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PARAMETERS AND EFFECTS OF MAGNETIC FIELD AND POTASSIUM CARBONATE IN WATER. APPLICATIONS

The polar water molecule has an angle between the two-hydroxyl O–H bonds of 104.5°. The unequal sharing of electrons gives a slight negative charge near the oxygen atom and a slight positive charge near the hydrogen atoms of the water molecule. Water is a polar solvent. Hydrogen electromagnetic bonds are formed between water molecules. They involve hydrogen atoms from one water molecule and oxygen from another one. A permanent magnetic field influences the formation of hydrogen bonds between water molecules. Current research by Wu and Brant, 2020 illustrates that the water conductivity at the magnetic induction $B = 13500$ *or 1.35 T increases from 100 to 250* $\mu S\cdot cm^{-1}$*. The amount of protons in water* (H^+) *decreases with the water alkalization and increasing pH. The work by Yap and co-authors' indicates that stronger effects on pH, oxidation-reduction potential (ORP), and dissolved oxygen (DO) are observed in the non-reversed polarity of the magnets. Our study uses a constant magnet with the magnetic induction* $B = 3000$ *G or 0.3 T; eight permanent magnets are applied to 1000 L of water. Potassium carbonate* (K_2CO_3) *is also added, by increasing the alkalinity of water. The application is in livestock as drinking water for sheep and goats.*

Keywords: magnetic field, water, potassium carbonate, animal husbandry.

1. Introduction

For pure distillated water, the magnetic field reorients the proton (H^+) spin [1]. The electric conductivity with the influence of a magnetic field increases [2]. In 2012, Coey proposed an explanation of the effects in water impacted by a magnetic field with dynamically ordered liquid-Like oxyanion polymers (DOLLOP) (3). With DOLLOP, it was shown that the gradient of the magnetic field is more essential for the effect than magnetic strength. Magnetic field impacts the reorganization and the structuring of electromagnetic hydrogen bonds [4, 5].

Water with ions subjected to a magnetic field affects ions [6]. The speed of ions toward the S and N magnetic poles increases, and, accordingly, the conductivity. The magnetic poles are arranged non-reversed, when water is activated with a permanent magnetic field. In a non-reversed scheme, where the

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Table 1. **Parameters are in our studies for physicochemical analysis in Bulgarian State Standard (BDS), ISO, Ordinance No. 9/2001, and additional parameters, which are not included in Ordinance No. 9/2001**

Parameter	Standard	Measuring unit	Maximum limit value
1. pH	BDS EN ISO 10523: 2012	pH values	≥6.5 and ≤9.5
2. Electrical conductivity	BDS EN 27888: 2000	$\mu S \cdot cm^{-1}$	2000
3. Calcium (Ca^{2+})	BDS ISO 9964-3 2002	$mg \cdot L^{-1}$	150
4. Sodium (Na^{+})	BDS ISO 9964-3: 2002	$mg \cdot L^{-1}$	200
5. Zinc (Zn^{2+})	BDS EN ISO 11885-2009	$mg \cdot L^{-1}$	4
6. Manganese (Mn^{2+})	BDS EN ISO 11885 2009 (item 9.5.3)	$\mu g \cdot L^{-1}$	50
7. Iron (Fe^{2+})	BDS EN ISO 11885-2009	$\mu g \cdot L^{-1}$	200
8. Sulfates (SO_4^{2-})	BDS EN ISO 10304-1: 2009	$mg \cdot L^{-1}$	250
9. Chlorides (Cl^{-1})	BDS EN ISO 10304-1: 2009	$mg \cdot L^{-1}$	250
Additional parameters			
10. Potassium (K^{+})	BDS ISO 9964-3: 2002	$mg \cdot L^{-1}$	–
11. Hydrogen carbonates (HCO_3^{-})	BDS EN ISO 9963-1: 2000	$mg \cdot L^{-1}$	–
12. Carbonates (CO_3^{2-})	BDS EN ISO 9963-1: 2000	$mg \cdot L^{-1}$	–

N and S poles of permanent magnets are arranged sequentially, stronger effects on pH, ORP, and OD are proven [7]. Effects of magnetic fields on pH and electric conductivity have also been demonstrated [8].

