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# Enhancement of Oxidation Reaction of 2-Deoxyribose by Ultrasound

Soojeong Shim† and Young H. Kim* (Applied Acoustics Lab, Department of Physics and Earth Science, Korea Science Academy of KAIST)

## Introduction

From daily lives to ultramodern technologies, water is used in almost every aspect of human activities. However, current water purification system is failing to follow the skyrocketing amount of wastewater.

Water purification process includes physical treatment, biological treatment, and advanced oxidation. Since chlorine is toxic, ozone is generally chosen for advanced oxidation process among a lot of countries all over the world. Although ozone has strong oxidizing power, its high cost and small solubility to water makes itself inefficient. Ultrasound is known to encourage ozone to be hydroxyl radical, which has bigger reactivity in water[1,2].

The goal of this research is to enhance both efficiency and effectiveness of oxidation reaction by high intensity ultrasound. 2-deoxyriobse were chosen as reactant of oxidation reaction.

## Materials and methods

Reactor was designed as shown in Fig.1, for such objectives; it should prevent temperature rise caused by vibration of water molecules by ultrasound, water evaporation and water leakage.

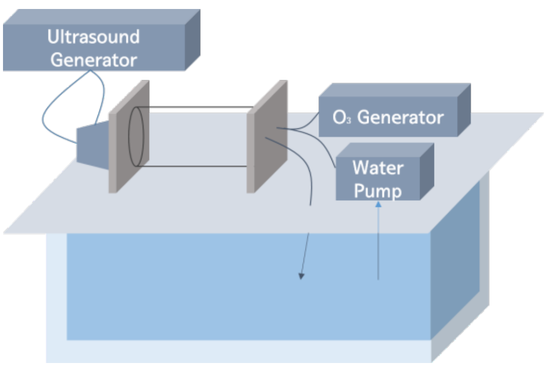


**Fig 1. Reactor design**

As shown in Fig 2, as ozone turns into hydroxyl radical, it oxidizes 2-deoxyriobse (Carbosynth, >99%). After heating with adding 2-thiobarbituric acid (Sigma-Aldrich, >98%), malondialdehyde is produced. It absorbs 532nm light, which can be measured with UV spectroscope(GE Healthcare Ultrospec 2100 pro).

$$\frac{1}{2}O_3 + \frac{1}{2}H_2O \rightarrow \frac{1}{2}O_2 + OH\cdot$$

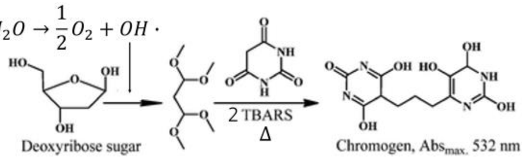


**Fig 2. Oxidation process of 2-deoxyribose**

## Results and discussions

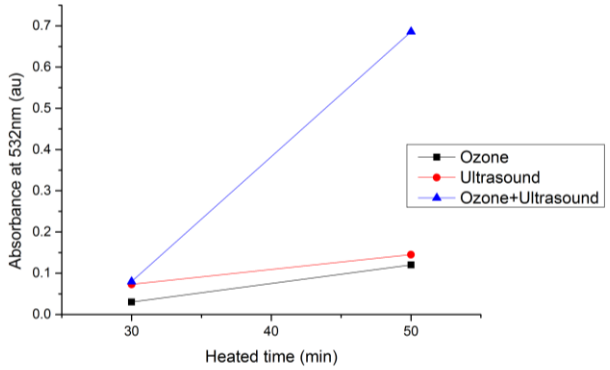


**Fig 3. Absorbance at 532nm. Not only the three different treatements, but also heating time greatly affected to the absorbance.**

2.6 L of 10 mM 2-deoxyribose was treated by applying 0.5 L/min ozone gas, or 126~128 kHz, 5.05 W ultrasound, or both for 10 hours. After then, 50 ml of treated 2-deoxyriobse was taken, and heated with adding 50 ml of 20 mM TBA. As shown in Fig 3, when the samples were heated for 30 minutes, absorbance showed small difference while 50-minutes-heated samples showed quite different absorbance. This indicates that samples need to be heated enough to produce MDA. Regardless of heating time, the one treated by both of ozone gas and ultrasound showed the biggest absorbance at 532nm.

