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Assessment of physicochemical and antibacterial properties of structured water samples from Ota, Ogun State, Nigeria

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ABSTRACT

We investigated the effect of structuring potable water with QNET Amezcua Bio Disc 3 (BD3). Seven water samples, including public tap, borehole, rain, bottled (2 brands), distilled, and sachet water, obtained from Ota, Nigeria, were analyzed for their physicochemical and antibacterial properties. The water samples were placed on the BD3 for 15 and 30 minutes, 1, 6, 12, 24, and 48 hours respectively, with the unstructured water serving as the control. Physicochemical properties were evaluated using standard methods described by the Association of Official Analytical Chemists (AOAC), elemental analysis was executed using the inductively coupled plasma atomic emission spectroscopy (ICP-OES), while microbial analysis was done using the most probable number method. Results showed that the samples' appearance, color, taste, and odor were clear, colorless, and unobjectionable. The alkalinity of the sachet (160 ± 2.01mg/l) and bottled (240 ± 1.12mg/l) water samples after treatment with BD3 was enhanced compared to the control sample (124 ± 1.00mg/l). Furthermore, supercharging with BD3 significantly ($p<0.05$) increased the pH and alkalinity of the water. There was a significant ($p<0.05$) increase in electrical conductance of all structured water samples when compared with the control groups except in sachet and borehole water samples. No significant ($p>0.05$) effect was observed for total dissolved solids when comparing the structured samples with the control. Most parameters assayed for were within the allowable limits. No heavy metals were detected. Supercharging up to 5 times enhanced the concentrations of calcium, potassium, iron, and magnesium ions significantly ($p<0.05$) across the groups compared to the control samples, while the sodium ion was significantly ($p<0.05$) reduced as the water samples were serially charged with the BD3. Supercharging of the infected autoclaved distilled water samples significantly ($p<0.05$) reduced the total viable count at low concentrations of *E. coli*. In conclusion, BD3 impacts high electrical conductivity on the structured water samples with increased efficacy of solved minerals and a potential antibacterial effect.

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Fig. 1. QNET Amezcua Bio Disc 3 (Source: https://www.qnet.net.ph/bio-disc-3/)

Introduction

Water is an essential nutrient and the most abundant molecule in biological systems. When water is not in adequate supply or quality, organisms do not thrive and may die. While the importance of water in biology may be taken for granted, it is universally recognized that water is needed for hydration and optimizing health and performance [3]. Structured water is water devoid of all unnatural matter and energy and is in its natural, balanced state on material and energetic levels [9]. It is a semi-crystalline type of water with higher viscosity, a lower density, and a higher surface tension [18]. Some technologies, such as vortexers, magnets, and frequency devices can shape and alter water. Theses gadgets work by subjecting water to particular magnetic fields and frequencies, which aids water by organizing the molecular structure of water. Biological water is bonded, active, energized, vitalized, or hexagonal in its orientation. Each water molecule acts as a donor and an acceptor of two electrons in a three-dimensional pattern created by hexagonal water, which has a larger angle of 109.50 ° [9]. Some properties of structured water include low surface tension with enhanced wetting capacity, and a pH value slightly higher than 7, which enhances its assimilation in body fluids [15]. Furthermore, the ability to neutralize the acidic chlorine effect, inhibit the deposition of dissolved substances, and unclamp water molecules while strengthening hydrogen bonding has been reported [6,13].

The physical properties of water are transparent, tasteless, odourless, and colourless. Water quality assessment helps identify contaminants, regardless of whether the water is structured. This is vital for ensuring the water is safe for consumption and domestic uses. Evaluating water quality helps detect harmful microorganisms, such as bacteria and viruses, which could pose significant health risks to humans and animals. Water quality assessment is necessary to ensure that water meets regulatory standards [11]. Compliance with these standards is vital for public health and environmental protection. While some people believe in the potential health benefits of consuming structured water, such as improved hydration, increased energy, and enhanced detoxification, there is a scanty scientific basis to support these claims [12]. The properties of water are well understood in conventional physics and chemistry. The idea that water can be "structured" in a way that provides significant health benefits has not been fully understood and embraced, as there is currently limited scientific evidence to support this claim. While some studies have suggested that structured water may have some unique properties, such as increased solubility and improved cellular hydration, these studies are generally limited in scope and have not been widely replicated [12]. Magnetized water, however, has received more attention in water-structuring research and the most reported benefits of structured water are those exposed to varied magnetic field strengths. In these studies, magnetized water was employed in the improvement of irrigation of crops and breeding of selected farm animals [15].

The Amezcua Bio Disc 3 (BD3) is a transparent, borosilicate glass disc infused with a special combination of granulated crystals, such as clear quartz and diamond, activated using a proprietary process. This commercial product has been evaluated in controlled research in the past, and the results showed that it might change several physical characteristics of water and increase plant growth and seed germination [12]. The glass disc, which measures 9 cm in diameter and 1 cm in thickness, features several geometric relief patterns on its top and bottom that are considered energetically active (Fig. 1). The glass found in solid-state lasers is comparable to the Amezcua Bio Disc 3 (BD3) made by QNET. It converts the incident light flux into almost coherent radiation. Previous physical investigations have demonstrated that normal tap water in a clear jar placed on top of the Amezcua Bio Disc 3 becomes structured and enhanced after 10 minutes and keeps getting more structured with longer periods [19]. This study was aimed at evaluating the effect of

BD3 on the physicochemical and antimicrobial properties of potable water from varied sources. Although a similar study has been conducted in Russia [12], this study was undertaken to ascertain this claim using different water samples from a community in Nigeria. Furthermore, we evaluated the antimicrobial effect of water structured with BD3, which has not been conducted previously. To the best of our knowledge, there is scanty literature in this line of research, hence the need to evaluate the effect of BD3 on various water quality parameters in a local community (Ota, Ogun State) in Nigeria.

Materials and methods

Study material: Seven different water samples, including public tap water, borehole water, rainwater (collected directly from the sky), bottled water (2 different brands), distilled water, and sachet water, were collected randomly and used for this study. QNET Amezcua Bio Disc 3 (Fig. 1) was used to produce the structured water.

Study location: The study was conducted in Ota, Ogun State, Nigeria, at latitude 6.68867 and longitude 3.23202.

Structuring of water samples: The slightly modified method described by Korokov [12] was used to structure the water. In this modified method, water structuring was done in two parts. In the first method, the water samples were placed in transparent water bottles, then on top of the Amezcua Bio Disc 3 (Fig. 1) for 15 and 30 minutes, 1, 6, 12, 24, and 48 hours, respectively. The samples were vortexed periodically. In the second method, water from a brand of bottled water samples was serially run through the BD3 up to 10 times (from the first to the last 10 times), which was described as the supercharged group.

Experimental design:

Grouping	Treatment Duration
1	Baseline study (No treatment on all water samples)
2	Bio Disc3 treatment for 15 minutes on all 9 samples
3	Bio Disc3 treatment for 30 minutes on all 9 samples
4	Bio Disc3 treatment for 60 minutes on all 9 samples
5	Bio Disc3 treatment for 12 hours on all 9 samples
6	Bio Disc3 treatment for 24 hours on all 9 samples
7	Bio Disc3 treatment for 48 hours on all 9 samples
8	Supercharging a brand of bottled water with Bio Disc3 (n=0,1,2,3,4,5,6,7,8,9, and 10)

Water quality analysis: Physicochemical and microbial analysis were carried out on the various water samples before and after treatment with QNET Amezcua Bio Disc3 to determine the effect on the various parameters. Water quality parameters determined include pH, color, acidity, electrical conductivity, alkalinity, taste, total dissolved solids (TDS), total suspended solids (TSS), total solid (TS), temperature, chloride, nitrate, nitrite, sulfate, phosphate, and dissolved oxygen (DO). These parameters were done using standard methods described in the official analysis methods of the Association of Official Analytical Chemists (AOAC).

Elemental analysis: Elemental analysis was done using the instrumentation method, inductively coupled plasma atomic emission spectroscopy (ICP-OES). The samples were analyzed using the Agilent 729-ES with a megapixel charge-coupled device (CCD) detector, and an Agilent Sample Preparation System (SPS3) autosampler was used for sample injection. Calibration and quality control were done using Agilent calibration solutions, which were stabilized with 2% v/v concentrated nitric acid. The instrument was set at a pump speed of 15rpm, nebulizer gas pressure of 220kPa, plasma gas flow of 15L/min, and auxiliary gas flow of 1.5L/min [22].

Microbial analysis: Microbial analysis determined include, Coliform and *E. coli* count. The method described by Gebrewahd et al. [8] was adopted with few modifications. Water samples were collected into sterile bottles to prevent contamination. The most probable number method examined Water samples for total coliforms and *E. coli.*

Total bacterial count: For each water sample, 1 ml of a (1:100) dilution was added to 19 ml of molten nutritional agar, thoroughly mixed, and put into a sterile Petri plate. The agar was allowed to set before incubating at 37°C for 24 hours. The generated colonies were counted, representing the results as cfu/ml.

Presumptive Coliform Test: The multiple-tube fermentation approach, reported by Shariq et al. [21], was used. In this approach, varied amounts of water samples were added to double and single-strength Mac Conkey soup in bottles with inverted sterile Durham tubes, as shown below:

i. water (50ml) was added to 50ml double strength medium;
ii. water (5 × 10ml) was added to 10ml of double strength medium; and
iii. water (5 × 1ml) was added to 5 mL of single-strength medium.

The bottles were aerobically incubated at 37°C for 24 hours before being tested for acid and gas generation. Each test batch was compared to sterile distilled water. The most probable number (MPN) of coliform per 100ml of water sample was calculated using McCrady's probability table after combining multiple positive and negative results.

Identification of isolate: Positive tubes from the presumptive test were sub-cultured on Mc Conkey agar to detect *Escherichia coli* and other coliforms. All the inoculation media were incubated aerobically at 37°C for 24 hours, and the isolates were further described by a combination of colonial and morphological characteristics on both solid media and conventional biochemical assays.

