



# **Use of Ozonated Water to Treat Peeled Shrimp Meat**

**Amrish Chawla\***  
**Jon W. Bell, Marlene E. Janes**  
**Louisiana State University**  
**Agricultural Center**

**Ozone V Conference**  
**April 2 – 4, 2007 Fresno, CA**



# Overview

## ➤ Introduction

- Importance of LA in US shrimp production
- Ozone review
- Shrimp processing

## ➤ Ozonated water and Shrimp research

- ❖ Phase I - Process Development Study
- ❖ Phase II – Treatment Optimization Study



# Overview

## ❖ Phase III – Quality and Safety Study

- Research Goals
- Experimental Design
- Results
- Conclusion

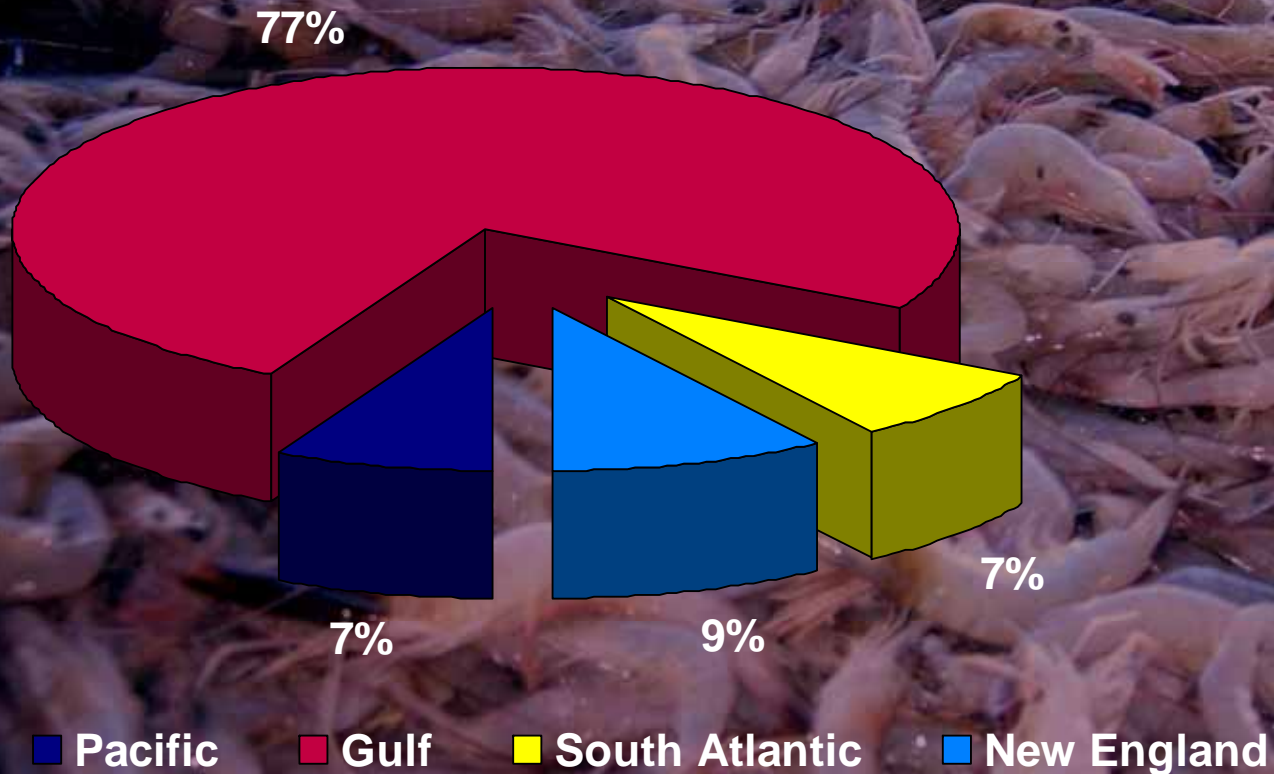
➤ Summary of Research

➤ Future Work

➤ Acknowledgments

# Introduction

## U.S. Shrimp Harvest, by Region in 2004



*Reference: FAS, USDA Fisheries of the United States, National Marine Fisheries Service. Landings and imports as head-off conversion.*

