Ozone for Gaseous Storage

Ozone can be used to greatly improve the quality of stored commodities such as fruits, vegetables, cheeses, nuts, etc. The use of ozone reduces or eliminates mold and fungus growth that would otherwise occur during periods of storage.

USDA Study, April 2000 - Effects of Ozone Gas on Fruit & Vegetable Quality

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Spores of *Botrytis cinerea*, *Monilinia fructicola*, *Penicillium digitatum*, and *Rhizopus stolonifer* were exposed to ozone at a concentration at 120 to 200 ppm at low (35±3% RH) or high (95% RH) humidity at 5, 15, or 25ºC for 5 minutes to 72 hours (until mortality equal to or greater than 95% occurred). After exposure, spore viability was determined by incubation on potato dextrose agar for 18 hours at 23-25ºC and germination was determined by examination at 250X. Dosages that killed 50% (LD_{50}) and 99% (LD_{99}) of the spores were estimated and expressed as the product of ozone concentration (1 or 100 ppm) multiplied by time (hours). Each test was repeated three times.

R. stolonifer was consistently more tolerant to ozone than the other fungi. Ozone was about six times more toxic at high relative humidity than at low humidity. For example, at 15ºC, the average LD_{50} for all the fungi at high humidity was 96.5 ppm*hr, while at low humidity it was 573 ppm*hr. At low humidity, ozone toxicity increased with temperature; it was approximately 5 times more toxic at 25ºC than 5ºC. At high humidity, ozone was most toxic at 25ºC, followed by 5ºC, and least toxic at 15ºC. At low humidity, ozone was most toxic at 25ºC, followed by 15ºC, and least toxic at 5ºC.

Influence of ozone gas on the appearance of fresh fruit and vegetables:

- Ozone was applied at a dosage that killed spores of many fungi
- Ozone concentration was about 20 ppm for 10 hours (measured CT in ppm*hr was 221.3). The temperature was 3ºC and the humidity was high, about 95% RH.

Results:

- Ozone at low concentrations greatly reduces the sporulation of green and blue mold
- Low ozone concentrations stop sporulation, while killing spores takes very high doses
    - **Inhibition of spore production is valuable for sanitation purposes for products in storage**
- Ozone must be present constantly or spore production will rapidly resume
- Spore production under warm conditions is probably too rapid for day/night ozone cycling to control sporulation

*DEL Agricultural Comments Regarding USDA Study:

- **White onions, Russet potatoes, & oranges performed very well in the test with no noticeable damage at ozone levels high enough to prevent mold and fungus growth**
- **Cheeses, while not studied in this experiment, are also candidates for ozone gaseous storage**

Informal Gaseous Ozone Test - Offutt Potato Farm, Grafton, ND:

Date: December 15, 1999 - April 1, 2000

Purpose of experiment:

Eliminate or reduce:

- Soft rot, pink rot, late blight
- Spread of rot to adjacent potatoes
- Sprouting

Product: Potatoes for chips

Start-Up:

- Gaseous Ozone Level
  - ~0.2 - 0.4 ppm measured in the air chamber
  - ~0.2 ppm measured at the bottom of the "pile"
  - ~0.0 ppm measured at the top of the "pile"

Week Four:

- Gaseous Ozone Level
  - ~0.2 - 0.4 ppm measured in the air chamber
  - ~0.2 ppm measured at the bottom of the "pile"
  - ~0.05 ppm measured at the top of the "pile"

Week Fifteen:

- Opened the bin and inspected potatoes; rating them as follows:

Rating Criteria	Worst	Norm	Ozone #1	Ozone #2
External Defects	15	5-10	3	0
Internal Defects	15	5-10	3	3
Combined Total	>30	10-20	6	3
Color	<60	>65	69	70

Summary:

- Potatoes were of exceptional quality
- No signs of ozone damage
- Chips fried very white
- "Bad" potatoes were controlled and did not affect adjacent potatoes
- No sprouting
- Fry quality of bin lasted two weeks longer than control bin (no ozone)

Second test for reconfirmation planned for next season.