We use K_2CO_3 for a greater ion dissociation with a chemical reaction

$$K_2CO_3 \to 2K^+ + CO_3^{2-},$$

$$CO_3^{2-} + H_2O \to HCO_3^- + OH^-.$$

As a result of the reaction, we get the following ions: K^+, HCO_3^-, and OH^-.

The dissociation of K_2CO_3 increases the following parameters: pH, ORP, and electric conductivity. There are also changed in the Non-equilibrium energy spectrum (NES) and Differential non-equilibrium energy spectrum (DNES) [5].

Moreover, the actions of magnetic [9] and electromagnetic fields [10] induce changes in physicochemical parameters.

The results were obtained using magnetically activated water for agricultural crops [11, 12]. Electromagnetically activated water improves the osmosis process [13] for plants, growth, and antimicrobial activity [14].

The results on sheep have demonstrated changes in daily and total milk production. The milk composition was improved. The ewes and lambs have improved in hematological and biochemical parameters [15]. The magnetic field exposure increases the shelf life of goat milk [16]. Scientific studies show that adding potassium carbonate to the diet increases the synthesis of milk fats in cows [17]. Carbohydrates can lead to fermentation, acidification, and a decrease in pH in the digestive system of domestic animals [18, 19]. An alkaline environment improves the alkaline balance in the digestive system and reduces inflammatory diseases [20]. In 2015, the possibility of combining water with potassium carbonate was indicated [21]. The studies and analyses aim to demonstrate the spectral parameters of potassium carbonate and water activated with a magnetic field. Based on the spectral peaks, the corresponding bio-effects of the obtained results are illustrated.

Bulgaria is rich in drinking waters. For people, the standards for water quality are specified in Ordinance No. 9/2001, Official State Gazette, issue 30, about the quality of water intended for drinking purposes, Bulgaria [22–25]. Table 1 lists the parameters for the physicochemical composition [25].

The studies with physicochemical indicators were performed in licensed laboratories of Bulgarian and EU standards.

The water quality for animals is published in Ordinance No. 44/2006, Veterinary Medical Requirements for Animal Breeding Sites, Bulgaria [26].

In Bulgaria, 70% of the water supply comes from surface water, and 30% comes from groundwater [27].

In Bulgaria, domestic animals drink mountain spring waters in the mountainous regions and water in the plains. In very few cases, they drink mineral water. A study has been conducted on 13 rock glaciers in the Rila and Pirin Mountains [28]. The melting ice and snow are sources of pure mountain water. Bulgaria is a country of high-mountain husbandry. Mountain water from streams and rivers flows toward lower sea levels. The Stara Planina Mountain has streams and rivers with such characteristics – as Yantra, Vit, Ogosta, Osam, *etc.*

Groundwaters pass through limestone, dolomite, and marble layers [29]. Bulgaria is divided into four river basins: the Danube River, the Black Sea, the East Aegean Sea, and the West Aegean Sea (30). Many domestic animals live in these basins, drinking from the plain regions. In the Danube Plain, the second largest river after the Danube is Iskar.

Bulgaria is rich in zeolite deposits; in the Rhodope Mountains, water is filtered through zeolite layers [31, 32].

The study aims to analyze the physicochemical parameters of waters affected by permanent magnetic fields and potassium carbonate. It will be demonstrated that those waters are suitable for the drinking for domestic animals such as sheep and goats.

2. Materials and Methods

2.1. Permanent Magnets

Standard: ISO 9001: 2008 for design, development, production, and trade of oxide magnets.

Type of the magnet: ferrimagnet; anisotropic; catalog No. 59847.