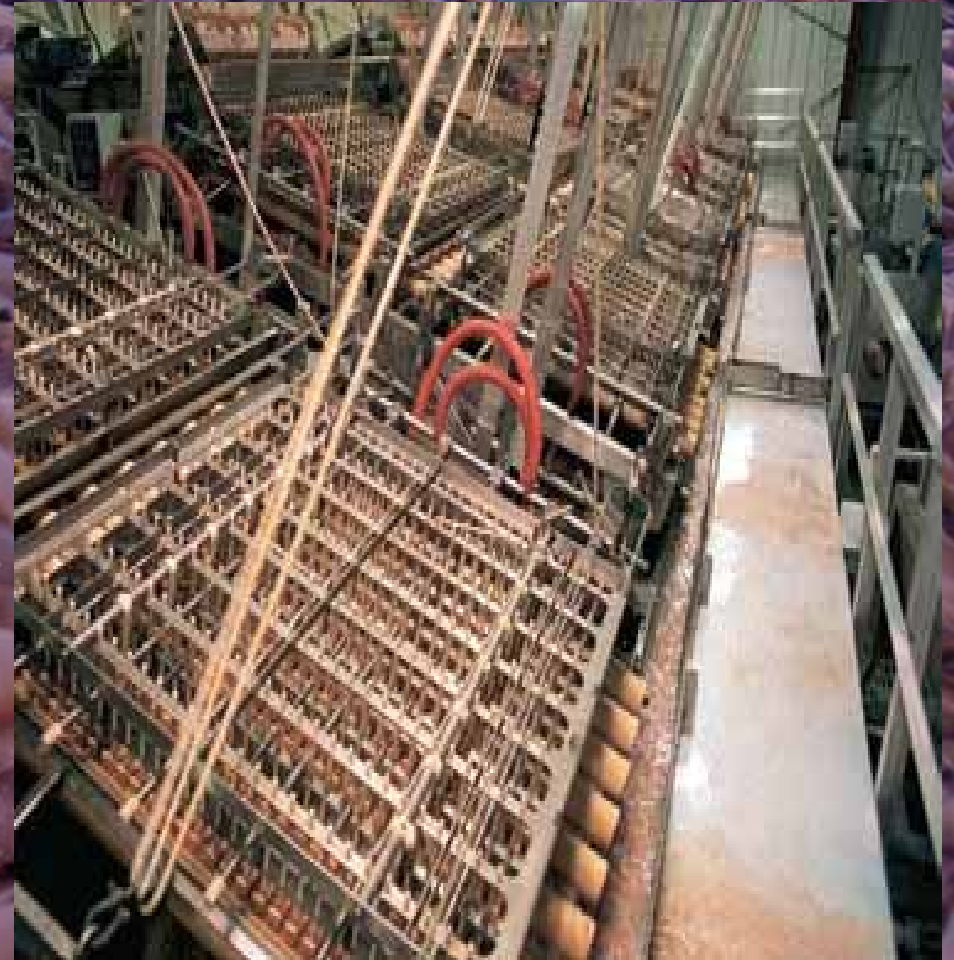
# Ozone Review

- **Approved for use by FDA and by USDA-FSIS.**
- **2.5 times more powerful and reacts 3000 times faster than chlorine.**
- **Leaves no residues/by-products**
- **Effective at low concentrations against a broad spectrum of both spoilage and pathogenic micro-organisms.**

*Reference: FDA/CFSAN - June 26, 2001 - Final Rule published in Federal Register 21 CFR Part 173, Docket No. 00F-1482)*

