Utilization of Ozone Water Generators for Preventing Infection in Home Care

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Functional water

Among the aqueous solutions that have been given reproducible and useful functions by human processing, those that have been scientifically clarified.

- Japanese Functional Water Foundation 1993 -

Electrolyzed water

Acidic electrolyzed water (Bactericidal ability)

Alkaline electrolyzed water (Intestinal regulation, washing detergent)

Ozone water

Bactericidal ability
Our previous study on acidic electrolyzed water with bactericidal ability

2. Studies on the Use of Electrolyzed Water as a Disinfectant at Home Care. GLOBAL HEALTH, pp. 5-7, 2014
9. Characteristics of strong acidic electrolyzed water. IFMBE Proceedings, 2005
Patent
1. Invention title: Apparatus and Method for Producing Electrolyzed water
   Inventor: Koichi Umimoto, Syunji Nagata
   JP patent No. 4580039

2. Invention title: Apparatus and Method for producing Electrolyzed water
   Inventor: Koichi Umimoto, Syunji Nagata

Patent application
1. Invention title: APPARATUSES AND TO METHOD TO PRODUCING ELECTROLYZED FLUID
   Inventor: Koichi Umimoto, Syunji Nagata, Aki Kamada

2. Invention title: DEVICE AND METHOD FOR PRODUCING ELECTROLYZED LIQUID
   Inventor: Koichi Umimoto, Syunji Nagata
   PCT/JP2013/002171

3. Invention title: DEVICE AND METHOD PRODUCING ELECTROLYZED LIQUID
   Inventor: Koichi Umimoto, Syunji Nagata
   PCT/JP2012/008363
**Advantage**

**Electrolyzed water** with bactericidal ability is easily made of water. This reverts to ordinary water after use.

**Anode side**

\[
\begin{align*}
\text{H}_2\text{O} &\rightarrow \frac{1}{2}\text{O}_2 + 2\text{H}^+ + 2e^- \\
2\text{Cl}^- &\rightarrow \text{Cl}_2 + 2e^- \\
\text{Cl}_2 + \text{H}_2\text{O} &\rightleftharpoons \text{HClO} + \text{HCl}
\end{align*}
\]

**Disadvantage**

↓

Ozone water

**Acidic electrolyzed water**
Purpose

The Hygiene management for infection is important in home care.
The ozone water is an attractive option for hygiene management in home care.
In this study,

We developed two devices for producing ozone water for use in home care.
We used the first, simple device to investigate the properties and bactericidal activity of ozone water. With the second, flowing water device, which produces ozone water for outdoor use, we studied the concentration of ozone water at different distances from the hose nozzle.
Simple device

1. Properties of ozone water
   To investigate the sustainability of ozone water,
   1) Fresh ozone water was put into a beaker and measured its ozone concentration over time.
   2) Hands were soaked into the fresh ozone water and measured its ozone concentration.

2. Bactericidal activity
   To investigate the bactericidal activity of ozone water,
   *Escherichia coli* (*E. coli*) gram-negative bacterium and *Staphylococcus aureus* (*S. aureus*) gram-positive bacterium were prepared. The bactericidal activity was assessed by counting the number of colonies of bacteria in the petri dish.
Anode side

\[ 5 \text{H}_2\text{O} \rightarrow \text{O}_2 + \text{O}_3 + 10\text{H}^+ + 10\text{e}^- \]

Cathode side

\[ 2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2 \]

Tap water (1 L) was electrolyzed by DC 20 V
Results

Ozone concentration during electrolysis

Changes in ozone concentration after generation
Changes in ozone concentration by soaking hands
Bactericidal activity of ozone water produced by simple device

E.Coli

$\times 10^6$ Dilution

$\downarrow$ Ozone water (1.1 ppm)  $\downarrow$

S.aureus

$\times 10^6$ Dilution

$0$ CFU/mL

$0$ CFU/mL
1. **Prototype of a flowing water device**
   A diamond-coated titanium plate is used as the anode, and a stainless as the cathode. The device consisted of an electric cell with built-in electrodes and a hose, which is directly connected to an outdoor water source. The ozone water is released by pressing the hose nozzle.

2. **Water release experiment**
   The ozone concentration in the water was measured at 0m, 2m and 4 m from the hose nozzle.
## Results

<table>
<thead>
<tr>
<th>Released distance of ozone water (m)</th>
<th>0</th>
<th>2</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ozone concentration in released water (ppm)</td>
<td>1.6±0.2</td>
<td>1.4±0.2</td>
<td>0.6±0.3</td>
</tr>
</tbody>
</table>
Conclusion

We developed two devices that can be used at home to produce ozone water for infection prevention.

Our simple device produces 1 ppm of ozone water within 20 minutes of starting electrolysis and the ozone disappears within 70 minutes. And also, the ozone water shows strong bactericidal activity.

The flowing water device maintains a bactericidal ozone concentration up to 2 m from the hose nozzle and is suitable for outdoor use.

The devices are useful for producing ozone water as a disinfectant for use in indoor and outdoor home care and are beneficial from both an economic and an environmental perspective.
Acknowledgement

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