Effect of QNET Amezcua Bio Disc3 treatment on water samples and laboratory-induced experimental microbial study: The

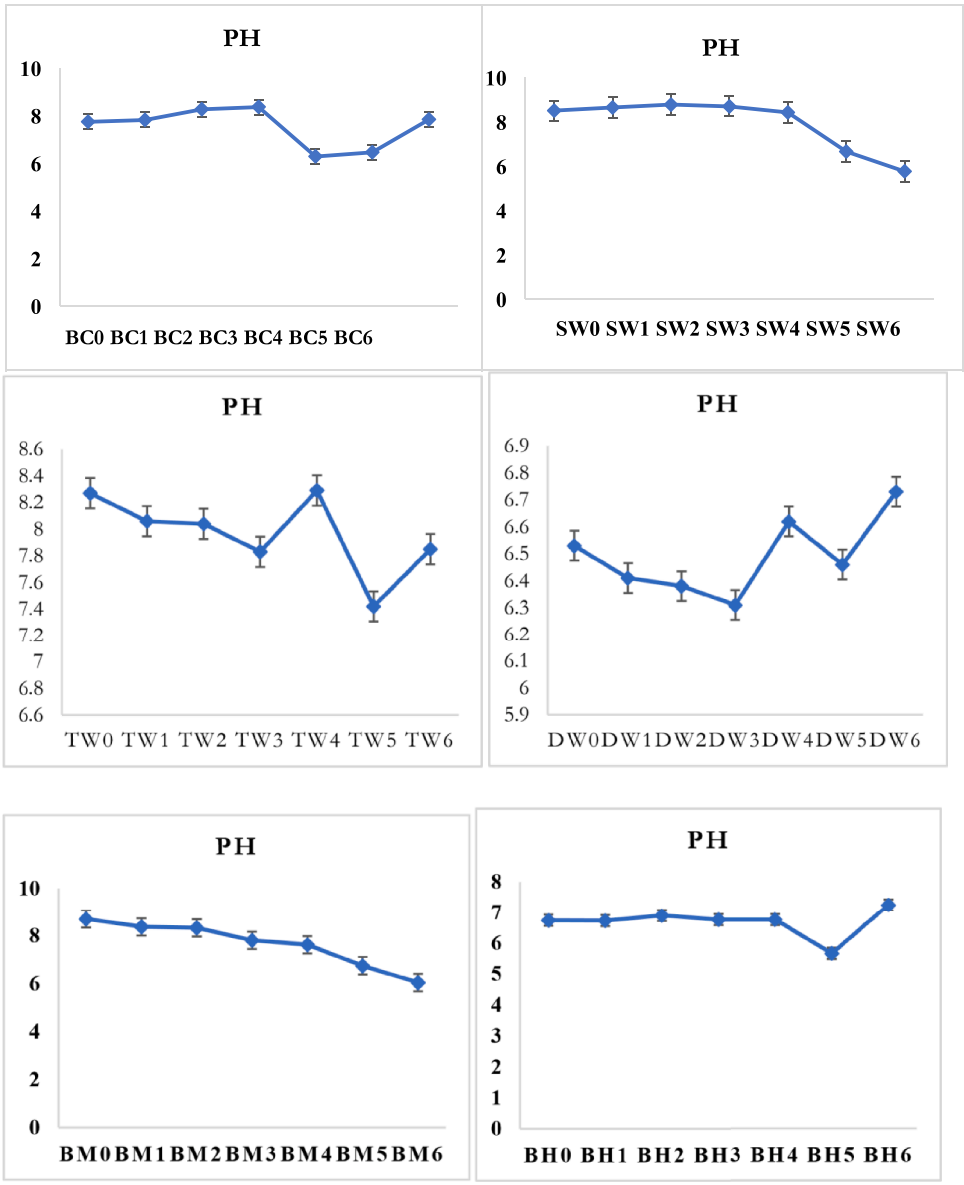

Fig. 2a. Effect of QNET Amezcua Bio Disc3 on pH of water samples placed on the disc at different durations. BC, BM, DW, TW, BH, and SW represent bottled water 1, bottled 2, distilled, tap water, borehole water, and sachet water, respectively. 0, 1, 2, 3, 4, 5, and 6 represent 0 mins, 15 mins, 30 mins, 1 hr, 12 hrs, 24 hrs, and 48 hrs respectively of treatment with QNET Amezcua BioDisc3. Results were reported as Mean ± SD from 3 replicates and $p<0.05$.

effect of QNET Amezcua Bio Disc 3 treatment on the microbial parameters of the samples was done at 0, 15, 30 minutes, and 1, 12, 24, and 48-hour exposures, respectively. Thereafter, an experimental study inoculating sterile (autoclaved) distilled water with *Escherichia coli* was done to determine the effect of QNET Amezcua Bio Disc3 in a controlled water environment. The Bio Disc 3 was then used to supercharge the water samples at 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 times respectively.

Statistical Analyses: Statistical analysis was done using Microsoft Excel and Statistical Package for Social Sciences (SPSS) version 11.0. The mean and standard deviations were calculated from three replicates. Analysis of Variance was used to evaluate data to determine significant differences at $p < 0.05$.

Results and discussion

Physicochemical analysis of water involves measuring and evaluating various physical and chemical properties of water. These properties provide valuable information about water's composition, quality, and suitability for various purposes, including drinking,

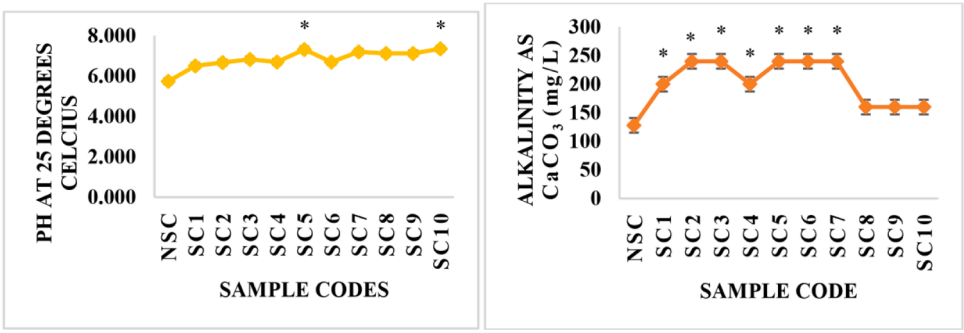

Fig. 2b. Effect of QNET Amezcua Bio Disc3-supercharging on pH and alkalinity of drinking water. NSC, SC1, SC2, SC3, SC4, SC5, SC6, SC7, SC8, SC9, and SC10 represents no supercharging and supercharging times 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 respectively. Results were reported as Mean ± SD from 3 replicates and $*p<0.05$.

industrial, agricultural, and environmental applications. In this study, we evaluated the effect of QNET Amezcua Bio Disc3 on the physicochemical properties of seven drinking water samples, including public tap water, borehole water, rainwater (collected directly from the sky), bottled water (2 different brands), distilled water, and sachet water. The parameters evaluated include pH, temperature, colour, taste, turbidity, dissolved oxygen, conductivity, alkalinity, total dissolved solids (TDS), total suspended solids (TSS), total solid (TS), major ions (chloride, nitrate, nitrite, sulfate, phosphate), mineral elements and heavy metals, and microbial parameters. These analyses provide essential data for monitoring water quality, managing water resources, and protecting public health and the environment. The table and charts below show the effect of treating the various water samples with QNET Amezcua Bio Disc 3.

Effect of QNET Amezcua Bio Disc3 treatment on sensory appeal of study samples

All the water samples appeared clear and colourless, and the odour and taste were unobjectionable. This means that the sensory appeal of the water samples treated with QNET Amezcua Bio Disc 3 was comparable to standard drinking water. This result is in accordance with the recommendations of the World Health Organization [26].

Effect of QNET Amezcua Bio Disc3 treatment on physicochemical properties of study samples

Here, the effect of QNET Amezcua Bio Disc3 treatment on the pH, alkalinity, turbidity, dissolved oxygen, total solids, electrical conductivity, nitrate, nitrite, sulphate, phosphate, and chloride is reported.

A. pH and alkalinity

Fig. 2a, b, c indicates the effect of QNET Amezcua Bio Disc3 treatment on the pH and alkalinity of study samples. pH is an important factor that affects the solubility of minerals and the behaviour of chemical species in water. pH levels influence the taste and palatability of water. Drinking water with extreme pH values can be unappealing and may discourage people from consuming adequate water, potentially leading to dehydration. For instance, excessively high pH levels could produce flat-tasting water that is not desirable, with scale formation [5]. Alkalinity measures the water's capacity to resist changes in pH when an acid is added. It primarily represents the presence of bicarbonate, carbonate, and hydroxide ions in the water. Alkalinity is crucial in drinking water for several reasons, including stabilizing its pH. This is important because extreme pH levels can affect water's taste, safety, and suitability for consumption.

Placing water samples on the Bio Disc also affected the pH and alkalinity of the various water samples, although no significant effect on the pH of the water samples treated was observed (Fig. 2a). Most of the samples had a near-neutral to alkaline pH (6.74 ± 0.02 – 8.42 ± 0.01). Treatment with the disc either maintained the pH or lowered it slightly. It was also observed that exposing distilled water (DW) and borehole water (BH) to the Bio Disc for 48 hours increased the pH compared to the lower time frames. However, the observed effect was not significant ($p>0.05$). Exposing tap water to the Bio Disc for 12 hours showed more effect on the pH than the other time frames. In Fig. 2b, we present the effect of supercharging bottled water brands on the pH and alkalinity. Supercharging 5 times and 10 times, respectively, showed a higher effect (7.32 ± 0.01 and 7.35 ± 0.02 respectively) than the non-supercharged (5.74 ± 0.03) and other time frames. Supercharging significantly ($p<0.05$) increased the pH and alkalinity values for all the treatment times when compared with the non-supercharged sample. The alkalinity of the sachet and bottled water samples after treatment with the disc was enhanced compared to the control samples. A significant effect was observed after 24 hours of treatment (Fig. 2c). The majority of our knowledge on structured water is derived from studies in which magnetic field energy was used to structure water, and an increase in pH and electrical conductivity has been reported in these studies [13].

