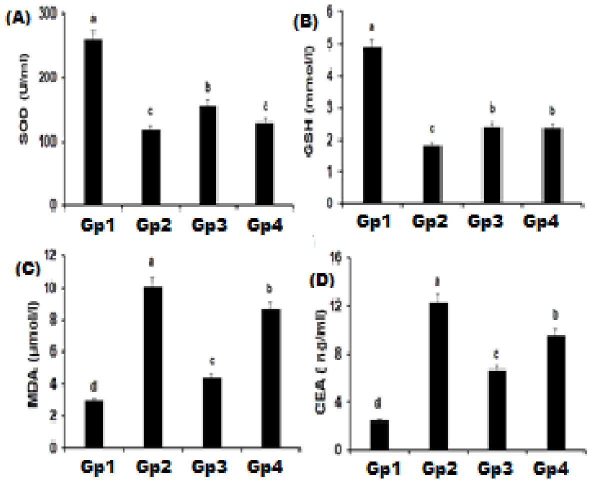

Figure 1. Effect of magnetized and alkaline water on oxidative stress and CEA in mice with ESC. Results are presented as means ±SD. Values with different superscript letters in each column indicate significant differences at $p< 0.05$. Gp1: normal control, Gp2: ESC-bearing mice, Gp3: ESC-bearing mice/ drunk magnetized water, Gp4: ESC-bearing mice/ drunk alkaline water

4. Discussion

Cancer comprises a group of diseases characterized by uncontrolled, malignant cell growth, accounting for approximately 13% of global deaths (Hassan et al., 2023). Traditional treatments frequently have significant side effects, and resistance to these therapies often leads to poor outcomes. Ehrlich's tumor is traditionally used in experimental oncology to investigate the effectiveness of various synthetic chemotherapy agents and to assess the antitumoral activity of different natural substances. This cancer model, which involves the induction of Ehrlich tumor cells, is widely utilized to understand tumorigenic, immunological, and physiological processes. It also helps in evaluating new diagnostic methods and therapeutic drug actions, as it closely resembles the pathological and behavioural processes related to human cancers (Doroshow, 2019). This study was conducted to investigate the effect of magnetized and alkaline water on

Ehrlich Solid Carcinoma in mice and its complications Water is the most essential nutrient for growth and development. It is common to search for beneficial foods, but few people realize that drinking water also has physiological reasons and some health benefits. According to food science and technology, water is vital for normal digestion and the development of healthy gut flora, which helps absorb all the required nutrients. Magnetization occurs when water is exposed to a magnetic field, and its microscopic composition and macroscopic properties change (Ibraheim and Khater., 2018). Magnetized water is made by passing water through a specially designed permanent magnet. The magnet may ionize and activate water molecules, changing their structure into a hexagonal shape, like the water in our bodies. The pH of magnetic water is 9.2, while the pH of regular water is 7.

Alkaline ionized water (AIW), produced through water electrolysis, is receiving increased attention for its potential health benefits in treating and preventing various diseases. Some studies indicate that AIW can help remove reactive oxygen species, improve digestion, reduce body fat, and protect against skin damage and oxidative diseases, primarily due to its negative oxidation-reduction potential and high hydrogen content (Ignacio et al., 2012). The results of this work revealed that in the group with ESC, the magnetized water significantly enhanced weight gain percentage, feeding intake, and feed efficiency ratio (FER). In contrast, alkaline water did not show notable differences from positive control, indicating that magnetized water was more effective. This result aligns with Alhazmi et al. (2021), who found that mice that drank magnetized water had a significantly higher weight gain than the control group.

Administering magnetized and alkaline water to mice with ESC significantly reduced tumor volumes over four weeks. Mice treated with magnetized water showed a reduction percentage of 89.11% by the fourth week, while those given alkaline water experienced a reduction percentage of 88.42%. These results are promising. It was observed that magnetized water was more effective than alkaline water in improving the lipid profile of mice with ESC. Our results support the findings of Hanafy et al. (2020), who discovered that the group treated with magnetized water showed significant effectiveness in increasing HDL-c and reducing TC, TG, LDL-c, and VLDL-c levels compared to the untreated group. The results are consistent with Zayed et al. (2018), who investigated the effect of Ginkgo biloba and magnetized water (GB and MW) on hyperlipidaemia in type 2 diabetic rats. They observed increased HDL-c and decreased LDL-c after GB and MW treatment compared to untreated diabetic rats. Hypercholesterolemia in diabetic rats is mainly caused by increased LDL-c and triglycerides. So, they found that cholesterol and triglyceride levels decreased to almost normal values after Ginkgo biloba and magnetized water administration to diabetic rats. Our results are consistent with those of Higashimura et al. (2018) who stated that the serum of mice administered with alkaline electrolyzed water (AEW) exhibited significantly reduced serum LDL-c activity. No appreciable difference in HDL-c level, TG, and TC activity was noticed with the AEW group.

