

The Effect of Quarantine Time on the Quality of Bottled Drinking Water (AMDK) that Use Ozonation Process

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Abstract. Bottled drinking water (AMDK) requires disinfection such as ozonation to ensure safe consumption. Ozonation disinfection is carried out to eliminate pathogenic microorganisms. The ozonation process can produce residual ozone which is a strong oxidizer and therefore harmful to health. To eliminate microorganisms and residual ozone, quarantine time is required. The purpose of this study was to determine the optimal quarantine time for the elimination of pathogenic microorganisms and remaining ozone in bottled drinking water. Bottled drinking water brand X samples were tested with a Completely Randomized Design (CRD) at 5 levels of quarantine time (0, 2, 4, 6, 8 hours) and 3 replications with parameters of pH, TDS, DO, Turbidity, and TPC analyzed using a WA2017SD digital tool and the standard TPC method. The results showed the best water quality with a pH value of 6.89; TDS 120 mg/L; DO 7.5 mg/L; Turbidity of 0.29 mg/L and TPC of 0.33 colonies/mL at a quarantine time of 6 hours effectively reduces microorganisms and ozone residues so that all water quality parameters meet the SNI 3553:2015 standard, therefore the quarantine time for AMDK using ozone is very important.

Keywords: Ozonation, Quarantine Time, Bottled Drinking Water (AMDK), Water Quality, Disinfection

Introduction

Water is a fundamental and irreplaceable necessity for human health, essential for preventing dehydration and supporting bodily functions. However, access to safe drinking water remains a global challenge. In 2017, a staggering 785 million people lacked access to basic drinking water, and at least 2 billion people were using water sources contaminated with feces, leading to the spread of dangerous diseases like diarrhea and cholera. To ensure the safety of bottled drinking water, the production process includes crucial steps like filtration and disinfection. Disinfection is a critical control point designed to eliminate pathogenic microorganisms. **Ozonation**, which utilizes ozone as one of the strongest oxidizers and most effective disinfectants, is highly efficient at killing these microorganisms and breaking down toxic organic compounds. Despite its effectiveness, the ozonation process can leave residual ozone in the bottled water. This residue can be a health concern if consumed. A common and effective method to minimize this risk is by **quarantining** the bottled water before it is distributed to consumers. The primary purpose of this quarantine is to allow the residual ozone to safely decompose back into oxygen, ensuring the water is safe for consumption. Therefore, this research was conducted to determine the optimal quarantine time required to ensure that bottled drinking water is free from ozone residue and safe for consumption.

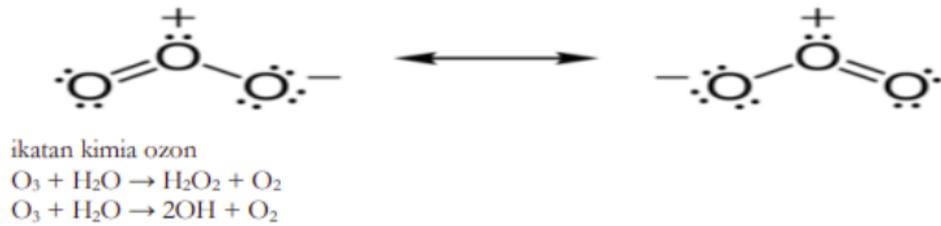


Figure 1. Ozone decomposes in water (Sofia, D. R. (2020))

Figure 1 shows the disinfection process of ozone works through oxidation by free radicals, such as hydrogen peroxide (H_2O_2) and hydroxyl radicals ($\bullet OH$), which are formed when ozone decomposes in water. The chemical reactions that occur when ozone decomposes in water are: $\bullet O_3 + H_2O \rightarrow H_2O_2 + O_2$ $\bullet O_3 + H_2O \rightarrow 2OH + O_2$ These hydroxyl radicals ($\bullet OH$) function by reducing or attaching to the bacterial cell wall. Over time, this will create holes in the bacterial cell wall, ultimately damaging and killing the bacteria.