Comparing the pH and alkalinity of the supercharged water samples with the control (no supercharging), alkalinity was enhanced. There was a 53.33% increase in the alkalinity of the water samples supercharged up to 2,3,5,6, and 7 times, compared to the non-supercharged sample (128 ± 2.00 mg/L). Alkaline water has been reported to confer health benefits to humans and animals by

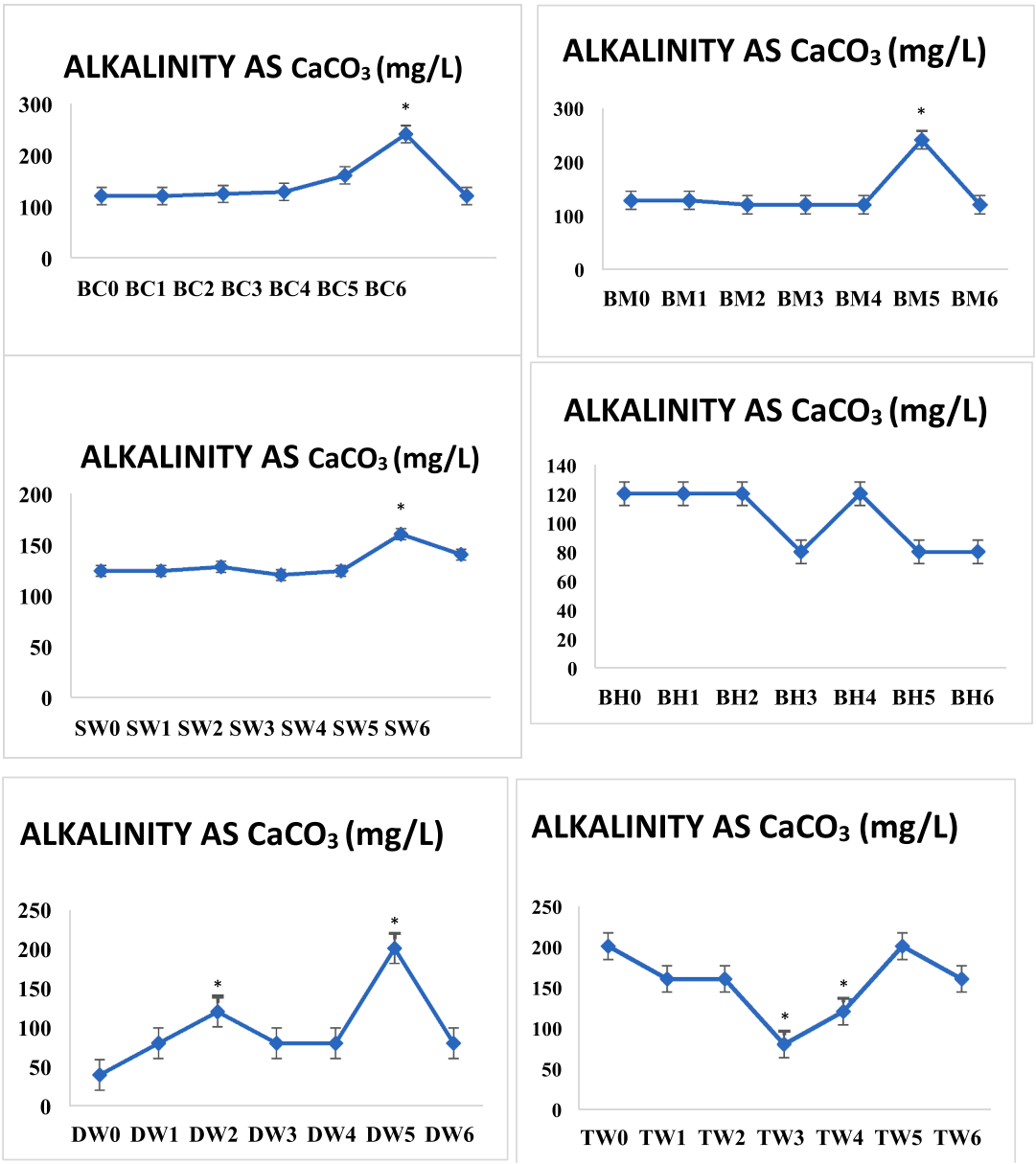

Fig. 2c. Effect of QNET Amezcua Bio Disc3 treatment on the alkalinity of water samples placed on the disc at different durations. BC, BM, DW, TW, BH, and SW represent bottled water 1, bottle 2, distilled, tap water, borehole water, and sachet water, respectively. 0, 1, 2, 3, 4, 5, and 6 represent 0 mins, 15 mins, 30 mins, 1 hr, 12 hrs, 24 hrs, and 48 hrs respectively of treatment with QNET Amezcua BioDisc3. Results were reported as mean± SD from 3 replicates and *p<0.05.

maintaining an ideal pH balance in the blood and scavenging free radicals. Some health benefits reported for alkaline water include the prevention of osteoporosis and the protection of pancreatic beta cells due to its antioxidant effect [16]. In a study on the effect of pH on fish growth, it was reported that at pH 8.5, optimum growth of the fish compared to those reared in a lower pH medium was observed [17].

B. Total Solids, Total Dissolved and Total Suspended solids

Total Solids represent the sum of all solids in a water sample, including both dissolved and suspended solids. Total Dissolved Solids (TDS) refer to the concentration of all dissolved substances in a water sample, including minerals, salts, metals, and other inorganic and organic substances that are in solution. Total Suspended Solids represent the concentration of solid particles suspended in the water and not in solution including particles such as silt, clay, algae, and other organic and inorganic matter that a filter can trap. Excessive

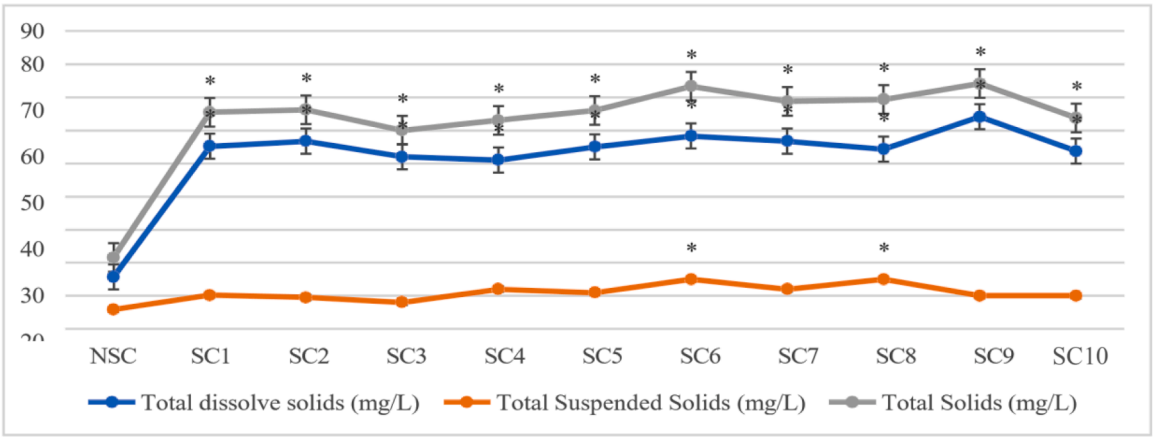

Fig. 3a. Effect of QNET Amezcua Bio Disc3 supercharging on total solids, total dissolved, and total suspended solids of drinking water. NSC, SC1, SC2, SC3, SC4, SC5, SC6, SC7, SC8, SC9, and SC10 represents no supercharging and supercharging times 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 respectively. Results were reported as mean± SD from 3 replicates and $p<0.05$.

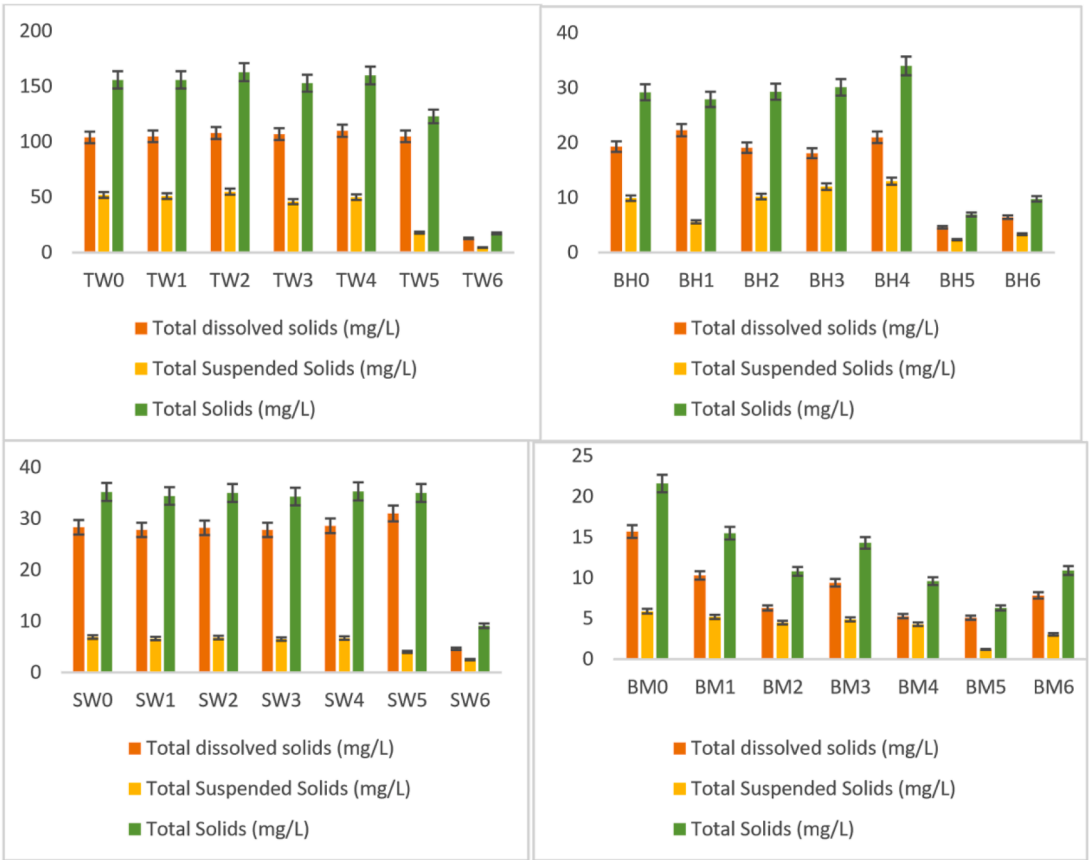

Fig. 3b. Effect of Bio Disc3 treatment on total solids, total dissolved and total suspended solids of water samples placed on the disc at different durations. BM, TW, BH and SW represent bottle water 2, tap water, borehole water and sachet water, respectively. 0, 1, 2, 3, 4, 5, and 6 represent 0 mins, 15 mins, 30 mins, 1 hour, 12 hours, 24 hours, and 48 hours respectively of treatment with QNET Amezcua BioDisc3.

minerals could elicit an unpleasant taste and lower the hue of the water. TDS is even considered the most essential water-related metric for determining quality. High TDS values could imply that the water is heavily mineralized or contaminated. According to the World Health Organization (WHO), the desired limit for TDS is 500 mg/l, while the maximum limit is 1000 mg/l for drinking purposes. It has been reported that high concentrations of TDS may be detrimental to those suffering from kidney and heart disease [14] and could

Table 1a
Effect of QNET Amezcua Bio Disc3 supercharging on Water Energetics

Sample Name	NSC	SC1	SC2	SC3	SC4	SC5
Phosphate (mg/L)	1.08 ± 0.04	0.09 ± 0.01	ND	ND	ND	ND
Chloride (mg/L)	35 ± 0.01	26.3 ± 0.01	26.3 ± 0.01	28,1 ± 0.01	26.4 ± 0.01	21.2 ± 0.01
Electrical Conductivity (μS/cm)	66.67 ± 2.13	85.23 ± 0.12*	85.00 ± 0.00*	100.50 ± 0.00*	157.37 ± 0.21*	164.33 ± 0.31*
Turbidity (NTU)	0.34 ± 0.00	0.27 ± 0.00	0.33 ± 0.00	0.26 ± 0.00	0.61 ± 0.01	0.40 ± 0.01
Salinity (ppt)	0.02 ± 0.00	0.04 ± 0.00	0.04 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.07 ± 0.00
Dissolved Oxygen (mg/L)	3.67 ± 0.09	4.53 ± 0.05	5.70 ± 0.01	7.60 ± 0.01*	7.70 ± 0.00*	8.47 ± 0.05*

NSC, SC1, SC2, SC3, SC4, and SC5 represent supercharging times 1, 2, 3, 4, and 5 respectively. Results were reported as mean± SD from 3 replicates and *p<0.05. ND implies not detected.

