

Piezoelectrically Treated Water: Structural Modifications and Implications for Hydration, Nutrition, and Food Quality

G. Goderdzishvili ¹, Mark Jones ¹, Abhishek Tippa ², Krishna Madappa ², Srinivasan Vithoba ², Harsha Marle Krishna ², P. Kačer ¹

¹Czech University of Life Sciences, Kamýcká 129, 165 00 Prague 6, Czech Republic

²4th Phase Water Technologies Pvt Ltd - Jiva Water Bengaluru, Karnataka, 560070, India

INTRODUCTION & AIM

INTRODUCTION

- ◆ The piezoelectric effect is the ability of certain crystalline materials to generate an electric charge when exposed to mechanical stress.
- ◆ Though it does not alter water's molecular structure, piezoelectricity can affect water behavior by influencing hydrogen-bond orientation, ion distribution, and interfacial structuring.

AIM

- ◆ “To study the influence of piezoelectric treatment on water's hydrogen bonding, density, and viscosity.”
- ◆ “To assess its applications in biological systems (blood, beer, and tomatoes) and in food quality improvement.”

METHOD

SAMPLES

- Normal Tap Water (22 °C)
- Piezoelectrically Treated Tap Water (22 °C)

ANALYTICAL TECHNIQUES

- Near-Infrared Fourier Transform Infrared Spectroscopy (FTIR)
- Near-Infrared Spectroscopy (NIR)
- Nuclear Magnetic Resonance (NMR)
- Pycnometric Density Measurement
- Kinematic and Dynamic Viscosity Measurements

Applications and Benefits of Piezoelectrically Treated Water

BIOLOGICAL SAMPLES

- Human Blood
- Beer and Tomatoes

ANALYTICAL TECHNIQUES

- Biomedx 40× Phase Objective
- Sensory Analysis
- Agronomic Technique

PIEZOELECTRIC WATER TREATMENT UNIT

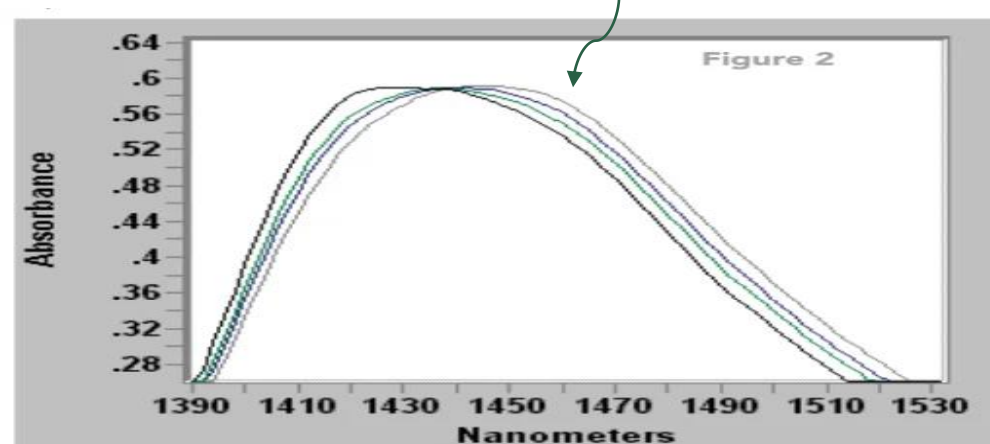


RESULTS & DISCUSSION

PHYSICOCHEMICAL EVALUATION OF TREATED VS. UNTREATED TAP WATER

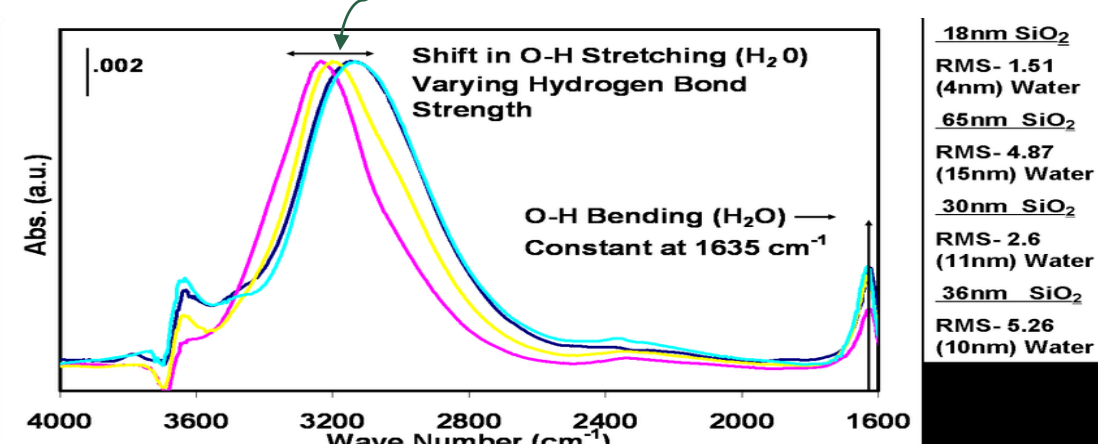
NIR SPECTROSCOPY:

- Tap Water – Upfield shift (~1440 nm) → WEAKER H-bonds
- Intermediate – Moderate H-bonding
- Piezo Water – Downfield shift (~1460 nm) → STRONGER H-bridges



FTIR SPECTROSCOPY:

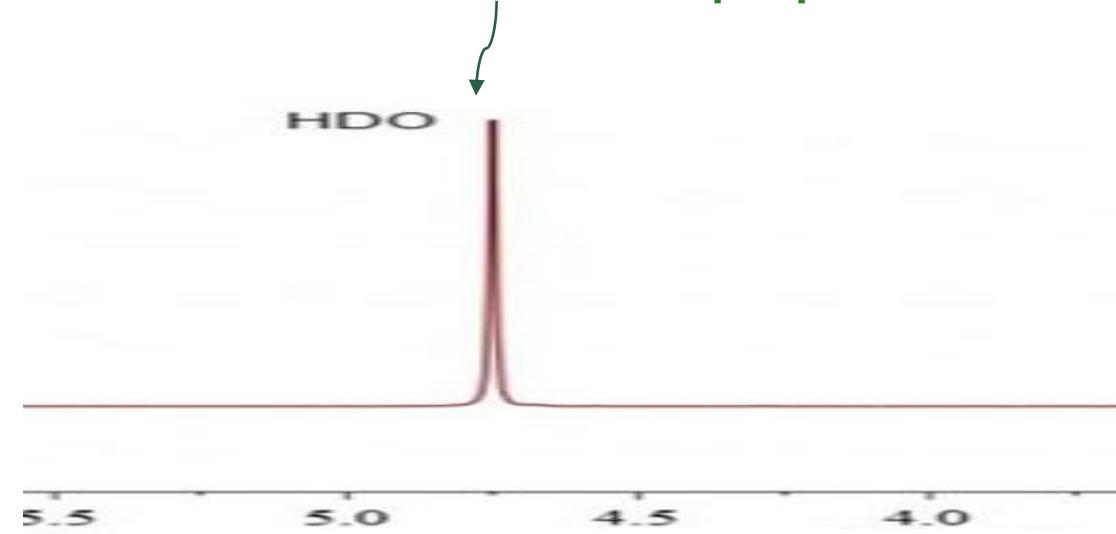
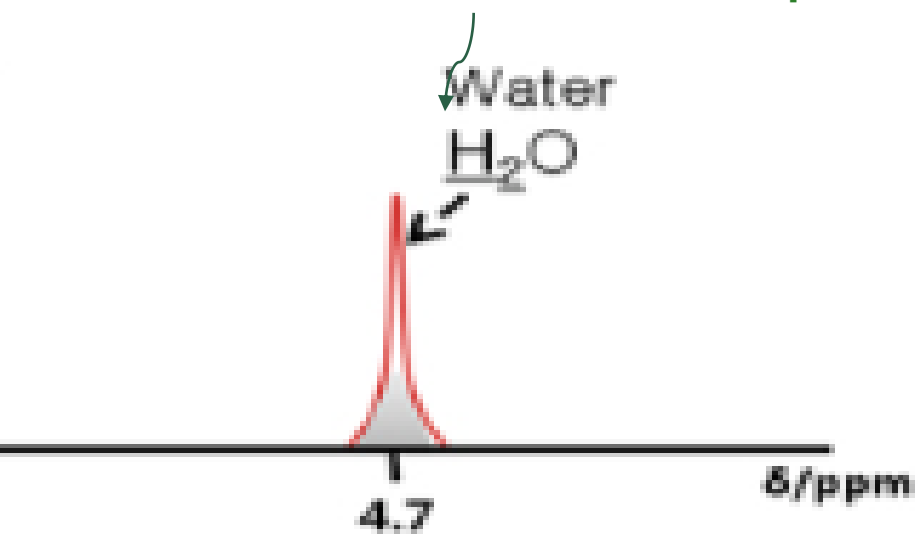
- Blue Curve – Peak below 3200 cm⁻¹ → downshifted → STRONGER H-bonding
- Pink Curve – Peak above 3200 cm⁻¹ → higher wavenumber → WEAKER H-bonding



