90th birthday series

What is "structured water"?

Douglas A. Kerr

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Summary

We often read that drinking "structured water" confers various health and wellness benefits. But what exactly is "structured water"? This article discusses this enigmatic substance.

It mentions the controversy over whether structured water actually exists, but does not propose a conclusion.

The article does not discuss the purported health or wellness benefits of "structured water" nor the physiological mechanisms that might be involved.

1 INTRODUCTION

1.1 Diversity of information

There is on the Internet a vast collection of articles, blog entries, and the like discussing "structured water". The various commenters and proponents emphasize different, and in some cases inconsistent, outlooks on the physical properties of this substance.

In this article I will mostly discuss those outlooks that seem to be fairly consistent in their mention on the Internet.

1.2 Controversy

There appears on the Internet various commentary from the "mainstream scientific community" asserting that there is no such substance as "structured water". Some writers go so far as to declare structured water to be the premise of a marketing scam.

I do not here weigh in on this controversy.

I am, however, sufficiently concerned that, in a abundance of caution, here I will sometimes speak of some "supposed" property of structured water, or introduce some "fact" with "It is said that…".

1.3 Level of detail here

In this article I will give far less definitive technical information than the reader might expect if I were, for example, writing about a continuous glucose monitor system or the mechanism of an insulin

pen. That is an consequence of the online “literature” of this enigmatic substance, which is not full of consistent and (to me) satisfying technical information.

2 THE BIG DIFFERENCE FROM “COMMON WATER”

Structured water is said to have an extended and persistent arrangement of the water molecules into a regular geometric pattern, whereas what we normally think of as “water” (which I will here call “common water”) has only transitory and localized clustering of small groups of molecules, not forming any regular pattern.

This difference in structure is said to give structured water measurably different physical properties from common water, as well as to impart to it the ability to benefit health and wellness.

3 A LITTLE MORE ABOUT THOSE LIQUIDS

3.1 Common water

In orthodox chemistry, *water* refers to a specific compound of oxygen and hydrogen with chemical formula H_2O. The term “water” without further qualification is ordinarily taken to mean its liquid phase, which is of interest here.

Although in chemistry the term “water” unambiguously refers to this compound, to avoid any uncertainty, in this article I will refer to it (in its liquid phase) as “common water”.

It is generally considered that the molecules of common water transiently gather into small 3-dimensional clusters. These clusters are constantly rearranging. There is no overall pattern to this clustering. This is said to be the centerpiece of its difference from structured water.

3.2 Structured water

Structured water (also often called “hexagonal water”) is supposedly a liquid water form in which the molecules have a regular, extended, and persistent hexagonal structure (thus the names). This is said to be the centerpiece of its difference from common water. Some have characterized this liquid as a polymer[1] of water.

It is sometimes said that the chemical formula of this liquid is H_3O_2, as contrasted with the H_2O formula of common water. (More about that in Section 5.)

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[1] A polymer is a substance having very large molecules that consist of many “repeat units”, which (at the lowest level) are molecules of some compound, these being linke together by various types pf bonds.

4 MOLECULAR ARRANGEMENTS

In common water, adjacent molecules (with the formula H_2O) are thought to be transiently bonded into small “clusters”.[2] This bonding is constantly changing (consistent with the “fluidity” of liquid water), and does not create any stable repetitive overall pattern of bonding. Drawings like the one in Figure 1 are often presented to illustrate this situation.

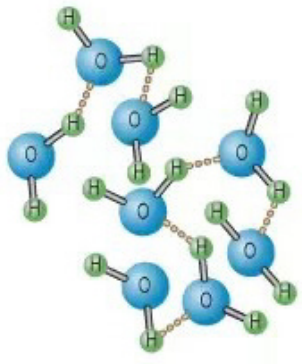

Figure 1. Clusters of common water molecules

In contrast, it is said that in structured water, the individual molecules are essentially bonded together in a persistent, extended hexagonal lattice pattern. This is sometimes illustrated as we see in Figure 2).