Table 1b
Effect of QNET Amezcua Bio Disc3 treatment on Water Energetics of Bottled Water 1

Sample Name	BC0	BC1	BC2	BC3	BC4	BC5	BC6
Nitrate (mg/L)	4.45 ± 0.27	5.13 ± 0.00	5.81 ± 0.00	3.10 ± 0.00	4.85 ± 0.27	5.06 ± 0.00	5.24 ± 0.00
Nitrite (mg/L)	1.00 ± 0.06	1.87 ± 0.01	3.57 ± 0.00	0.70 ± 0.00	3.35 ± 0.06	5.66 ± 0.00	4.62 ± 0.00
Sulphate (mg/L)	1.29 ± 0.00	1.76 ± 0.00	1.68 ± 0.00	0.73 ± 0.01	11.47 ± 0.01	13.15 ± 0.00	2.16 ± 0.00
Phosphate (mg/L)	2.08 ± 0.04	2.13 ± 0.01	1.40 ± 0.01	2.07 ± 0.00	3.83 ± 0.00	3.13 ± 0.02	1.69 ± 0.00
Chloride (mg/L)	35.7 ± 0.01	35 ± 0.00	31.5 ± 0.01	36.2 ± 0.00	35 ± 0.12	38 ± 0.01	34.8 ± 0.01
Electrical Conductivity (μS/cm)	46.57 ± 2.13	48.60 ± 2.08	56.62 ± 1.03*	80.4 ± 0.86*	105.43 ± 0.39*	87.83 ± 0.19*	95.43 ± 0.17*
Turbidity (NTU)	0.04 ± 0.00	0.02 ± 0.00	0.03 ± 0.01	0.14 ± 0.04	0.20 ± 0.00	0.16 ± 0.00	0.12 ± 0.01
Salinity (ppt)	0.02 ± 0.00	0.02 ± 0.00	0.01 ± 0.00	0.03 ± 0.00	0.05 ± 0.00	0.04 ± 0.00	0.02 ± 0.00
Dissolved Oxygen (mg/L)	3.67 ± 0.09	6.43 ± 0.05	6.5 ± 0.08	7.43 ± 0.09	4.90 ± 0.00	3.30 ± 0.00	5.53 ± 0.12

BC0, BC1, BC2, BC3, BC4, BC5, and BC6 represent exposure to the water on QNET Amezcua Bio Disc 3 for varied time frames of 0, 15, 30 minutes, 1 hour, 12, 24, and 48 hours respectively. Results were reported as mean± SD from 3 replicates and *p<0.05

Table 1c
Effect of QNET Amezcua Bio Disc3 treatment on Water Energetics of Sachet Water

Sample Name	SW0	SW1	SW2	SW3	SW4	SW5	SW6
Nitrate (mg/L)	3.71 ± 0.27	4.66 ± 0.00	5.41 ± 0.00	3.14 ± 0.00	2.92 ± 0.00	3.12 ± 0.00	3.52 ± 0.00
Nitrite (mg/L)	1.01 ± 0.06	1.31 ± 0.00	1.22 ± 0.00	1.61 ± 0.00	1.57 ± 0.00	1.52 ± 0.00	1.32 ± 0.00
Sulphate (mg/L)	2.32 ± 0.00	3.91 ± 0.00	3.83 ± 0.00	2.44 ± 1.02	2.49 ± 0.00	2.74 ± 0.00	3.59 ± 0.00
Phosphate (mg/L)	1.53 ± 0.07	1.91 ± 0.00	1.67 ± 0.00	1.49 ± 0.00	1.69 ± 0.00	1.21 ± 0.00	1.24 ± 0.00
Chloride (mg/L)	36.8 ± 0.01	31.5 ± 0.01	28 ± 0.01	35 ± 0.01	31.5 ± 0.01	26 ± 0.01	26.3 ± 0.01
Electrical Conductivity (μS/cm)	45.17 ± 1.60	46.07 ± 1.59	43.97 ± 1.45	42.27 ± 0.46	43.23 ± 0.60	43.93 ± 0.91	43.40 ± 0.29
Turbidity (NTU)	0.02 ± 0.00	0.07 ± 0.02	0.08 ± 0.05	0.02 ± 0.00	0.21 ± 0.00	0.10 ± 0.01	0.09 ± 0.01
Salinity (ppt)	0.02 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.02 ± 0.00
Dissolved Oxygen (mg/L)	6.33 ± 0.09	6.50 ± 0.08	5.80 ± 0.08	6.27 ± 0.09	4.50 ± 0.14	5.60 ± 0.00	3.97 ± 0.05

SW0, SW1, SW2, SW3, SW4, SW5, and SW6 represent exposure of the water on QNET Amezcua Bio Disc 3 for varied time frames of 0, 15, 30 minutes, 1 hour, 12, 24, and 48 hours respectively. Results were reported as mean ± SD from 3 replicates and p>0.05.

elicit laxative/constipation effects [20]. TDS values from this study range between 1.3 ± 0.03 to 104 ± 0.02 mg/l, with the highest value obtained in a public tap water sample. This is expected because the other water samples have been treated before it was used in the study, and groundwater contains more solids due to more solid matter in the ground. However, the values obtained are below the limit set by the WHO. Fig. 3a shows the effect of supercharging on the total solids, total dissolved and suspended solids of portable drinking water. The results showed a significant ($p<0.05$) effect when comparing the treated samples with the control. This could mean that the minerals are more dissolved using the supercharging method. No significant ($p>0.05$) difference was observed in the samples treated with the Bio Disc when compared with the control samples (Fig. 3b) for samples placed on the Bio Disc at different durations. However, at 48hours, there was a reduction in these parameters compared with the control and the other samples exposed for a shorter period. This could suggest that prolonged exposure to the disc could alter the mineral composition of the water. However, the value obtained was below the allowable limit. Although there are few studies on using Bio Disc 3, several reports have been on magnetized water. Water exposed to a magnetic field softens and increases its pH and total dissolved solids. By increasing the solubility of minerals, magnetic water can enhance the delivery of nutrients to every area of the body [25].

Magnetic flux arranges water molecules into one by the relaxation bonds generated where the bond angle lowers to less than 105°. This results in less consolidation between water molecules and increased molecule size, thus producing a change in pH and total dissolved solids [10].

C. Water energetics

Table 1d
Effect of QNET Amezcua Bio Disc3 treatment on Water Energetics of Rainwater

Sample Name	SR0	SR1	SR2	SR3	SR4	SR5	SR6
Nitrate (mg/L)	11.19 ± 0.00	2.52 ± 0.00	10.61 ± 0.00	23.33 ± 0.00	26.22 ± 0.00	11.38 ± 0.27	0
Nitrite (mg/L)	2.53 ± 0.00	0.57 ± 0.00	2.40 ± 0.00	5.27 ± 0.00	5.92 ± 0.00	2.57 ± 0.06	0.000
Sulphate (mg/L)	2.64 ± 0.00	2.96 ± 0.00	1.68 ± 0.00	14.13 ± 0.03	15.09 ± 0.10	12.86 ± 0.10	1.45 ± 0.00
Phosphate (mg/L)	0.73 ± 0.00	0.78 ± 0.00	1.01 ± 0.00	0.84 ± 0.00	0.75 ± 0.00	0.82 ± 0.00	1.56 ± 0.00
Electrical Conductivity (μS/cm)	9.45 ± 0.36	14.74 ± 0.28*	10.33 ± 0.50*	22.80 ± 0.00*	23.50 ± 0.24*	22.07 ± 0.29*	23.48 ± 0.60*
Turbidity (NTU)	0.94 ± 0.00	1.00 ± 0.00	1.00 ± 0.06	4.57 ± 0.45	7.74 ± 0.46	4.72 ± 0.05	1.92 ± 0.12
Salinity (ppt)	ND	ND	ND	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	ND
Dissolved Oxygen (mg/L)	6.17 ± 0.19	6.47 ± 0.05	6.47 ± 0.05	6.43 ± 0.05	7.30 ± 0.00	7.90 ± 0.00	7.40 ± 0.08

SR0, SR1, SR2, SR3, SR4, SR5, and SR6 represent exposure to the water on QNET Amezcua Bio Disc 3 for varied time frames of 0, 15, 30 minutes, 1 hour, 12, 24, and 48 hours respectively. Results were reported as mean± SD from 3 replicates and *$p<0.05$. ND implies not detected.