# Shrimp Processing

## ➤ Semi-Mechanical Process



# Phase I: Process Development Study

## ➤ Recirculation Setup



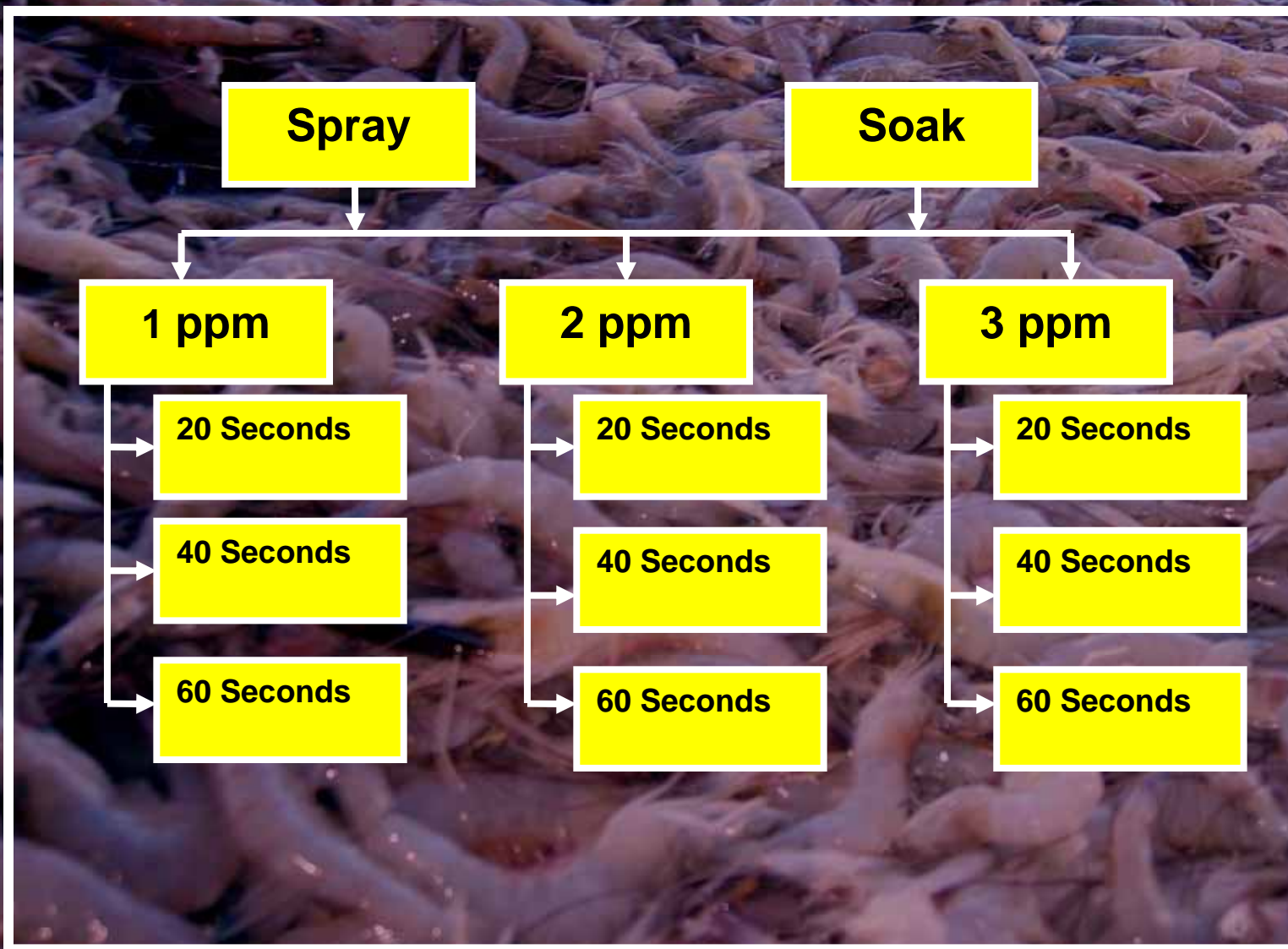
# Phase I: Process Development Study

## ➤ Flow Through Setup



# Phase II: Optimization Study

## Treatment matrix



# Phase II: Optimization Study

## Spray application



# Phase II: Optimization Study

Soak application





## Conclusions

- Higher ozone concentrations and longer times are more effective for microbial destruction.
- Soaking more effective than spray.
- No immediate negative oxidation effect in the shrimp.
- Optimal treatment selected was 3 ppm soaking for 60s.
- Lowering water temperature increased ozone concentration.

# Phase III: Quality Improvement and Safety Study

- To investigate the effect of optimized treatment in peeled shrimp held in ice.
- Microbial tests
  - Aerobic Plate Counts (APC)
- Chemical tests
  - TBARS
  - Bioamine Production (putrescine, cadaverine)
- Consumer Sensory Study

# Experimental Design

## Shrimp Procurement



# Experimental Design

## Hand Peeling



# Experimental Design

## Ozone Treatment





# Experimental Design

## Bioamine Analysis

- The extraction of bioamines was carried out using the method described by Benner et. al. 2003
- An Electron Capture Detector was used for bioamine detection
- Samples were injected using an Auto sampler
- The instrumentation was controlled by LabQuest Chromatography Data System (Finnigan Corp, Austin, TX)

# Experimental Design

## Columns and Retention Times

Column	DB 210	HP 225
Retention times (PFP derivatives)		
Putrescine	8.36 min	10.04 min
Cadaverine	9.18 min	10.70 min
Hexanediamine	9.79 min	11.15 min

# Experimental Design

## Consumer Sensory Study

- Sensory Descriptors developed by NMFS for grading of raw shrimp were used.
- A 4 point scale was developed with the help of the descriptors.
- Scale 1 = “Fail”, 2 = “Borderline Fail”  
3 = “Borderline Pass”, 4 = “Pass”



# Experimental Design

## Consumer Sensory Study

- Study carried out at the Food Processing and Technology Pilot Plant, LSU campus.
- 254 consumers took part in the study
- 12 coded samples presented in random order to each of 254 consumers.