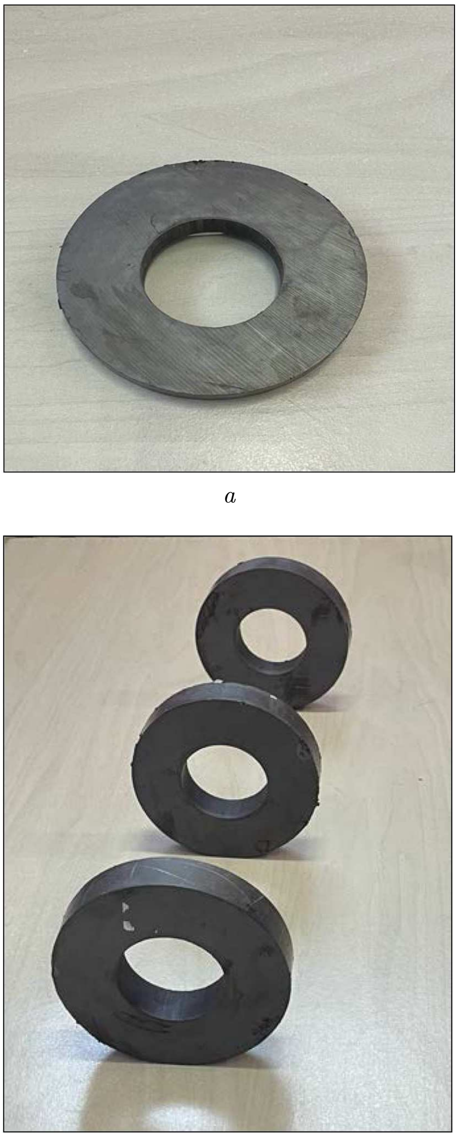
Size: 51/110/20 mm (Fig. 1, *a, b*).

Producer: Feromagnet PLC, Pernik, Bulgaria.

2.2. Scheme for 1000 L water influenced with permanent magnetic field and dissolved potassium

Fig. 2 illustrates a 1000 L water container scheme influenced by a permanent magnetic field and dissolved potassium carbonate. The distance between the magnets' components is 8 cm. The component with 5 magnets is 50 cm long in the one-ton container, and the component with 3 magnets is 38 cm long outside the one-ton container. The pipe diameter is 50.8 mm.

The biggest application of water and non-organic compounds is with anisotropic magnets [34].



a

b

Fig. 1. Permanent magnets – one (*a*) and three (*b*)

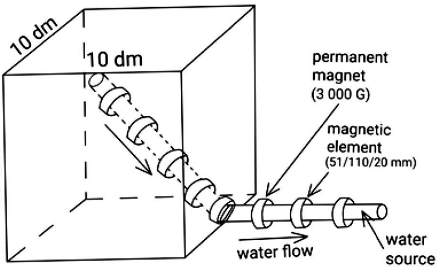


Fig. 2. Scheme for 1000 L water influenced by a permanent magnetic field and dissolved potassium carbonate

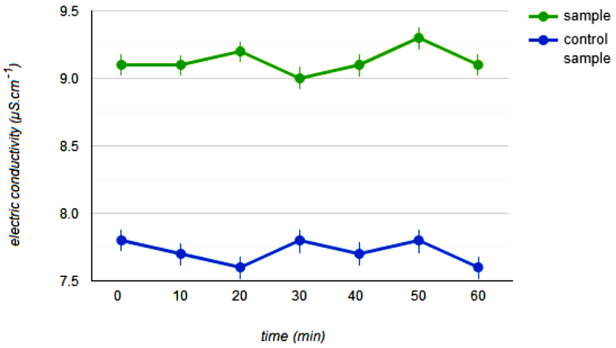


Fig. 3. Results with a magnetic field of B = 3000 G on distilled water during exposure and after 10 minutes after exposure

Table 2. **Results with a magnetic field of B = 3000 G on distilled water during exposure and after 10 minutes after exposure**