*yhkim627@kaist.ac.kr

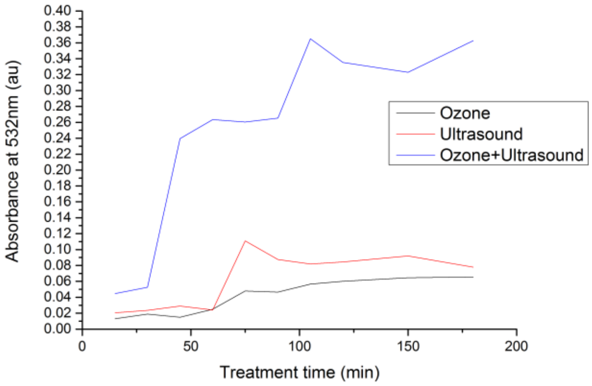


**Fig 4. Average absorbance of samples treated in three different ways at 532 nm.**

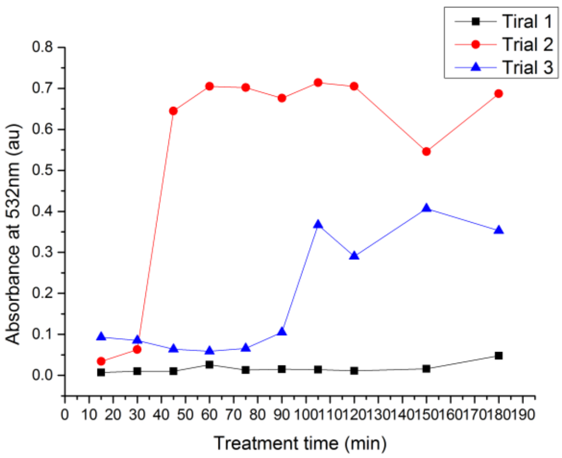


**Fig 5. Absorbance of three samples applied ozone and ultrasound at the same time. Trial 1 had three to 26 times bigger absorbance than trial 3.**

3.0 L of 10 mM 2-deoxyribose was treated by applying 0.5 L/min ozone gas, or 126~128 kHz, 5.05 W ultrasound, or both for 180minutes. After then, 50 ml of treated 2-deoxyriobse was taken, and heated for 60 minutes with adding 50 ml of 20 mM TBA. As shown in Fig 4, average absorbance of sample treated with ozone and ultrasound at the same time were three to 11 times bigger than average absorbance of ozone-treated sample. Sample treated with ultrasound had 0.96 to 2.3 times of absorbance of ozone-treated sample.
However, due to a nonlinear effect of ultrasound, samples treated with ultrasound had a broader range of absorbance. Fig 5 shows that the biggest ozone-and-ultrasound-treated sample had 26 times of absorbance of smallest sample treated identically. Twice out of three times of ozone-and-ultrasound treatment resulted in giant absorbance, however, once out of three times of the treatment leaded to similar or smaller absorbance than treatment solely with ozone. Ultrasound generator used in this experiment swiped its frequency between 126~128 kHz in order to satisfy resonance condition at different water temperature. Frequency discordance induced by water temperature increase seems to be the reason why one of three samples were not affected by ultrasound.

## Conclusions

Applying ultrasonic wave to 2-deoxyriobse oxidizing process using ozone showed tendency to absorb more light at 532nm than both processes applying ozone or ultrasound solely, indicating more production of hydroxyl radical. Both average absorbance and two of three individual samples applied both ozone and ultrasound revealed that much more MDA was produced by oxidation of 2-deoxyribose by hydroxyl radical. However, due to nonlinear effect of ultrasound, individual assays with same treatment showed large difference relative to samples treated without ultrasound. In addition, one of three assays of samples treated with ozone and ultrasound showed similar absorbance to samples treated with ozone only, because of discordance of resonance condition of ultrasound. Ultrasound generator with bigger swap range will be helpful to enhance oxidation process without dissonance.

## Acknowledgment

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## References

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