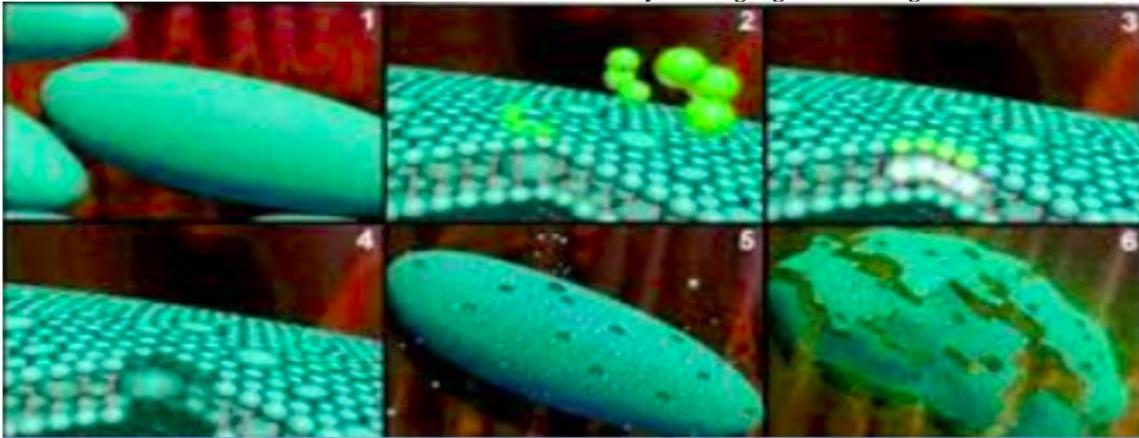


Figure 2. Hydroxyl radicals ($\bullet OH$) function by reducing or attaching to the bacterial cell wall (Sofia, D. R. (2020))

As shown in **figure 2**, ozone, with its oxidizing properties, can kill various microorganisms, including Escherichia coli, Salmonella enteritidis, and various other pathogenic bacteria. Its main mechanism is through the oxidation process, where ozone damages the outer cell walls of microorganisms (cell lysis), leading to their death.

Methods

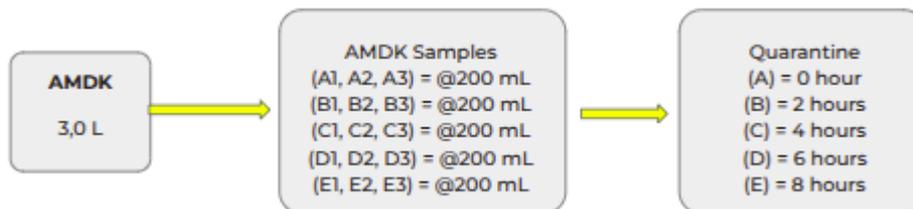


Figure 3. Sampling Method

Figure 3 shows samples were taken in one batch and at the same time, totaling 15 cups of 200 mL each. These 15 cups were divided into five, each quarantined for 0, 2, 4, 6, and 8 hours. Each quarantine period consisted of three cups (triplicate). The parameters analyzed at each quarantine period were pH, DO, TDS, turbidity, and TPC.