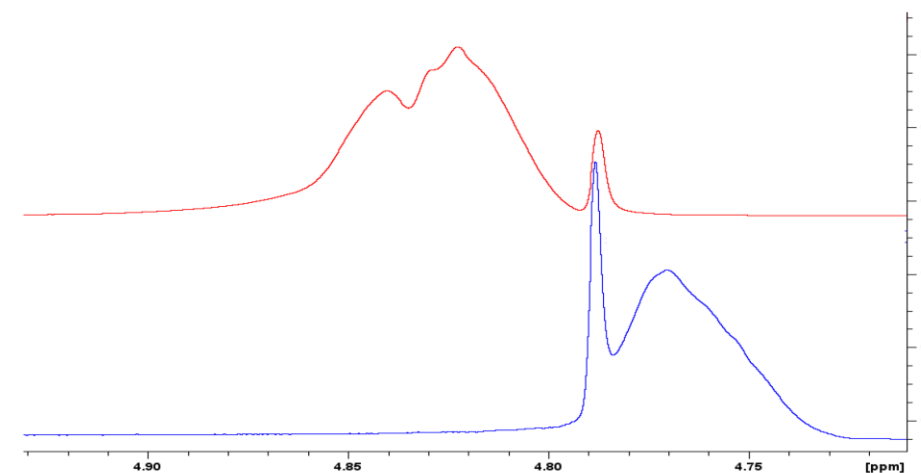
¹H NMR SPECTROSCOPY:

- ◆ Water peak ~4.5–5.0 ppm → H-bonding & proton exchange
- ◆ WEAKER H-bonds → broader peaks

- ◆ STRONGER H-bonds → sharper peaks



- Piezo Water: broader, downfield peak (~4.82 ppm) → STRONGER H-bonds, higher structural order.
- Tap Water: sharper, upfield peak (~4.78 ppm) → WEAKER H-bonds, lower organization.



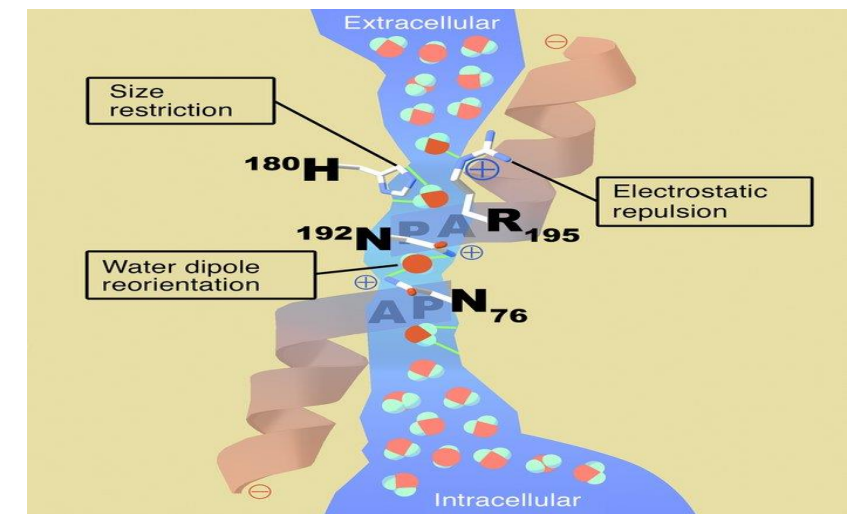
WATER DENSITY AS AN INDIRECT MEASUREMENT OF HYDROGEN BOND LENGTH IN NORMAL AND PIEZOELECTRICALLY AFFECTED WATER

Property	Untreated Water	After Piezoelectric Treatment	Expected Trend
Density (g/cm ³)	0.997	1.00 – 1.02	↑ Slight increase
Kinematic Viscosity (×10 ⁻⁶ m ² /s)	0.89	0.90 – 0.95	↑ Moderate increase
Dynamic Viscosity (mPa·s)	0.89	0.90 – 1.00	↑ Slight increase

BIOLOGICAL APPLICATION OF PIEZOELECTRICALLY TREATED WATER

Aquaporins: Pathways for Piezoelectrically Treated Water and Enhanced Bioavailability

Piezoelectric Treatment → reorganized hydrogen bonds → smaller water clusters → structured water → enhanced membrane hydration → aquaporin activation → increased membrane permeability → improved bioavailability.