Table 1e
Effect of QNET Amezcua Bio Disc3 treatment on Water Energetics of Bottled Water 2

Sample Name	BM0	BM1	BM2	BM3	BM4	BM5	BM6
Nitrate (mg/L)	2.52 ± 0.00	3.95 ± 0.27	2.39 ± 0.00	3.29 ± 0.27	2.96 ± 0.00	2.62 ± 0.00	2.37 ± 0.00
Nitrite (mg/L)	0.57 ± 0.00	0.57 ± 0.06	0.51 ± 0.00	0.74 ± 0.06	1.18 ± 0.00	1.52 ± 0.00	1.31 ± 0.00
Sulphate (mg/L)	3.52 ± 0.00	1.39 ± 0.04	2.64 ± 0.00	3.84 ± 0.00	3.09 ± 0.06	4.47 ± 0.00	4.32 ± 0.00
Phosphate (mg/L)	2.10 ± 0.37	1.17 ± 0.00	0.84 ± 0.00	3.00 ± 0.01	1.73 ± 0.01	0.07 ± 0.00	0.023 ± 0.00
Chloride (mg/L)	31.5 ± 0.01	24.5 ± 0.01	43.3 ± 0.01	37.5 ± 0.01	36.3 ± 0.01	30 ± 0.01	38 ± 0.01
Electrical Conductivity (μS/cm)	5.84 ± 0.19	5.42 ± 0.37	5.11 ± 0.09	14.20 ± 1.37*	12.30 ± 0.07*	17.17 ± 0.34*	19.32 ± 0.02*
Turbidity (NTU)	ND	0.01 ± 0.01	ND	0.04 ± 0.00	0.52 ± 0.01	0.03 ± 0.00	0.10 ± 0.00
Salinity (ppt)	ND	ND	ND	ND	ND	ND	ND
Dissolved Oxygen (mg/L)	6.43 ± 0.04	6.27 ± 0.12	6.43 ± 0.12	4.60 ± 0.00	7.63 ± 0.12	4.27 ± 0.05	4.13 ± 0.05

BM0, BM1, BM2, BM3, BM4, BM5, and BM6 represent exposure to the water on QNET Amezcua Bio Disc 3 for varied time frames of 0, 15, 30 minutes, 1 hour, 12, 24, and 48 hours respectively. Results were reported as mean± SD from 3 replicates and *$p<0.05$. ND implies not detected.

Table 1f
Effect of QNET Amezcua Bio Disc3 treatment on Water Energetics of Distilled Water

Sample Name	DW0	DW1	DW2	DW3	DW4	DW5	DW6
Nitrite (mg/L)	9.06 ± 0.00	12.58 ± 0.00	13.49 ± 0.00	11.27 ± 0.00	13.89 ± 0.00	11.84 ± 0.06	13.89 ± 0.00
Sulphate (mg/L)	9.65 ± 0.06	10.28 ± 0.06	6.81 ± 0.04	8.21 ± 0.00	14.50 ± 0.00	12.27 ± 0.00	12.99 ± 0.00
Phosphate (mg/L)	1.35 ± 0.00	1.02 ± 0.00	1.05 ± 0.00	1.20 ± 0.00	ND	ND	ND
Chloride (mg/L)	70 ± 0.01	70 ± 0.00	114 ± 0.01	82.3 ± 0.01	70 ± 0.01	19.3 ± 0.01	22.8 ± 0.01
Electrical Conductivity (μS/cm)	5.64 ± 0.48	5.78 ± 0.57	4.96 ± 0.91	5.13 ± 0.00	4.80 ± 0.02	5.44 ± 0.13	5.22 ± 0.79
Turbidity (NTU)	0.27 ± 0.01	0.34 ± 0.01	0.38 ± 0.01	0.28 ± 0.00	0.35 ± 0.00	0.38 ± 0.00	0.41 ± 0.00
Salinity (ppt)	ND	ND	ND	ND	ND	ND	ND
Dissolved Oxygen (mg/L)	4.23 ± 0.05	4.90 ± 0.00	6.33 ± 0.05	7.50 ± 0.00	4.30 ± 0.08	3.37 ± 0.05	3.70 ± 0.00

DW0, DW1, DW2, DW3, DW4, DW5, and DW6 represent exposure to the water on QNET Amezcua Bio Disc 3 for varied time frames of 0, 15, 30 minutes, 1 hour, 12, 24, and 48 hours respectively. Results were reported as mean± SD from 3 replicates and *$p<0.05$. ND implies not detected.

Table 1g
Effect of QNET Amezcua Bio Disc3 treatment on Water Energetics of Tap Water

Sample Name	TW0	TW1	TW2	TW3	TW4	TW5	TW6
Nitrate (mg/L)	47.21 ± 0.00	45.47 ± 0.00	43.55 ± 0.00	42.80 ± 0.00	47.83 ± 0.00	44.54 ± 0.00	43.78 ± 0.00
Nitrite (mg/L)	16.45 ± 0.00	13.89 ± 0.00	12.84 ± 0.00	13.93 ± 0.00	15.32 ± 0.00	12.32 ± 0.00	14.41 ± 0.00
Sulphate (mg/L)	61.24 ± 8.46	50.68 ± 0.04	23.26 ± 0.19	39.16 ± 0.04	27.03 ± 0.04	32.89 ± 0.00	30.27 ± 0.00
Phosphate (mg/L)	2.44 ± 0.00	3.86 ± 0.01	2.18 ± 0.00	2.14 ± 0.01	2.23 ± 0.00	ND	ND
Chloride (mg/L)	24.5 ± 0.01	28 ± 0.01	36.8 ± 0.02	28 ± 0.01	31.5 ± 0.01	19.3 ± 0.01	26.3 ± 0.01
Electrical Conductivity (μS/cm)	153.70 ± 0.14	156.30 ± 0.00	154.80 ± 0.00	157.90 ± 0.00	162.50 ± 0.92*	161.40 ± 0.00*	172.90 ± 0.14*
Turbidity (NTU)	1.16 ± 0.02	1.10 ± 0.01	0.98 ± 0.00	1.14 ± 0.00	1.03 ± 0.01	0.59 ± 0.01	0.54 ± 0.02
Salinity (ppt)	0.07 ± 0.00	0.07 ± 0.00	0.07 ± 0.00	0.07 ± 0.00	0.07 ± 0.00	0.07 ± 0.00	0.07 ± 0.00
Dissolved Oxygen (mg/L)	6.50 ± 0.00	3.70 ± 0.00	5.27 ± 0.05	4.57 ± 0.05	4.87 ± 0.05	6.70 ± 0.00	5.63 ± 0.05

TW0, TW1, TW2, TW3, TW4, TW5, and TW6 represent exposure to the water on QNET Amezcua Bio Disc 3 for varied time frames of 0, 15, 30 minutes, 1 hour, 12, 24, and 48 hours respectively. Results were reported as mean± SD from 3 replicates and *$p<0.05$. ND implies not detected.

Table 1h
Effect of QNET Amezcua Bio Disc3 treatment on Water Energetics of Borehole Water

Sample Name	BH0	BH1	BH2	BH3	BH4	BH5	BH6
Nitrate (mg/L)	2.46 ± 0.01	2.52 ± 0.00	2.52 ± 0.00	2.57 ± 0.00	3.46 ± 0.00	3.68 ± 0.01	4.24 ± 0.05
Nitrite (mg/L)	1.14 ± 0.00	0.97 ± 0.00	0.99 ± 0.00	1.48 ± 0.00	1.14 ± 0.00	0.83 ± 0.00	1.32 ± 0.00
Sulphate (mg/L)	4.21 ± 0.04	4.47 ± 0.00	4.21 ± 0.04	5.03 ± 0.00	6.12 ± 0.00	5.56 ± 0.00	6.32 ± 0.04
Phosphate (mg/L)	0.30 ± 0.00	0.22 ± 0.00	0.37 ± 0.00	0.35 ± 0.01	0.41 ± 0.00	0.32 ± 0.00	0.37 ± 0.01
Chloride (mg/L)	33.3 ± 0.02	29.5 ± 0.01	28 ± 0.00	34.8 ± 0.00	37.5 ± 0.00	38 ± 0.01	36.3 ± 0.01
Electrical Conductivity (μS/cm)	53.90 ± 0.16	52.70 ± 0.22	49.33 ± 0.21	49.4 ± 0.22	54.21 ± 0.15	47.80 ± 0.57	49.57 ± 0.17
Turbidity (NTU)	0.19 ± 0.10	0.15 ± 0.01	0.22 ± 0.05	0.17 ± 0.00	0.13 ± 0.12	0.15 ± 0.23	0.27 ± 0.00
Salinity (ppt)	0.02 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	ND
Dissolved Oxygen (mg/L)	4.43 ± 0.05	4.00 ± 0,00	4.20 ± 0.00	4.20 ± 0.00	5.33 ± 0.05	5.70 ± 0.00	5.40 ± 0.08

BH0, BH1, BH2, BH3, BH4, BH5, and BH6 represent the exposure of the water on QNET Amezcua Bio Disc 3 for varied time frames of 0, 15, 30 minutes, 1 hour, 12, 24, and 48 hours respectively. Results were reported as mean± SD from 3 replicates and *$p<0.05$. ND implies not detected.

Table 2a
Mineral composition of QNET Amezcua Bio Disc3 supercharged water

Element (wavelength) (mg/L)	NSC	SC1	SC2	SC3	SC4	SC5
Calcium (396.847)	2.53 ± 0.00	5.00 ± 0.03*	8.00 ± 0.01*	7.00 ± 0.01*	6.00 ± 0.01	11.00 ± 0.01*
Iron (238.204)	0.03 ± 0.00	4.93 ± 0.02*	4.93 ± 0.01*	4.08 ± 0.01*	3.45 ± 0.01*	3.08 ± 0.01*
Potassium (766.491)	0.79 ± 0.00	2.40 ± 0.00*	7.00 ± 0.01*	4.01 ± 0.01*	2.89 ± 0.01*	2.41 ± 0.02*
Magnesium (279.553)	1.57 ± 0.01	4.40 ± 0.01*	4.43 ± 0.02*	3.80 ± 0.01*	4.60 ± 0.01*	5.90 ± 0.012*
Manganese (257.610)	0.017 ± 0.00	0.78 ± 0.00	ND	ND	ND	ND
Sodium (589.592)	5.03 ± 0.01	4.00 ± 0.00	4.30 ± 0.01	3.44 ± 0.01*	3.20 ± 0.01*	ND
Zinc (213.857)	0.004 ± 0.0002	0.002 ± 0.0001	0.004 ± 0.0001	0.002 ± 0.0001	0.002 ± 0.0002	0.002 ± 0.0001

NSC, SC1, SC2, SC3, SC4, and SC5 represent supercharging times 1, 2, 3, 4, and 5 respectively. Results were reported as mean± SD from 3 replicates and *$p<0.05$. ND implies not detected.