Time (min)	Control sample electric conductivity $\mu\text{S}\cdot\text{cm}^{-1}$	Sample electric conductivity $\mu\text{S}\cdot\text{cm}^{-1}$
0	7.8	9.1
10	7.7	9.1
20	7.6	9.2
30	7.8	9.0
40	7.7	9.1
50	7.8	9.3
60	7.6	9.1

Drinking water comes from a water source where sheep and goats' flocks are raised. The water pipe is placed in permanent magnets. The magnetically activated water flows through the source into the troughs for the domestic animals to drink. Sheep and goats drink 7–8 L per day. One container with 1000 L daily can provide fresh water for up to 100 animals, 2000 L for up to 200 animals, and 3000 L for up to 300 animals. It is constantly replenished, allowing the water to be influenced by the magnetic field.

2.3. Fourier transform infrared spectroscopy

Fourier-IR spectrometer Brucker Vertex was used to research the IR spectra of potassium carbonate.

Thermo Nicolet Avatar 360 Fourier-transform IR has the following parameters: average spectral range: 370–7800 cm^{-1}; visible spectral range 2500–8000 cm^{-1}; resolution: 0.5 cm^{-1}; accuracy of wave number: 0.1 at 2000 cm^{-1}

3. Results and Discussion

3.1. Results with magnetic field

Experiments were conducted to investigate the effects of a permanent magnetic field on distilled water with an electric conductivity of 7.8 ± 0.4 $\mu\text{S}\cdot\text{cm}^{-1}$. The magnetic induction was B = 3000, G = 0.3 T. The volume of the distilled water was 1 L. The sample was distilled water influenced by a magnetic field with induction 0.3 T. The control sample was distilled water.

The studies were conducted with samples and control samples of water every 10 minutes without activation with a permanent magnetic influence. The results are presented in Table 2 and Fig. 3.

The following results were obtained using Student's t-test: $p < 0.001$; $r = -0.05$. The comparison of the data on the electric conductivity of the sample and control measured during one hour at 10 min intervals shows a significant difference of $p < 0.001$ in mean values according to the Student's test.

3.2. Results with potassium carbonate

3.2.1. Research of the water solution of K_2CO_3

Potassium carbonate dissociates into K^+ and CO_3^{2-} ions in solutions:

$$\text{K}_2\text{CO}_3 \to 2\text{K}^+ + \text{CO}_3^{2-},$$

CO_3^{2-} reacts with water (H_2O) to form carbonic acid (H_2CO_3)

$$\text{CO}_3^{2-} + \text{H}_2\text{O} \to \text{HCO}_3^- + \text{OH}^-,$$

HCO_3^- can react again with water:

$$\text{HCO}_3^- + \text{H}_2\text{O} \to \text{H}_2\text{CO}_3 + \text{OH}^-.$$

Potassium carbonate with a molar concentration of 0.1 M or concentration of 13.82 $\text{g}\cdot\text{L}^{-1}$ has pH = 11.5.

With 0.1 M or 13.82 $\text{g}\cdot\text{L}^{-1}$, the concentration of the hydroxide ions (OH^-) is 3.16×10^{-3} M:

$$\text{pOH} = -\log(3.16 \times 10^{-3}) = 2.5,$$

$$\text{pH} = 14 - \text{pOH} = 11.5.$$

With 0.01 M or 1.382 $\text{g}\cdot\text{L}^{-1}$, the concentration of the hydroxide ions (OH^-) is 3.16×10^{-4} M:

$$\text{pOH} = -\log(3.16 \times 10^{-4}) = 3.5,$$

$$\text{pH} = 14 - \text{pOH} = 10.5.$$

With 0.001 M or 0.1382 $g \cdot L^{-1}$, the concentration of the hydroxide ions (OH^-) is 3.16×10^{-5} M:

$$\mathrm{pOH} = -\log(3.16 \times 10^{-5}) = 4.5,$$

$$\mathrm{pH} = 14 - \mathrm{pOH} = 9.5.$$

With 0.0001 M or 0.01382 $g \cdot L^{-1}$, the concentration of the hydroxide ions (OH^-) is 3.16×10^{-6} M:

$$\mathrm{pOH} = -\log(3.16 \times 10^{-6}) = 5.5,$$

$$\mathrm{pH} = 14 - \mathrm{pOH} = 8.5.$$

For the volume 1000 L with 13.8 g, the pH = 8.5.

