

Ozone Treatment: The Green Technology

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Abstract

One of the most effective ways to extend the shelf life of any food is by implementing various preservation treatments on the food. Food processing and preservation are both essential for the food security. Nowadays, due to increasing population and various other aspects like starvation, food processing and preservation is necessary to fulfil the needs of millions. Different thermal and non-thermal technologies are developed for food processing, so that food processing time is reduced and product shelf life is extended, with minimum nutrient loss.

Introduction

Global hunger index shows that 43 countries have alarming or serious levels of hunger, 18 countries with moderate, serious or alarming hunger levels have higher 2023 GHI scores than 2015 and 58 countries will fail to reach a low level of hunger by 2030 (<https://www.globalhungerindex.org/pdf/en/2023.pdf>). To fulfil the need of food of millions of people in upcoming years, processing and preservation of food is the most important aspect. By applying different techniques of food processing, wastage of raw form of food is reduced and the availability of the food will also be increased. Various chemical and thermal treatments which are used during processing of fruits, vegetable and grains, have some drawbacks such as nutrient loss, texture and change in taste. New technologies such as high-pressure processing, cold plasma treatment, radio frequency treatment, pulse electric field and ionizing treatment are some of the non-thermal technologies developed for preservation of the food, ozone treatment is one of such technologies. Ozone treatment is a non-thermal food preservation technology. Ozone treatment is very efficient in elimination of insects, reduction of mycotoxins and inactivation of microorganism and the most important advantage is that it does not affect the quality of the processed food (Tiwari *et al.*, 2010).

Ozone Treatment

Ozone treatment is a non-thermal technology. Ozone is a strong oxidizing agent which kills 99.9%

microorganisms with the advantage of zero residues in the final product. Due to its oxidative nature a wide range of pathogens can be disinfected with high efficiency. Ozone gas filled in cold storage can potentially reduce the pathogens and spoilage causing bacteria in a food storage. Ozone treatment was found to be effective against *C. jejuni* and *P. fluorescens* (Bigi *et al.*, 2021). Ozone has a reduction potential of 2.08eV. Ozone functions against fungi, mould, biofilm, helps in depletion of biomass and inactivate microorganisms. It also helps in reducing aflatoxin B₁ and killing the larvae of different insects (Xue *et al.*, 2023).

Microbial biofilms are produced by *Pseudomonas* spp. strains, which is a primary source of contamination in various dairy products. Ozone treatment can be used in combination with either treatment as a hurdle technology to enhance the efficiency of currently used sanitation protocols in food processing environment (Panebianco *et al.*, 2022).

Ozone treatment is a green technology used for a wide range of processes such as clean in place for various equipments, fermentation of wine and beverage and in post-harvest treatment. Ozone can be used to inhibit the growth of various spoilage causing microbes in wine processing. It helps in reducing the population of undesirable yeasts such as *Brettanomyces* spp. during fermentation. The concentration of anthocyanin compound in wines may enhanced with the help of ozone treatment. It also helps in maintaining and enhancing the colour, pH, physiochemical properties, oxidative stability and aroma forming volatile compounds and esters (Mostashari *et al.*, 2022). Ozone treatment can also be used for sanitation purpose, microbes' inhibition, depletion of biomass, grain storage and in beverage processing.

Mechanisms of Ozone Treatment

1. For microbial inactivation

At first the ozone will come in contact with the microorganism cell wall. Ozone molecule will oxidize the glycolipids and glycoproteins. Ozone will oxidize the lipids bound in the membrane and enzymes. Due

to which the membrane of the cell will disintegrate. Eventually the cell constituents will start leaking and cell lysis will occur (Xue *et al.*, 2023).

2. For Fungi and Mould

Ozone exposure to fungi and mould will lead to inhibit the conidia germination due to which the hyphae growth will not occur. Ozone will alter the metabolism function of fungi due to which the oxidative stress in the fungi will be increase and apoptosis happens (Xue *et al.*, 2023).

3. For Biofilms

Mechanism of action of ozone against biofilm is still under study. Ozone reduces the capability of microorganism to produce extra cellular polymeric matrix and the oxidative stress leads to reduction in total biofilm forming biomass eventually led to loss of extracellular polymer matrix (Panebianco *et al.*, 2022a).

Applications of Ozone Treatment

• Meat and Meat products

The keeping quality of meat and its products depends upon total microbial load on the meat. Ozone helps in reducing the microbial load of meat by using spray washing water.

• Poultry

The poultry meat washed with ozonised water helps in reducing the total bacterial load. It also does not show any effect on colour of meat and do not induce any off-flavors on poultry meat.

• Fish

The ozone treatment helps in reducing the total coliforms on the fish and also helps in inhibition of post larvae. The shelf life is also increased by 25%.

• Fruits

After harvesting, using contaminated water for washing and during storage and handling, the microbial load of the fruits has been increased. With the use of ozone treatment even at low concentrations the bacterial load of fruits has been decreased. It also helps in reducing the ethylene concentration.

• Vegetable

Ozone treatment helps in extending the shelf life of variety of vegetable such as potatoes, carrot and cabbage. There is no change in the organoleptic properties of the vegetables. The internal browning of mushroom is also reduced by the ozone treatment without any significant change in weight and texture.

Advantages of Ozone Treatment

- Elimination of hazardous chemical residues.
- Better fumigation method.

- No change in texture of fruits and vegetable after treatment.
- No effect on organoleptic properties of various products.
- Helps in lowering the microbial load.
- Very less contact time.
- Lower operating cost.

Limitations of Ozone Treatment

- Ozone can cause asthma.
- Regular inspection is required for any leaks.
- Initial cost is high due to which not suitable for small processors.
- Unstable in water causing improper doses.
- Different microorganisms have different resistivity for ozone.

Conclusions

Ozone treatment is a green and non-thermal technology. It helps in reducing the microbial load on fruits, vegetables, poultry meat and beverages. It helps in reducing the spoilage causing yeast in wine. There is no nutrient loss in ozone treatment. Ozone treatment helps in extending the shelf life of various product. It does not change the colour and texture of the product. There is also no change in organoleptic properties of fruits and vegetables. Although the initial cost is high but it also has long term benefits. The adaptability of ozone treatment is still under growing stage.

References

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