Result and Discussion

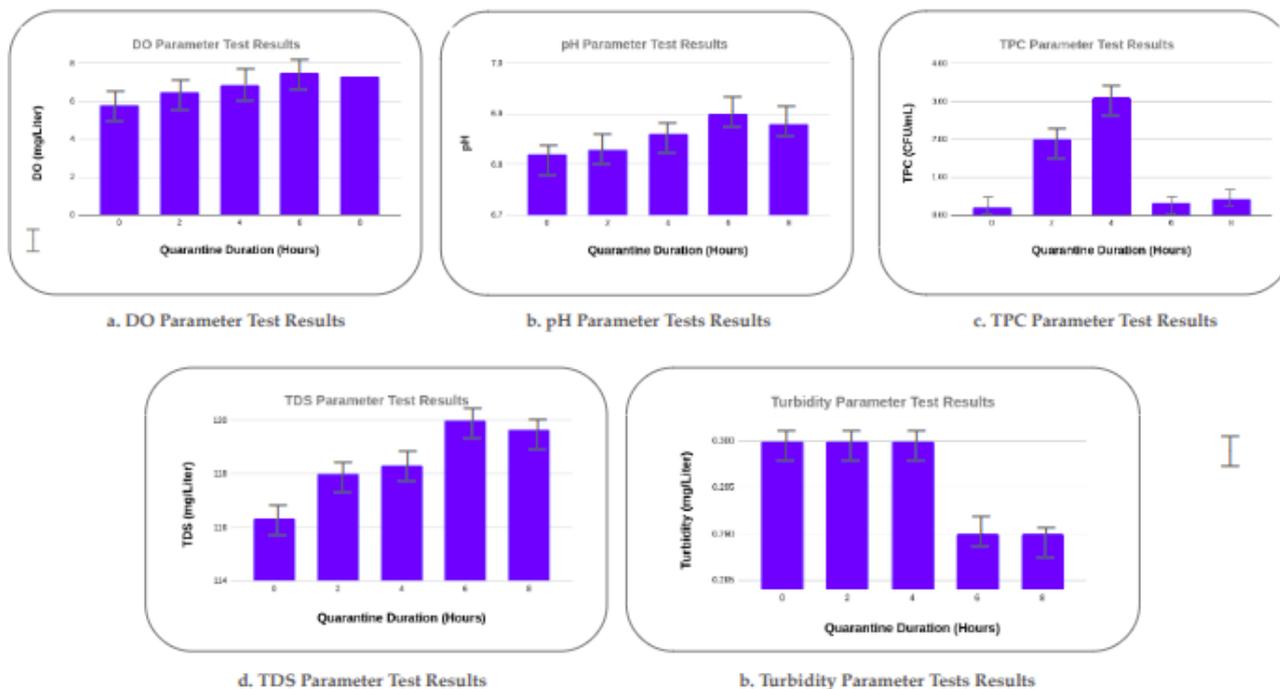


Figure 4. a. DO Parameter Test Results
 b. pH Parameter Tests Results
 c. TPC Parameter Test Results
 d. TDS Parameter Test Results
 e. Turbidity Parameter Tests Results

Figure 4 shows the overall examination results for all water quality parameters (pH, TDS, DO, turbidity, TPC) in the AMDK product have met the drinking water quality requirements of Permenkes 492 of 2010 and Minister of Industry Regulation No. 78/M-IND/PER/11/2016 as stated in SNI Mineral Water SNI 3553:2015. In more detail, let's look at the results for each parameter: pH: The lowest average pH value was 6.82 (0 hours) and the highest was 6.88 (8 hours). The graph shows that the overall pH values meet the reference standards of Permenkes 492 of 2010 (pH 6.5–8.5) and SNI Mineral Water (pH 6.0–8.5). The highest water quality based on pH was achieved at 6 hours. TDS: The lowest average TDS was at 0 hours (116.3 mg/L) and the highest at 6 hours (120 mg/L). All TDS values meet the standards of Permenkes 492 of 2010 and SNI 3553 (< 500 mg/L). DO (Dissolved Oxygen): The lowest average DO was at 0 hours (5.8 mg/L) and the highest at 8 hours (14.66 mg/L). All DO values meet the standards of Permenkes 492 of 2010 and SNI Mineral Water (min. 4 mg/L). (Note: There is a significant difference between the DO value in the PDF table (e.g., 14.16 mg/L for 6 hours) and the value possibly represented by this slide's graph (appears around 6-7 mg/L) and the DO value in the conclusion on slide 7 (7.5 mg/L). The data presented in the PDF thesis is prioritized as a reference.) Turbidity: The lowest average turbidity was at 6 and 8 hours (0.29 NTU) and the highest at 0, 2, and 4 hours (0.30 NTU). All turbidity values meet the SNI 3553:2015 standard (< 1.5 NTU). The best water quality based on turbidity was achieved at 6 and 8 hours. TPC (Total Plate Count): TPC results show the lowest average value of 1×10^0 CFU/ml and the highest of 9.2×10^1 CFU/ml. All samples showed results that met the health requirements for beverages, as they did not exceed the limit of 10^6 CFU/ml set by Permenkes RI No. 1096/Menkes/PER/VI/2011 and SNI 7388 of 2009. (Note: There is a significant difference between the TPC value in the PDF table (e.g., 0 or 1×10^0 for 6 hours) and the value in the conclusion on slide 7 (0.33 CFU/mL). The data presented in the PDF thesis is prioritized as a reference.) Overall, the results indicate that the best quarantine times for safe and healthy water quality, in descending order, are 6 hours, 8 hours, 4 hours, 2 hours, and 0 hours. Specifically, at 6 hours, it shows that the ozone contained in the water has dissipated.

Conclusions

The best water quality with pH value of 6.89; TDS 120 mg/L; DO 7.5 mg/L; Turbidity of 0.29 mg/L and TPC of 0.33 CFU/mL at a quarantine time of 6 hours effectively reduces microorganisms and ozone residues so that all water quality parameters meet the SNI 3553:2015 standard, therefore the quarantine time for AMDK using ozone is very important.

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