3.2.2. IR Fourier spectral analysis of K_2CO_3

Figure 4 shows the results with IR Fourier Spectral Analysis of K_2CO_3.

3.3. Effects of magnetic field on the spectrum of water with salts

The effects of a magnetic field on crystal forms of $CaCO_3$ are shown. Results were obtained at 708 and 883 cm^{-1} [35]. These correspond to the peaks obtained at 706 and 883 cm^{-1} in the spectrum of K_2CO_3 (Table 3). The peak at 883–887 cm^{-1} is characteristic of the magnetic field activation [14].

3.4. Parameters of water with K_2CO_3 influenced by a magnetic field

The first investigation of slightly mineralized water with Total Dissolved Solids (TDS) = 31.5 $mg \cdot L^{-1}$ was executed. The electrical conductivity was 63.9 $\mu S \cdot cm^{-1}$ and pH = 8.19.

OA B = 3000 G permanent magnetic field influenced one liter of water, increasing the electrical conductivity to 70.3 $\mu S \cdot cm^{-1}$. The difference was 6.4 $\mu S \cdot cm^{-1}$, and pH = 8.23.

In the second investigation, 14 $mg \cdot L^{-1}$ K_2CO_3 was added to water. The following results were obtained: electrical conductivity was 93.8 $\mu S \cdot cm^{-1}$ and pH = = 8.49.

This solution was influenced by a permanent magnetic field with B = 3000 G. The electric conductivity was 100.3 $\mu S \cdot cm^{-1}$.

Table 3 illustrates the absorption bands of the IR spectrum.

Table 4 illustrates the parameters of electric conductivity for 24 h.

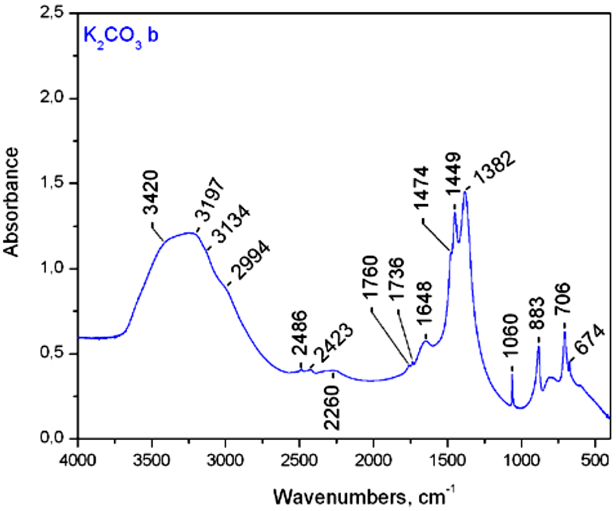


Fig. 4. Results with IR Fourier Spectral Analysis of K_2CO_3

Table 3. **Absorption bands in an IR spectrum**

Absorption bands		
Wave number (cm^{-1})	Wavelength (μm)	Type
3420	2.92	Strong
3197	3.13	Same
3134	3.19	”
2994	3.34	Medium
2486	4.02	Weak
2423	4.13	Same
1760	5.83	”
1736	5.76	”
1648	6.07	”
1474	6.78	Strong
1449	6.90	Same
1382	7.23	”
1060	9.43	Weak
883	11.33	Medium
706	14.16	Same
674	14.84	”

The results illustrate the influence of the magnetic field on the solution of K_2CO_3.

1. Orientation of water molecules and the structuring of hydrogen bonds.

The magnetic fields can change the orientation of water molecules in a solution. Water is with polar molecules, and it can reorganize its structure under the influence of external magnetic fields. There is the process of structuring the hydrogen bonds.