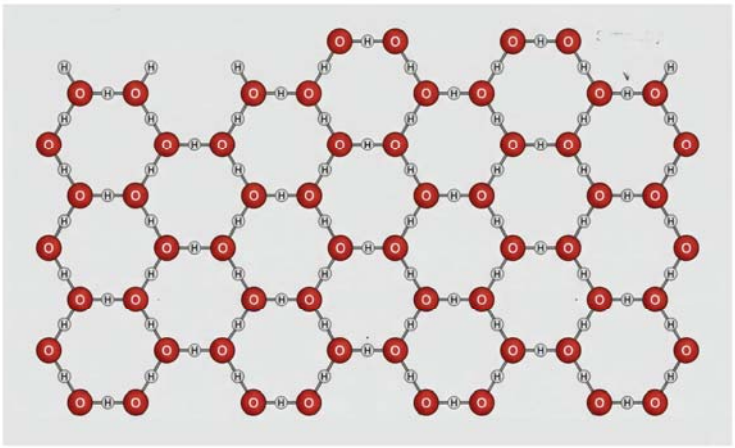

Figure 2. Structured water–structure as often shown

The red dots represent oxygen atoms. The smaller gray dots represent hydrogen atoms.

This figure portrays a two-dimensional structure, consistent with the common description of structured water being composed of multiple

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[2] This bonding between separate molecules is spoken of as “noncovalent bonding”, being distinguished from “covalent bonding”, which is the bonding between atoms of a molecule.

layers, free to slip over one another (thus providing for the “fluidity” of the structured water, much as we have for common water).

This illustration does not show us the difference between covalent bonds (which join the atoms of a molecule) and noncovalent bonds (which connect separate molecules).

5 ABOUT H_3O_2

If, on the two-dimensional structure shown in Figure 2, we try to identity the individual water molecules (perhaps planning to draw a line around each one), we find that it just does not work out. [3]

If that could have worked out, then over a large area, in the limit, we would expect the ratio of the number of hydrogen atoms to the number of oxygen atoms to approach 2:1, consistent with the chemical formula for common water, H_2O.

However, it turns out that in that structure, over a large area, in the limit, the ratio of the number of hydrogen atoms to the number of oxygen atoms approaches 3:2.

So, it is reasoned by some, the underlying “molecule” of structured water must have three hydrogen atoms and two oxygen atoms; that is, it would have the chemical formula H_3O_2.

There is, however, no compound recognized in mainstream chemistry with the formula H_2O_3. But that is often a short way of referring to the negative ion whose complete symbol is $H_3O_2^-$ (often called the *bihydroxide anion*). It consists of a hydroxide ion (OH^-) bonded to a water molecule (H_2O).

These ions have a negative electrical charge of one electron’s-worth each. Some proponents of structured water tell us that, indeed, structured water has an overall negative electrical charge.

This is not a standalone “molecule” but rather a “subassembly” that can be part of some more complex substance. But much research on the bihydroxide anion tells us that (in a liquid context) it can only exist for a very brief time (just a few picoseconds), it being only part of an intermediate product in certain chemical processes.

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[3] We have the same problem in understanding the structure of ice, which is often presented (in a view of a single two-dimensional layer, exactly as we see in Figure 2. The key is that if we actually look at the three dimensional structure of ice (with multiple layers, each such as seen in Figure 2, bonded together), then in fact we can decompose that into water molecules (with chemical formula H_2O).

6 SOME PHYSICAL PROPERTIES

As I mentioned above, there is great diversity of discussion about the physical properties of structured water.

Some commenters mention the following differences between the physical properties of structured water and common water:

a. The density (specific gravity) of structured water is significantly greater than that of common water.

b. The viscosity of structured water is significantly greater than that of common water.

c. The surface tension of structured water is significantly less than that of common water.

d. Structured water has a significantly greater index of refraction than common water.

e. Structured water has a significantly lower freezing temperature than common water.

f. Structured water has a significantly higher boiling temperature than common water.

g. Structured water has a net negative electrical charge (whereas common water is neutral).

7 ACQUIRING STRUCTURED WATER

7.1 Introduction

Here are a few of the many ways described to acquire structured water, as found on the Internet.