PHYSIOLOGICAL AND HAEMATOLOGICAL EFFECTS OF PIEZOELECTRICALLY TREATED WATER: EVIDENCE FROM FOUR CASE STUDIES

Using BIOMEDX 40X phase objective

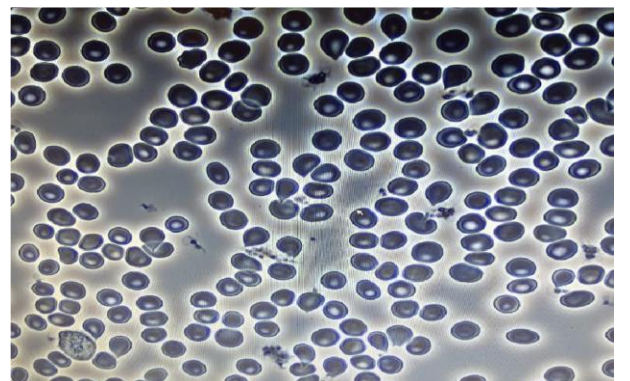
CASE STUDY 1

- ♀ 45 y/o female, night-shift worker
- ⚠ Before: Very fatigued after blood draw
- 💧 After piezoelectrically treated Water: Instant energy boost
- 🌙 Next morning: Slept 8 h (vs usual 3 h)

BEFORE

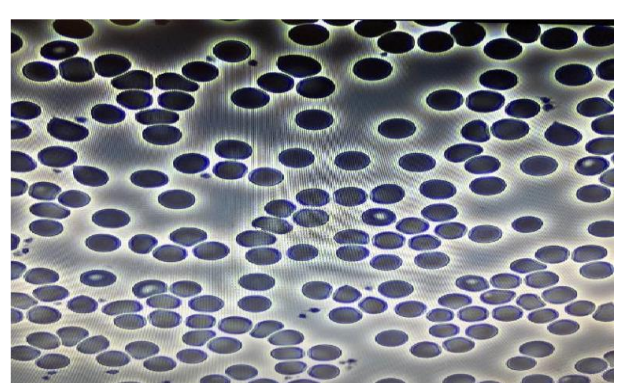
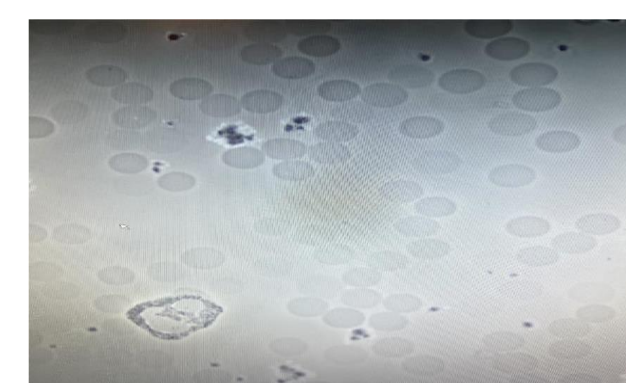