Table 4. **Parameters of electric conductivity for 24 h**

Parameters of 1 L low mineralized water 31.5 ppm with 25 $\mathrm{mg \cdot L^{-1}}$ activated with 3000 G magnetic field	
Time (h)	Electric conductivity ($\mu\mathrm{S \cdot cm^{-1}}$)
Beginning	100.3
1	106.2
2	106.0
3	107.3
4	109.9
5	110.4
6	111.3
7	111.1
8	111.0
9	110.8
10	110.4
11	110.3
12	109.4
13	108.7
14	108.7
15	108.3
16	108.5
17	108.8
18	108.4
19	108.7
20	108.5
21	108.4
22	108.4
23	108.3
24	108.1

2. Influence on the solubility.

The magnetic fields affect the solubility of solids in the solvents. The effects depend on the strength and orientation of the magnetic field and the nature of the solute and solvent. Our studied solvent is low-mineralized water with added potassium carbonate.

3. Changes in chemical reactions.

With changes in the solubility and molecule orientation, as well as potential on ionic transport, magnetic fields may change the rate of the chemical reactions in the solutions.

4. Conclusion

The research and analyses prove that enhancing water properties through exposure to a permanent magnetic field and introducing potassium carbonate can improve the quality of milk and dairy products sourced from sheep and goats.

As a model system in our research, we make the analyses with 1 litter of water with K_2CO_3 and influenced by a magnetic field of 3000 G. This novel approach, involving a 1000, 2000, and 3000-liter plastic containers treated with a permanent magnetic field and dissolved potassium carbonate, creates an alkaline environment within the container. One of the effects is on the gastric acidity of animals and conferring the protection against various diseases.

The spectral results obtained with the FTIR method show that the joint effect of the magnetic field and potassium carbonate is connected with the peaks for the wave numbers.

The following peak for $\tilde{v} = 883$ cm^{-1} is common between the spectrum of K_2CO_3 and the spectrum of the magnetic field.

The extrapolated results, encompassing 1000, 2000, and 3000 liters of drinking water, demonstrated compliance with relevant regulations regarding drinking water quality.

Notably, potassium, carbonate, and hydrogencarbonate ions were found to be exempt from a regulatory limit of reactions. Furthermore, the studies by different authors established significant alterations in key parameters for sheep, goats, and cows. The parameters were Daily and total milk production, composition, and hematological and biochemical factors. The scientists proved the effects on ewes and growth.

Extending the shelf life of goat milk under the influence of the magnetic field is an area of ongoing research aimed at understanding its potential impact on preservation and quality maintenance.

This intriguing discovery has potential implications for dairy production.

However, it is essential to note that introducing carbohydrates may lead to processes such as fermentation, acidification, and pH reduction within the digestive systems of domestic animals. Creating an alkaline environment is beneficial in maintaining an alkaline balance and mitigating inflammatory conditions.

In summary, this research underscores the potential of magnetic field-activated water and potassium carbonate as influential factors in enhancing animal husbandry practices and dairy production quality for sheep and goats.

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ПАРАМЕТРИ ТА ЕФЕКТИ МАГНІТНОГО ПОЛЯ І КАРБОНАТУ КАЛІЮ У ВОДІ. ЗАСТОСУВАННЯ

Вода є полярним розчинником. Між її молекулами створюються водневі зв'язки, в яких приймають участь атоми водню з однієї молекули води та кисень з іншої. Постійне магнітне поле впливає на формування водневих зв'язків. В роботі Ву і Бранта (2020) показано, що електропровідність води у магнітному полі $B = 1{,}35$ Тл змінюється з 100 до 250 мкСм · см$^{-1}$. Відомо також, що кількість протонів у воді зменшується зі зростанням її лужності. В даній роботі ми діяли постійним магнітним полем (8 магнітів, поле кожного $B = 0{,}3$ Тл) на воду об'ємом 1000 л, додавали карбонат калію (K_2CO_3) і використовували її як питну воду для овець та кіз.

Ключові слова: магнітне поле, вода, карбонат калію, скотарство.