Table 1a-h show the effect of treating water samples with QNET Amezcua Bio Disc3 on nitrate, nitrite, sulfate, phosphate, electrical conductivity, salinity, turbidity, dissolved oxygen, and chloride. Turbidity refers to the cloudiness or haziness of water caused by suspended particles such as sediment, silt, clay, organic matter, and microorganisms. High turbidity levels indicate reduced water clarity, which can affect the aesthetics of drinking water and consumer satisfaction. It could also indicate the presence of microbial or chemical contamination and is an early warning sign for water quality issues. Salinity refers to the concentration of dissolved salts, particularly sodium chloride, in water. High salinity levels can be detrimental to potable water and biological systems.

Dissolved oxygen (DO) is the amount of oxygen found in water. Insufficient DO levels can cause hypoxia (low oxygen) or anoxia (absence of oxygen). The physical-chemical elements that determine the DO level in water are temperature, salinity, atmospheric pressure, water surface agitation, and chemical oxygen consumption, such as sulfide oxidation and nitrification [4]. DO levels are often used as an indicator of overall water quality. Low levels may suggest pollution, excessive nutrient loading, or other environmental stressors. Monitoring dissolved oxygen is key to water quality assessments and environmental management.

Nitrate is generally considered harmless, but it can be converted to nitrite in the body through nitrate reduction. High nitrate levels in the body can lead to methemoglobin formation, a form of hemoglobin that cannot carry oxygen effectively. This condition is known as methemoglobinemia, or "blue baby syndrome," and it can be particularly harmful to infants. Nitrate exposure has also been associated with other health concerns, including certain cancers and adverse reproductive effects. Therefore, monitoring nitrate levels in drinking water protects public health. The WHO recommends a maximum nitrate concentration in drinking water of 50 milligrams per liter NO_3^-. The detrimental effects of excess nitrate in humans are primarily due to the conversion of nitrate to nitrite. It has been reported that physiological quantities of nitrite suppress stages 1–3 of colon cancer proliferation and metastatic potential, and growing epidemiological studies also indicate that dietary nitrate intake may relate to thyroid cancer [24].

Phosphate and sulfate are naturally occurring ions in water and are generally considered essential for human health in appropriate concentrations. Phosphorus is an essential mineral that plays a crucial role in various biological processes. Phosphorus is vital for bone and teeth formation, energy metabolism, and cell structure. While phosphorus is essential, excessive intake, often through highly processed foods or certain additives, may be associated with health issues such as kidney problems. However, natural phosphate levels in water are typically not a health concern. Similarly, sulfate is an essential component of certain amino acids and vitamins. It is involved in various biological processes, including synthesizing proteins and coenzymes. Sulfate in water is generally not a major source of dietary sulfur. The sulfate levels in drinking water are typically low and are not considered a health concern for the general population. Ingestion of water containing a high sulfate concentration can have a laxative effect, exacerbated when sulfate is combined with magnesium [24].

Treatment of the water samples with QNET Amezcua Bio Disc3 did not significantly ($p>0.05$) alter the concentrations of nitrate, nitrite, sulfate, phosphate, salinity, turbidity, and dissolved oxygen of the structured water samples compared with the control samples across all the groups. All values were within the WHO allowable limits. However, there was a significant ($p<0.05$) increase in the electrical conductance of all structured water samples compared to the control groups except in satchel and borehole water samples (Tables 1a-h). There was up to a 2-fold increase in electrical conductivity with increasing supercharging times for the supercharged

Table 2b
Mineral composition of QNET Amezcua Bio Disc3 treated bottled water 1

Element (wavelength) (mg/L)	BC0	BC1	BC2	BC3	BC4	BC5	BC6
Calcium (396.847)	2.53 ± 0.02	2.20 ± 0.01	1.30 ± 0.02	1.80 ± 0.01	0.16 ± 0.01	0.22 ± 0.01	2.20 ± 0.01
Iron (238.204)	0.27 ± 0.01	0.30 ± 0.01	0.27 ± 0.01	0.38 ± 0.01	0.33 ± 0.01	0.32 ± 0.01	0.39 ± 0.01
Potassium (766.491)	0.79 ± 0.02	0.29 ± 0.01	0.25 ± 0.02	0.51 ± 0.01	0.190 ± 0.00	0.24 ± 0.01	0.47 ± 0.01
Magnesium (279.553)	0.56 ± 0.01	0.54 ± 0.001	0.32 ± 0.02	0.25 ± 0.01	0.24 ± 0.01	0.32 ± 0.01	0.33 ± 0.00
Manganese (257.610)	0.017 ± 0.00	0.017 ± 0.00	0.061 ± 0.01	0.02 ± 0.00	0.0000	0.004 ± 0.01	0.04 ± 0.00
Sodium (589.592)	5.03 ± 0.02	4.70 ± 0.01	5.23 ± 0.02	5.00 ± 0.01	5.00 ± 0.01	5.00 ± 0.01	5.50 ± 0.02
Zinc (213.857)	0.04 ± 0.01	0.014 ± 0.01	0.56 ± 0.02	0.002 ± 0.02	0.00 ± 0.01	0.00 ± 0.01	0.007 ± 0.02

BC0, BC1, BC2, BC3, BC4, BC5, and BC6 represent exposure to the water on QNET Amezcua Bio Disc 3 for varied time frames of 0, 15, 30 minutes, 1 hour, 12, 24, and 48 hours respectively. Results were reported as mean± SD from 3 replicates and $p>0.05$. ND implies not detected.

Table 2c
Mineral composition of QNET Amezcua Bio Disc3 treated bottle water 2

Element (wavelength) (mg/L)	BM0	BM1	BM2	BM3	BM4	BM5	BM6
Calcium (396.847)	1.019 ± 0.01	1.16 ± 0.01	1.08 ± 0.01	0.0000	0.0000	0.03 ± 0.01	0.0000
Iron (238.204)	0.03 ± 0.01	0.034 ± 0.01	0.034 ± 0.01	0.03 ± 0.01	0.06 ± 0.01	0.0000	0.20 ± 0.01
Potassium (766.491)	0.147 ± 0.01	0.212 ± 0.01	0.127 ± 0.00	0.106 ± 0.02	0.041 ± 0.00	0.14 ± 0.02	0.08 ± 0.01
Magnesium (279.553)	0.23 ± 0.01	0.29 ± 0.02	0.31 ± 0.02	0.0000	0.0000	0.01 ± 0.01	0.0000
Manganese (257.610)	0.007 ± 0.02	0.008 ± 0.01	0.008 ± 0.00	0.002 ± 0.01	0.0000	0.0000	0.0000
Sodium (589.592)	0.49 ± 0.01	0.65 ± 0.02	0.51 ± 0.01	2.10 ± 0.01	1.90 ± 0.01	0.56 ± 0.01	0.34 ± 0.02
Zinc (213.857)	0.006 ± 0.01	0.009 ± 0.02	0.008 ± 0.01	0.00 ± 0.01	0.003 ± 0.02	0.001 ± 0.02	0.0006

BM0, BM1, BM2, BM3, BM4, BM5, and BM6 represent exposure to the water on QNET Amezcua Bio Disc 3 for varied time frames of 0, 15, 30 minutes, 1 hour, 12, 24, and 48 hours respectively. Results were reported as mean± SD from 3 replicates and $*p<0.05$. ND implies not detected.

Table 2d
Mineral composition of QNET Amezcua Bio Disc3 treated sachet water

Element (wavelength) (mg/L)	SW0	SW1	SW2	SW3	SW4	SW5	SW6
Calcium (396.847)	2.92 ± 0.01	2.608 ± 0.01	2.474 ± 0.01	2.33 ± 0.01	2.50 ± 0.01	0.99 ± 0.01	0.90 ± 0.01
Iron (238.204)	0.037 ± 0.01	0.04 ± 0.01	0.033 ± 0.01	0.033 ± 0.01	0.07 ± 0.01	ND	ND
Potassium (766.491)	0.49 ± 0.01	0.34 ± 0.01	0.374 ± 0.01	0.58 ± 0.01	0.45 ± 0.01	0.34 ± 0.01	0.26 ± 0.01
Magnesium (279.553)	0.74 ± 0.01	0.73 ± 0.01	0.66 ± 0.01	0.61 ± 0.01	0.56 ± 0.01	0.46 ± 0.01	0.41 ± 0.01
Manganese (257.610)	0.021 ± 0.01	0.021 ± 0.01	0.018 ± 0.01	0.017 ± 0.01	0.019 ± 0.01	0.007 ± 0.01	0.012 ± 0.01
Sodium (589.592)	7.29 ± 0.01	5.88 ± 0.01	6.37 ± 0.01	6.79 ± 0.01	6.133 ± 0.01	5.167 ± 0.01	5.80 ± 0.01
Zinc (213.857)	0.01 ± 0.01	0.017 ± 0.01	0.014 ± 0.01	0.013 ± 0.01	0.003 ± 0.01	0.001 ± 0.01	0.002 ± 0.02

SW0, SW1, SW2, SW3, SW4, SW5, and SW6 represent exposure of the water on QNET Amezcua Bio Disc 3 for varied time frames of 0, 15, 30 minutes, 1 hour, 12, 24, and 48 hours respectively. Results were reported as mean± SD from 3 replicates and $*p<0.05$

Table 2e
Mineral composition of QNET Amezcua Bio Disc3 treated distilled water

Element (wavelength) (mg/L)	DW0	DW1	DW2	DW3	DW4	DW5	DW6
Calcium (396.847)	0.13 ± 0.01	ND	ND	ND	ND	5.90 ± 0.01*	3.30 ± 0.01*
Iron (238.204)	0.13 ± 0.001	ND	0.08 ± 0.001	ND	ND	ND	0.09 ± 0.01
Potassium (766.491)	0.12 ± 0.01	0.13 ± 0.01	ND	ND	0.75 ± 0.01*	0.50 ± 0.01*	1.00 ± 0.01*
Magnesium (279.553)	0.12 ± 0.01	ND	ND	ND	ND	ND	7.00 ± 0.01*
Manganese (257.610)	0.0012 ± 0.01	ND	ND	ND	ND	ND	ND
Sodium (589.592)	0.37 ± 0.01	ND	ND	ND	ND	ND	ND
Zinc (213.857)	0.004 ± 0.01	0.003 ± 0.01	0.003 ± 0.01	0.003 ± 0.01	0.003 ± 0.01	0.006 ± 0.01	0.010 ± 0.01

DW0, DW1, DW2, DW3, DW4, DW5, and DW6 represent exposure to the water on QNET Amezcua Bio Disc 3 for varied time frames of 0, 15, 30 minutes, 1 hour, 12, 24, and 48 hours respectively. Results were reported as mean± SD from 3 replicates and $*p<0.05$. ND implies not detected.

water samples. Electrical conductivity is directly related to the concentration of dissolved ions in water. As the number of dissolved ions increases, so does the electrical conductivity. It also provides a measure of the salinity of water. The observed electrical conductance could be a result of the ability of Bio Disc 3 to confer energy-balancing properties on the water samples. The Bio Disc 3 from QNET energizes water using the proprietary process technology and has a masterful geometry design that creates a field of essential energy-balancing qualities and optimally balances the body's interactions with environmental stressors [12]. Our finding agrees with the study on physical and chemical properties of untreated and magnetically treated tap water where the electrical conductivity was significantly increased, especially with 1000 Gs, compared to untreated tap water with no significant changes observed in pH, salinity, dissolved oxygen content or chloride concentration [1].