AFTER



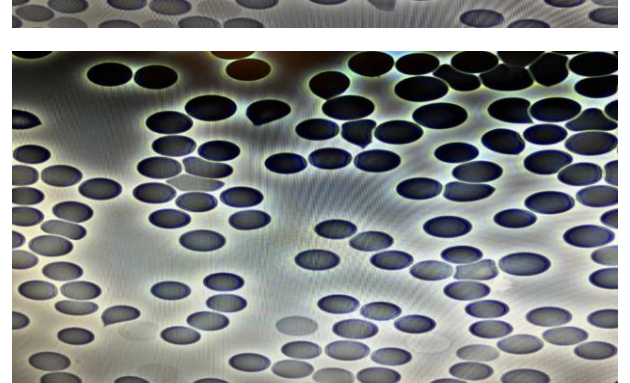
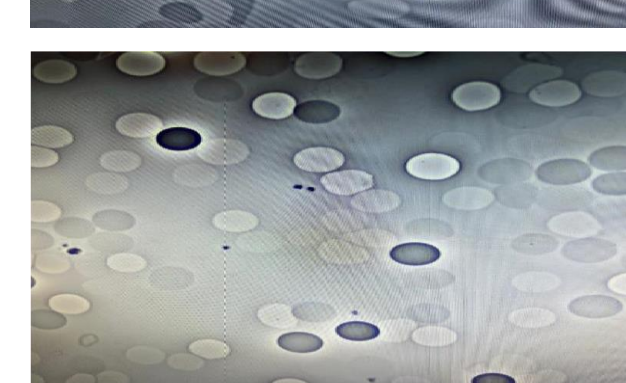
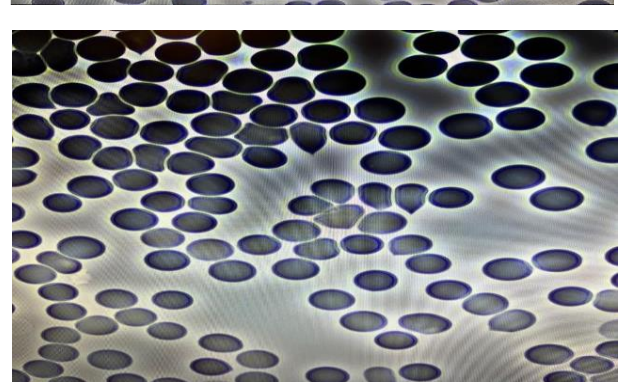
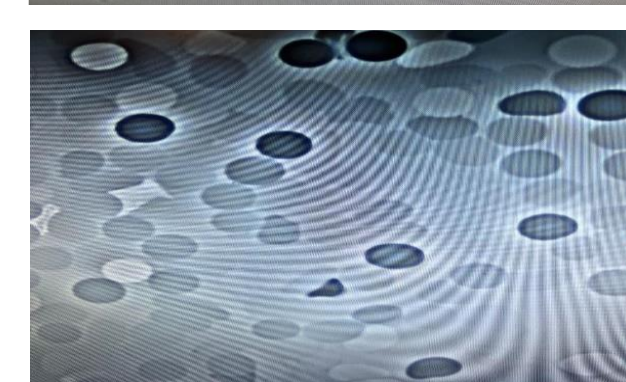
CASE STUDY 2

- ♀ 40 y/o female, mother of three
- 🏠 Health: Chronic fatigue, mold & parasite exposure
- 😴 Status: Persistent tiredness affecting daily life and well-being



CASE STUDY (3–4)

- 👤 Two regular alkaline-water users
- ⚠ Before: Acute fatigue reported
- 💧 Intervention: Drank 1 L of piezoelectrically treated water
- 🕒 Follow-up: 3 h after intake
- ⚡ Observation: Both noted a clear energy boost



✓ RESULT: Red Blood Cell (RBC) Analysis

- Before:
 - ◆ RBC aggregation, hemolysis, low mobility, and fatigue
- After:
 - Clear separation, improved morphology, reduced hemolysis

SENSORY ANALYSIS OF BEER AND TOMATO CROP PERFORMANCE

BEER Sensory Analysis Results

(After piezoelectrically treated water use in beer production)

▲ Significant differences:

- Beer Clarity
- Foam Quality
- Saturation



TOMATOES 🍅 (After Piezoelectrically Treated Water)

- 💧 Irrigation improved growth:
 - ☑ Weight: +55.6% (84 g vs 54 g)
 - ✂ Girth: +15.6% (52 mm vs 45 mm)
 - 🌱 Height: +28.0% (64 mm vs 50 mm)
- ✓ RESULT: Enhanced tomato growth and efficiency



CONCLUSION

Piezoelectrically treated water reorganizes hydrogen bonds, forming stable molecular clusters that enhance hydration, bioavailability, and biological performance.

- RBCs: Improved morphology, mobility, and reduced aggregation → better cellular hydration and vitality
- Tomatoes: +55.6% weight, +15.6% girth, +28% height → enhanced nutrient uptake and growth efficiency
- Beer: Greater clarity, foam stability, and saturation → improved fermentation quality
- ☑ Results demonstrate a strong link between piezoelectrically treated water, cellular function, and product quality.

Overall, these findings highlight the potential of piezoelectric water treatment to enhance biological efficiency and food production performance, supporting further scientific investigation.

ACKNOWLEDGMENTS / REFERENCES

We thank Dr. Kosak (RMI Ltd.) for NIR measurements, Dr. Vymyslický (ANAMET Ltd.) for surface tension and density analyses, Prof. Lenka Kouřimská (CZU Prague) for contributions to the beer sensory analysis, and Dr. Tereza Kačerová (University of Oxford) for NMR expertise. Their technical support was invaluable.

Ryu H et al., Int J Mol Sci. 20 (2019) 1437.

Li Z et al. Adv Energy Sustain Res. 2024; 5(5): 2300235.