7.2 Natural sources

Advocates of the use of structured water often state that the water flowing in streams and the like is largely structured water. It is said that the "swirling" and "vortex" motion of the water in such cases leads to much of it becoming "structured" [4].

7.3 Generation at home

A number of devices and practices have been described for use by consumers to generate structured water at home. These include:

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[4] The implication being that before it had "spent time in a creek" (perhaps as it fell as rain) it had been common water.

a. A glass bottle containing crystals, notably of quartz.

b. Devices that cause the water to swirl and create a vortex, perhaps in the presence of magnets.

c. Setting a glass or pitcher of water in direct sunlight for a while.

d. Stirring a glass of water with a stick wrapped with copper wire.

e. Devices that use the “Pollack principle” (see Section 10.11) to generate structured water.

7.4 Purchase “ready to drink”

A number of vendors sell what seems to be structured water “ready to drink”, typically in glass bottles or gallon jugs.

One listing for such a product says:

> ...features hexagonal structured clusters...and is energetically amplified with a balanced network of spirited crystals.

It continues:

> Testing confirmed that [this water[forms **beautiful hexagonal structured clusters**, the hallmark of high-quality, energetically vital water.

8 THE RUSSIAN DISCOVERY

In the late 1960s, Russian scientists reported that they had discovered and characterized a new form of water, a water polymer (eventually spoken of as “polywater”), with many properties different from those of common water. It was found in a measurable concentration when common water rose into a very small diameter capillary tube. The intimation today was that this substance existed only near the walls of its container.

The discovery of flaws in their work (notably the supposed presence of various contaminants in the liquid tested, those leaching from the capillary tube itself) led to their findings being discredited.

9 THE WORK OF E. R. LIPPINCOTT

In 1969, E.R. Lippincott, of the University of Maryland, and other authors published an article in a respected scientific joiurnal describing spoke of as “polywater”, a water polymer with many properties different from those of common water. This work built on earlier work the Russian scientists spoken of just above.

But in 1971, another article was published that debunked Lippincott’s work, mainly on the grounds that again, there had been significant contaminants in the liquid being tested.

10 THE WORK OF GERALD POLLACK

10.1 Introduction

In 2013, Gerald H. Pollack, PhD, a professor at the University of Washington, a recognized researcher in many aspects of water, published *The Fourth Phase of Water: Beyond Solid, Liquid, And Vapor*. This book is widely cited in connection with the matter of structured water. As a consequence, I will spend a fair while discussing various key aspects of Pollack's work.

10.2 The "exclusion zone" amd "EZ water"

The central aspect of Professor Pollack's book begins with his observation that if we have a vessel containing water, and the wall of that vessel is of a certain nature[5], then there is a very thin region near that wall, called by Pollack the "exclusion zone" (EZ)[6], that seemingly cannot be penetrated by, say, small particles suspended in the water at large (or even substances dissolved in the water at large). This region may typically be 0.1 mm thick (seemingly small, but quite substantial compared to molecular dimensions).

Pollack goes on to suggest that this exclusion is a result of the liquid in that zone not being liquid water in its familiar form, but rather a different liquid form of water (which Pollack calls "EZ water"[7]), with various properties different from "ordinary water".

Pollack describes that we might expect this EZ water to have essentially the properties commonly ascribed to structured water (as mentioned in Section 6).

10.3 A "fourth phase" of water?

Pollack suggests that this substance be considered a "fourth phase" of water, beyond the three familiar phases, solid, liquid and vapor.

He goes on to posit that this phase (also liquid) has the molecules of water arranged in a different way than they are in common water. This would comprise "layers" of a repetitive 2-dimensional pattern (perhaps even the one seen in Figure 2).

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[5] For example a *hydrophilic* material. The term "hydrophilic" literally means "water loving". It refers to materials that are attracted to water or which attract water.

[6] Pollack sys the term was coined by a colleague.

[7] The reader first encountering the term "EZ water" would be tempted to think that, as is often done colloquially, "EZ" was a slang shorthand for "easy". Not so here.