Table 2f
Mineral composition of QNET Amezcua Bio Disc3 treated borehole water

Element(wavelength) (mg/L)	BH0	BH1	BH2	BH3	BH4	BH5	BH6
Ca 396.847	3.73 ± 0.01	3.00 ± 0.01	3.37 ± 0.01	3.67 ± 0.02	4.27 ± 0.00	3.57 ± 0.02	3.30 ± 0.01
Fe 238.204	0.0000	0.0000	0.0000	0.19 ± 0.01	0.024 ± 0.01	0.03 ± 0.02	0.13 ± 0.01
K 766.491	0.44 ± 0.01	0.42 ± 0.00	0.48 ± 0.02	0.40 ± 0.01	0.36 ± 0.01	0.36 ± 0.01	0.41 ± 0.01
Mg 279.553	0.36 ± 0.00	0.34 ± 0.01	0.27 ± 0.02	0.27 ± 0.01	0.048 ± 0.01	0.04 ± 0.02	0.69 ± 0.00
Mn 257.610	0.006 ± 0.01	0.005 ± 0.02	0.005 ± 0.00	0.010 ± 0.01	0.010 ± 0.01	0.010 ± 0.02	0.013 ± 0.01
Na 589.592	5.36 ± 0.01	5.30 ± 0.01	5.40 ± 0.02	5.20 ± 0.01	5.00 ± 0.00	4.90 ± 0.01	4.00 ± 0.00
Zn 213.857	0.013 ± 0.01	0.010 ± 0.00	0.010 ± 0.01	0.010 ± 0.00	0.007 ± 0.01	0.022 ± 0.00	0.017 ± 0.01

BH0, BH1, BH2, BH3, BH4, BH5, and BH6 represent the exposure of the water on QNET Amezcua Bio Disc 3 for varied time frames of 0, 15, 30 minutes, 1 hour, 12, 24, and 48 hours respectively. Results were reported as mean± SD from 3 replicates and *p<0.05

Table 2g
Mineral composition of QNET Amezcua Bio Disc3 treated tap water

Element (wavelength) (mg/L)	TW0	TW1	TW2	TW3	TW4	TW5	TW6
Calcium (396.847)	24.00 ± 0.01	22.00 ± 0.01	22.00 ± 0.01	22.00 ± 0.01	22.00 ± 0.01	23.00 ± 0.00	23.00 ± 0.01
Iron (238.204)	2.80 ± 0.02	1.90 ± 0.01	1.50 ± 0.00	1.80 ± 0.00	1.50 ± 0.01	1.50 ± 0.01	5.37 ± 0.00*
Potassium (766.491)	3.20 ± 0.01	3.10 ± 0.01	3.10 ± 0.01	3.20 ± 0.01	3.10 ± 0.01	8.00 ± 0.01*	5.00 ± 0.01*
Magnesium (279.553)	2.70 ± 0.00	2.60 ± 0.01	2.60 ± 0.00	2.60 ± 0.01	2.60 ± 0.01	5.40 ± 0.00*	5.30 ± 0.01*
Manganese (257.610)	0.01 ± 0.001	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.001	0.01 ± 0.00	0.07 ± 0.001	0.065 ± 0.001
Sodium (589.592)	7.50 ± 0.01	7.50 ± 0.01	7.50 ± 0.01	7.50 ± 0.01	7.50 ± 0.01	7.00 ± 0.01	6.40 ± 0.01
Zinc (213.857)	0.0031 ± 0.01	0.0023 ± 0.01	0.002 ± 0.00	0.0024 ± 0.01	0.0017 ± 0.01	0.0031 ± 0.01	0.0023 ± 0.01

TW0, TW1, TW2, TW3, TW4, TW5, and TW6 represent exposure to the water on QNET Amezcua Bio Disc 3 for varied time frames of 0, 15, 30 minutes, 1 hour, 12, 24, and 48 hours respectively. Results were reported as mean± SD from 3 replicates and *p<0.05

Table 2h
Mineral composition of QNET Amezcua Bio Disc3 treated rainwater

Element (wavelength) (mg/L)	SR0	SR1	SR2	SR3	SR4	SR5	SR6
Calcium (396.847)	1.69 ± 0.01	2.04 ± 0.00	1.54 ± 0.01	1.90 ± 0.01	1.83 ± 0.02	1.80 ± 0.01	1.50 ± 0.01
Iron (238.204)	0.043 ± 0.01	0.035 ± 0.001	0.027 ± 0.001	0.023 ± 0.001	0.039 ± 0.001	0.03 ± 0.001	0.21 ± 0.001*
Potassium (766.491)	0.28 ± 0.01	0.40 ± 0.01	0.42 ± 0.01	0.34 ± 0.01	0.32 ± 0.01	0.29 ± 0.01	0.41 ± 0.01
Magnesium (279.553)	0.10 ± 0.01	0.15 ± 0.01	0.36 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.05 ± 0.01
Manganese (257.610)	0.01 ± 0.001	0.014 ± 0.002	0.011 ± 0.003	0.0180 ± 0.001	0.014 ± 0.001	0.014 ± 0.002	0.0127 ± 0.001
Sodium (589.592)	0.85 ± 0.01	1.04 ± 0.00	0.51 ± 0.01	0.43 ± 0.01	0.34 ± 0.01	0.34 ± 0.01	0.50 ± 0.01
Zinc (213.857)	0.014 ± 0.00	0.038 ± 0.00	0.023 ± 0.01	0.018 ± 0.01	0.016 ± 0.01	0.002 ± 0.01	0.004 ± 0.01

SR0, SR1, SR2, SR3, SR4, SR5, and SR6 represent exposure to the water on QNET Amezcua Bio Disc 3 for varied time frames of 0, 15, 30 minutes, 1 hour, 12, 24, and 48 hours respectively. Results were reported as mean± SD from 3 replicates and p<0.05.

Effect of QNET Amezcua Bio Disc3 treatment on elemental/mineral composition of the study samples

Elemental analysis helps identify specific mineral elements in water, including essential nutrients and potentially harmful contaminants. It allows the detection of pollutants such as heavy metals (e.g., lead, mercury, cadmium) and metalloids (e.g., arsenic) that can adversely affect ecosystems and human health. Table 2a-h show the mineral and elemental composition of the study water samples structured with QNET Amezcua Bio Disc3. A comprehensive elemental analysis was done to determine the presence of nutrients and potentially toxic elements in the water samples. A total of 23 elements were assayed, including arsenic, aluminum, silver, barium, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, potassium, magnesium, manganese, sodium, nickel, lead, selenium, thorium, titanium, uranium, vanadium, and zinc. Structuring of the water samples with QNET Amezcua Bio Disc3 did not significantly ($p>0.05$) impact negatively on the mineral elements examined. No heavy metals were detected in the structured water samples. However, some major macro elements, including calcium, potassium, magnesium, and zinc, which are required for normal physiological functioning of the body, were significantly ($p<0.05$) enhanced when compared with the control group. Supercharging up to 5 times (11.00 ± 0.00 mg/L) significantly ($p<0.05$) increased the calcium content of bottled water compared to the non-supercharged water (2.53 ± 0.00 mg/L) (Table 2a). Calcium is an important macro-element required for optimum growth and development of bones and teeth. The permissible limit is 75mg/L. Structuring the water sample with the Bio Disc enhanced the water samples, albeit within the allowable amounts. Sodium was also significantly ($p<0.05$) reduced in the supercharged group, which indicates the possibility of the Bio Disc to lower high blood pressure, which could benefit hypertensive patients.

However, it was observed that the concentrations of calcium, potassium, iron, and magnesium ions were significantly ($p<0.05$) increased across the supercharged groups while the sodium ion was significantly ($p<0.05$) reduced as the water samples were serially charged with the Bio Disc3 (Table 2a). All water sample types structured with Amezcua Bio Disc 3 showed increased efficacy of solved minerals compared to unstructured samples. Iron was enhanced in a rainwater sample at 48 hours of treatment, while iron, potassium,

Table 3a
Effect of QNET Amezcua Bio Disc3 treatment on microbial load of the study samples

Sample	Total Viable Count (Cfu/ml)	MPN/100ML	Sample	Total Viable Count (Cfu/ml)	MPN/100ML
BM0	3.0×10^3	0	DW0	4.0×10^5	0
BM1	9.0×10^3	0	DW1	8.0×10^5	0
BM2	Nil	0	DW2	Nil	0
BM3	1.0×10^3	0	DW3	Nil	0
BM4	8.0×10^3	23	DW4	Nil	0
BM5	Nil	0	DW5	Nil	0
BM6	Nil	0	DW6	Nil	0
BC0	Nil	0	BH0	2.0×10^3	4
BC1	1.7×10^4	0	BH1	1.4×10^4	21
BC2	1.0×10^3	0	BH2	Nil	7
BC3	Nil	0	BH3	1.0×10^3	0
BC4	3.0×10^3	0	BH4	Nil	0
BC5	Nil	0	BH5	4.0×10^3	0
BC6	Nil	0	BH6	Nil	0
SW0	1.0×10^3	0	TW0	6.0×10^3	460
SW1	3.0×10^3	4	TW1	2.0×10^3	23
SW2	7.0×10^4	4	TW2	Nil	1100
SW3	2.6×10^4	240	TW3	2.0×10^3	150
SW4	1.5×10^4	240	TW4	1.5×10^4	240
SW5	Nil	0	TW5	Nil	11
SW6	Nil	0	TW6	2.0×10^3	0
SC1	Nil	4	SC6	Nil	15
SC2	1.0×10^3	43	SC7	Nil	23
SC3	Nil	240	SC8	Nil	150
SC4	2.0×10^3	9	SC9	Nil	43
SC5	Nil	75	SC10	Nil	4

Table 3b
Effect of supercharging experimentally infected water with QNET Amezcua Bio Disc3.