An improvement in liver enzymes (ALT and AST) and kidney function parameters (creatinine and urea) was observed in the ESC mice treated with magnetized and alkaline water. The findings align with those of Ibrahim et al. (2022), who discovered that inoculating mice with Ehrlich carcinoma cells led to liver dysfunction and metabolic disturbance. They observed a significant increase in serum creatinine and urea levels in mice injected with Ehrlich carcinoma cells compared to the control group. Our results agree with the findings of Alhazmi et al. (2021) who found statistically significant differences in serum ALT and AST. Our study showed that mice drinking magnetized water had significantly lower serum ALT and AST levels than mice that received tap water. This result is consistent with Higashimura et al. (2018), Who reported that the alkaline water-treated animals had considerably decreased serum ALT activity and had no significant difference in AST activity compared to the control groups.

The present results indicated that magnetized and alkaline water increased blood levels of the superoxide dismutase (SOD) enzyme and glutathione while reducing malondialdehyde

(MDA) levels compared to the positive control. According to a study by Hanafy et al. (2020), magnetized water effectively influences the oxidant-antioxidant balance. This includes reducing the levels of MDA, increasing SOD and glutathione peroxidase activity in the heart, kidney, and liver, and lowering the levels of nitric oxide. These effects collectively result in a reduction in oxidative stress. The findings of Alhazmi et al. (2021) suggested that mice consuming magnetized water showed the highest GSH level. There was a statistically significant difference in the activity of antioxidant enzymes catalase and SOD between the group of mice consuming magnetized water and those consuming tap water, with a significantly higher level of both enzymes present in the magnetized water group. In the liver homogenate, mice consuming magnetized water exhibited significantly higher catalase, GSH-Px, and SOD activities compared to those consuming tap water. Similarly, in the kidney homogenate, mice consuming magnetized water had substantially higher catalase and GSH-Px activities than the tap water-consuming group. The findings support the results of Zayed et al. (2018), who found that the levels of glutathione reductase and SOD were comparable to the control group after administering Ginkgo biloba and magnetized water (GB and MW) to rats. Their study demonstrated that GB and MW treatments could decrease renal oxidative stress in diabetic glomeruli. Yacout et al. (2015) found that drinking magnetic water resulted in higher glutathione peroxidase (GSH-Px) and superoxide dismutase (SOD) activities compared to nonmagnetic water consumption.

It was observed that all cancer groups treated with magnetized water and alkaline water experienced significant decreases in the tumor marker (CEA) levels in the blood compared to the positive control group. Understanding the mechanisms behind the Warburg effect could lead to innovative cancer treatment strategies that specifically target cancer cells' unique metabolic characteristics such as using alkaline water or magnetized water, which are alkaline in nature. This alkaline water decreases the acidity environment necessary for cancer growth and hence prevents cancer progression (Netanya and Robert, 2019).

Magnetized water has higher pH and electric conductivity compared to general drinking water (Xu and Sun, 2008). Some study results have presented that the magnetization of water increased the permeability through cell membranes (Gonet, 1985, Lednev, 1991) and that the magnetic field directly affected intracellular fluid and intracellular substances to activate enzymes inside the cells and accelerated biochemical reactions in the body (Liboff et al., 2003). Thus, it is possible that drinking magnetized water activates antioxidant enzymes in the body and reduces DNA damage, but the detailed mechanism of how the magnetized water can reduce DNA damage is not yet known.

In cancer research, it's important to examine changes in the water structure around malignant cells. Studies using nuclear magnetic resonance (NMR) spectroscopy have shown that protons in the water surrounding tumors have a longer spin-lattice relaxation time than those near-normal cells. This indicates that water molecules in tumors are less structured and can move more freely. This difference may be significant in understanding cancer, but more research is needed to explore its potential for early diagnosis. Monitoring changes in the magnetic properties of water in tumors during chemotherapy and other treatments could also be valuable for evaluation (John and Löwdin, 1987).

Conclusion

The study demonstrated that both magnetized and alkaline water can significantly improve human and animal health. There was a notable reduction in tumor size and an improvement in oxidative stress associated with Ehrlich's tumor. Additionally, magnetized water improved blood lipids, decreasing serum TC, TG, LDL-c, and VLDL-c levels while increasing HDL-c levels. Moreover, liver enzymes (ALT and AST) and kidney function parameters (creatinine and urea) showed positive improvements. The magnetized water outperformed alkaline water in reducing inflammatory factors. It is recommended to include magnetized water in the daily diet as a preventive measure against various diseases and to promote overall human health.

Conflict of interest

The authors declare no conflict of interest.

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