In his book he describes in some detail how this unique substance is structured, and how it is created in the “EZ zone”. I will not attempt to synopsize that here.

10.4 Similarity to the structure of ice

The structure often described for such substances as Pollack’s EZ water (as seen, for example in Figure 2) looks much like the structure of the most common form of ice, if we limit ourselves to a two-dimensional “layer” of the substance of interest.

Of course, EZ water is much different from ice. For one thing, at least at “room temperature”, it is a solid, while EZ water is a liquid. How can that be?

The key is that of course both these substances are actually of interest in a three-dimensional context. There they might both comprise many layers of some fundamental structure, perhaps indeed for both as seen in Figure 2. But certainly, the details of the bonds between layers differ between EZ water and ice.

10.5 Relation to the work of Lippincott

Pollack points out that the EZ water he describes seems very similar to the “polywater” earlier described by Lippincott, and that perhaps Lippincott was essentially correct–perhaps his Russian predecessors as well.

10.6 “Tentacles” of the exclusion zone

Pollack tells us that, while the “exclusion zone” as a contiguous layer will only have a thickness of a fraction of a millimeter, it can send out “tentacles”, very thin filaments of EZ water that can reach a length of up to a meter.

10.7 Progressive “degrading” of the exclusion zone

Pollack describes in detail how, as we move away from the vessel wall, the “EX water” becomes progressively “degraded” back into common water (Pollack speaks of the structural lattice becoming “eroded”.)

10.8 EX water “in bulk”?

Notwithstanding the observation of lengthy “tentacles” of EZ water, it does not seem that EZ water could exist truly in bulk (as if we wanted to fill a beaker with it, or a gallon jug).

Pollack himself, in his book, refers to what I call here “common water” as “bulk water”, thus perhaps suggesting that EZ water cannot be expected to exist “in bulk” (*e.g.,* in a gallon jug).

10.9 Support for the concept of “structured water”?

Many enthusiasts of “structured water” have seized upon Pollack’s book as confirming, observationally and theoretically, that there is indeed “structured water”, namely, the EZ water posited by Pollack.

But, as I mention in Section 10.8, it is not at all clear that the substance Pollack describes can exist “in bulk”.

10.10 About “H_2O_3”

Pollack does discuss that the ratio of hydrogen atoms to oxygen atoms in EZ water has been confirmed as “3:2” (based on certain testing by others), but stops short of suggesting a chemical formula of H_3O_2 for the substance.

10.11 Generating structured water *à la* Pollack?

At least one manufacturer of structured water generating devices describes their operating principle as the generation of thin layers of structured water, seemingly as Pollack describes as happening near the walls of a vessel.

Here, however, the process is described as continuing indefinitely, forming one layer of structured water after another to generate an unlimited quantity of structured water to, for example send to a “structured water” faucet.

10.12 Alternate theories

A very esoteric paper by Daniel C. Elton *et al*, *Exclusion Zone Phenomena in Water—A Critical Review of Experimental Findings and Theories*, summarizes work forth by other researchers to reproduce and and/or explain the “exclusion zone” phenomenon reported by Pollack.

According to the abstract of the paper, some of these researchers report indeed being able to reproduce that phenomenon, and perhaps attribute the phenomenon to the presence of a liquid substance different from water. Some put forth alternate explanations as to the nature of that substance. Some assert that this substance is not a “4th phase” of water.

I have not read this paper itself.

11 INTRACELLULAR WATER

“Intracellular water” refers to the liquid that is inside the cells of, for example, a human being. In fact, in a human, about 40% of the overall body mass is said to be intercellular water.

There seems to be considerable evidence that the liquid inside cells behaves differently from common water.Proponents of structured water point out that structured water is rather like intracellular water.

It may be that the liquid inside cells is essentially the “exclusion zone” water described by Pollack. The small dimensions of cells might mean that their entire interior is within the “exclusion zone” where Pollack says that this liquid is formed and can exist. Thus, structured water might in fact be similar to the liquid inside cells.

12 ABOUT “90TH BIRTHDAY SERIES”

This article is one of several publications made around the time of the 90th birthday of the author, May 8, 2026.

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