Sample	Total Viable Count (Cfu/ml) ($1.5.x10^8$ /ml)	Total Viable Count (Cfu/ml) ($3.0 \times 10^{8)}$	MPN/100ML
SCP	Nil	Nil	0
SC0	$3.2 \times 10^{6.}$	2.6×10^6	1100^+
SC1	2.4×10^6	7.0×10^5	1100^+
SC2	1.7×10^6	2.2×10^6	1100^+
SC3	1.7×10^6	1.6×10^6	1100^+
SC4	1.6×10^6	2.5×10^6	1100^+
SC5	1.1×10^6	1.9×10^6	1100^+
SC6	4.0×10^5	8.0×10^5	1100^+
SC7	3.0×10^5	8.0×10^5	1100^+
SC8	3.0×10^5	2.5×10^6	1100^+
SC9	3.0×10^6	2.1×10^6	1100^+
SC10	2.6×10^6	3.2×10^6	1100^+

SCP represents sterile distilled water, while SC0 represents distilled water infected with *E. coli.*

and magnesium were enhanced after 24 hours of treatment (Table 2h). It may be concluded that structured water has enhanced vibrational and chemical transmissions, which could help in optimizing mineral uptake.

Effect of QNET Amezcua Bio Disc3 treatment on microbial load of the study samples

Microbial analysis is an integral component of a comprehensive water quality assessment, complementing chemical and physical analyses. It provides a holistic understanding of water quality and the potential health risks associated with microbial contaminants. Microbial contaminants such as bacteria, viruses, and parasites can cause waterborne diseases, posing a significant threat to public health. Providing information about the microbial quality of drinking water builds public confidence in the safety of the water supply. Transparent reporting and adherence to microbial standards help reassure the public about the reliability of their drinking water.

Results in Table 3a show the absence of Coliforms and *E. coli* in all BM treatment groups with significantly reduced microbial load in the structured water. BC had no viable count at 0 minute but had growth at 15 and 30 minutes, which could have resulted from the proliferation of microorganisms. However, it later significantly ($p<0.05$) reduced microbial count with no coliform present. SW had an increase in the microbial count at 30mins, then reduced slightly at other time intervals, but there was an increase in coliforms (MPN/100ml).

DW had an inconsistent number of bacterial counts and the presence of Coliforms at 15 minutes; this might be a result of collecting samples or environmental factors. BH significantly reduced bacterial counts with no significant number of coliforms and seemed to

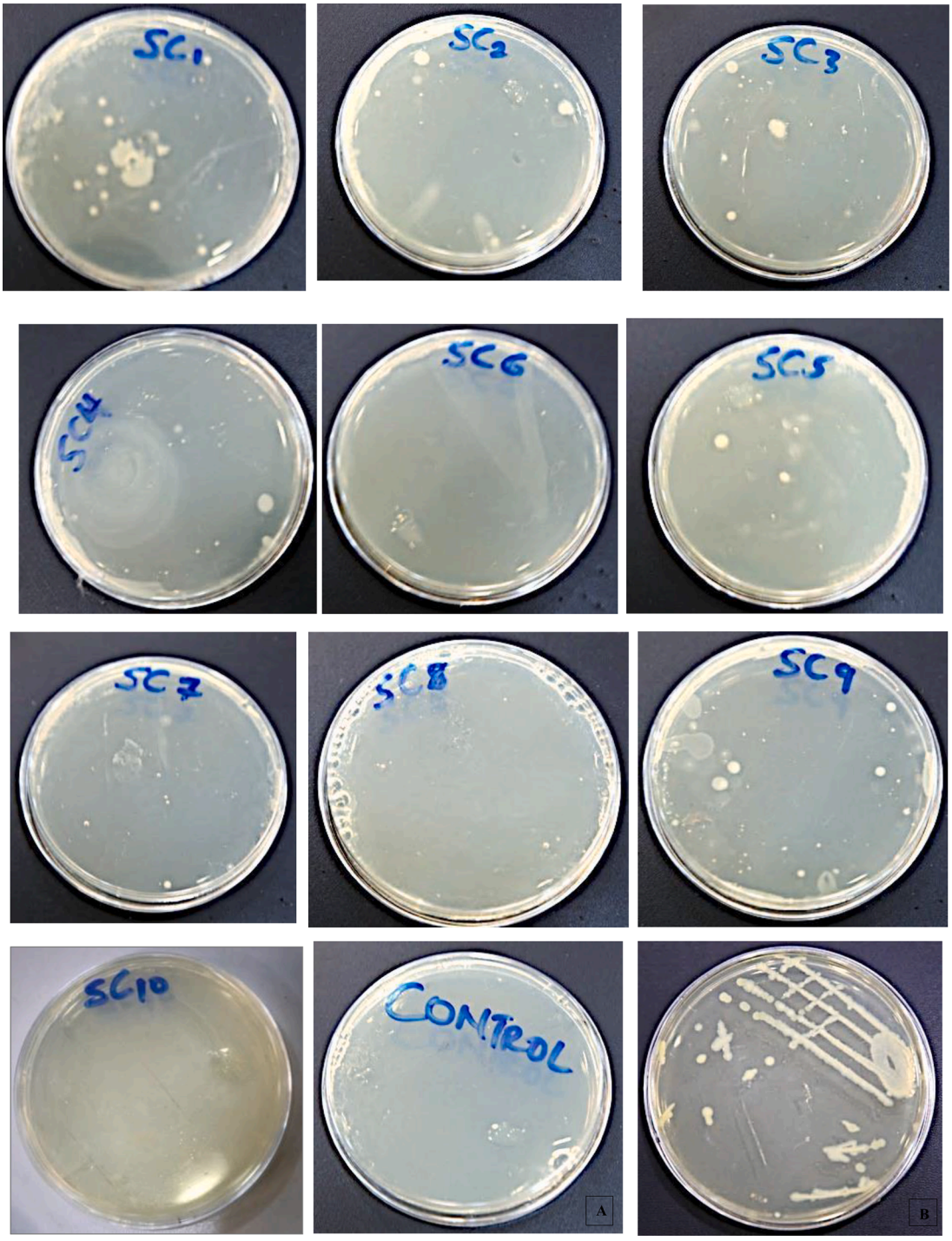

Plate 1. Effect of varied supercharging times (SC_1 – SC_{10}) on *E coli* - infected distilled water culture. A represents positive control (uninfected distilled water) while B represents negative control (infected distilled water without supercharging).

reduce the coliform significantly at 24 hours and 48 hours, respectively. TW significantly reduced bacterial counts at the time intervals but had a high number of coliforms and *E. coli* (MPN/100ml).

Table 3b shows the effect of QNET Amezcua Bio Disc3 on the microbial load of experimentally- infected water. The microorganism introduced was *Escherichia coli*. Supercharging of the infected autoclaved distilled water samples significantly ($p<0.05$) reduced the total viable count. The culture of the water samples is shown on Plate 1. In Table 3c, we report the results of the biochemical tests and isolates identified. Positive (+ve) and negaive (-ve) rods were identified from the Gran's reaction. Suspected organisms identified

Table 3c
Biochemical tests evaluation and isolate identification.

S/N	Gram's Reaction	Colonial morphology on Nutrient Agar	Coagulase	Citrate	Urease	H_2S	Indole	Motility	MIR	VP	Starch	Oxidase	Catalase	Lactose		Sucrose		Glucose		Maltose		Suspected organism
														A	G	A	G	A	G	A	G	
1	-ve rod	Smooth and circular	-	-	-	-	+	+	+	-	-	-	+	+	+	+	+	+	+	+	+	*Escherichia coli*
2	-ve rod	Creamy white, circular and raised	-	+	+	-	-	-	-	+	-	-	+	+	+	+	+	+	+	+	+	*Klebsiella* sp
3	-ve rod	Smooth and translucent	-	+	-	+	-	+	+	-	-		+	+	+	+	+	+	+	+	+	*Citrobacter* sp
4	+ve coccci	Yellow and circular	+	-	+	-	-	-	+	+	-	-	+	+	-	+	-	-	-	+	-	*Staphylococcu s aureus*
5	+ve rod	Rough and fuzzy white	-	-	-	-	-	+	+	+	+		+	-	-	+	-	+	-	+	-	*Bacillus* sp

+ve represents positive, while -ve represents negative. A stands for acid production, while G stands for gas production.

include *Escherichia coli, Klebsiella* sp., *Citrobacter* sp., *Staphylococcus aureus*, and *Bacillus* sp. All organisms were positive for catalase test.

In a study where broiler chicks challenged by *Salmonella enteritidis* were treated with magnetic water, there was a non-significant reduction of total bacterial count in the jejunum and colon of the broiler chicken compared to chicks that were given un-magnetized tap water [7]. Although, the mechanism is not fully understood, Sultan et al. [23] found that treating water with constant magnetic fields always results in a disinfection effect, while Anne et al. [2] concluded that maximum disinfection efficiency was 82.2% for bacteria exposed to a magnetic flux of 10 mT for 6 hours. This demonstrates that the magnetic field can function as an inhibitory factor against *E. coli.* The QNET Amezcua BioDisc 3 may possess similar effects of magnetic field on water following the observed effects in this study.

Supercharging seems to reduce the microbial count although coliform count was not affected.

In conclusion, this study showed the beneficial effects of physicochemical and microbial load analysis on various water samples treated with the Amezcua Bio Disc 3. All water sample types structured with Amezcua Bio Disc 3 showed increased efficacy of solved minerals (calcium, potassium, iron, magnesium, etc.) compared to water sample types that were not structured. A pH value slightly higher than seven was observed, which may enhance assimilation in body fluids. The structured water samples' high electrical conductivity is a validation of the Amezcua Bio Disc 3's energy-conferring properties, buttressing its effect as a wellness product. Furthermore, experimentation with the Amezcua Bio Disc 3 with the different water samples significantly reduced the microbial counts. This therefore, implies that the Amezcua Bio Disc 3 confers antibacterial properties on water samples contaminated with *E. coli*. Further study on the effect of potable water structured with the device on biological systems is recommended to validate claimed health enhancement properties.

CRediT authorship contribution statement

Abiodun H. Adebayo: Conceptualization, Supervision, Writing – review & editing. **Okukwe C. Obode:** Investigation, Methodology, Writing – original draft. **Bosede T. Adekeye:** Investigation, Methodology. **Bamidele Durodola:** Investigation, Methodology.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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