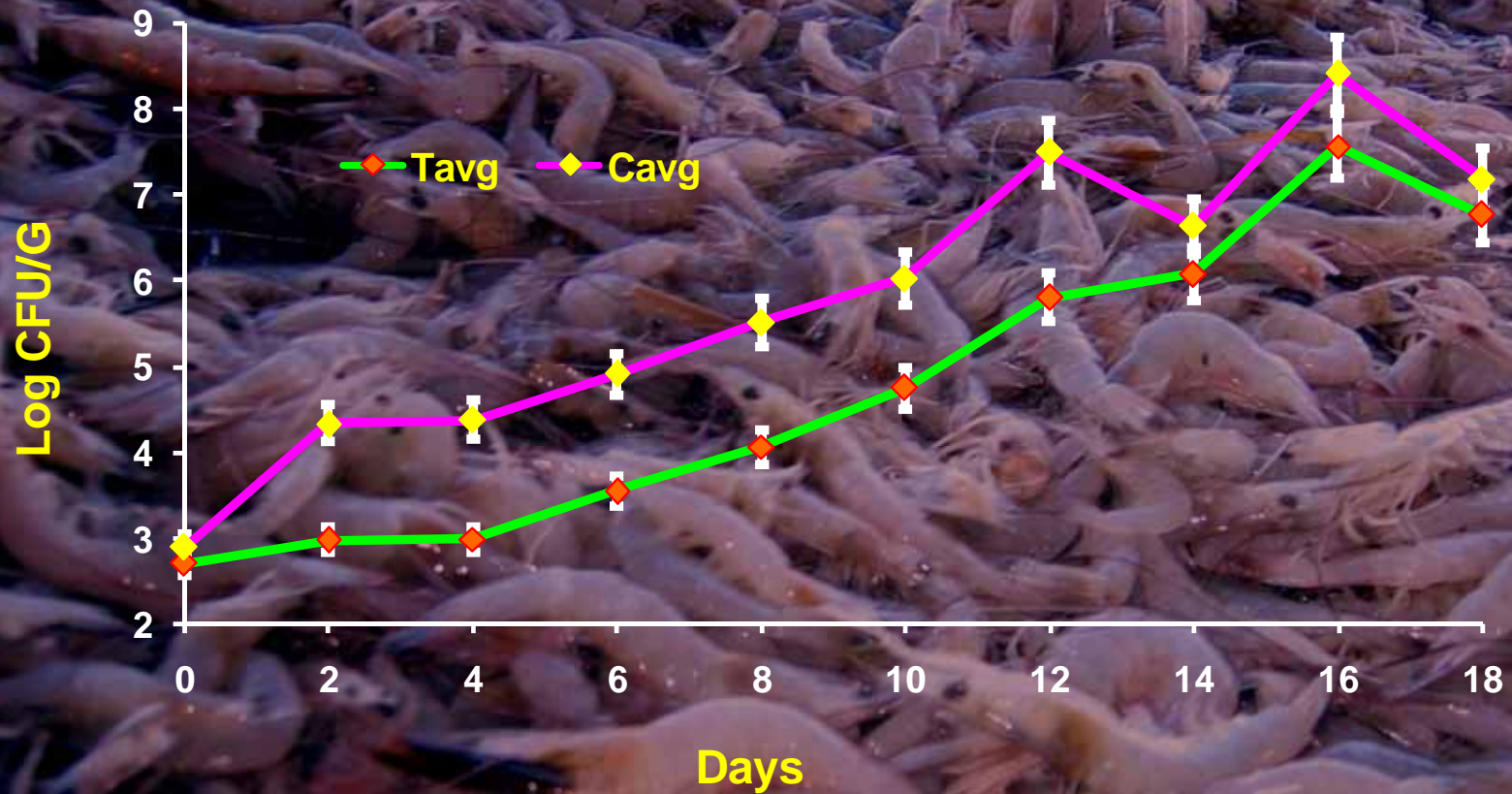
# Experimental Design

## Consumer Sensory Study

### ➤ Statistical Analysis

- Frequency Distribution done using PROC FREQ in SAS
- Freidman's statistic calculated using Graph Pad Prism® Software
- Rank sums comparison done using Graph Pad Prism® Software
- Microbial and Bioamine data analyzed using JMP<sub>In</sub>®

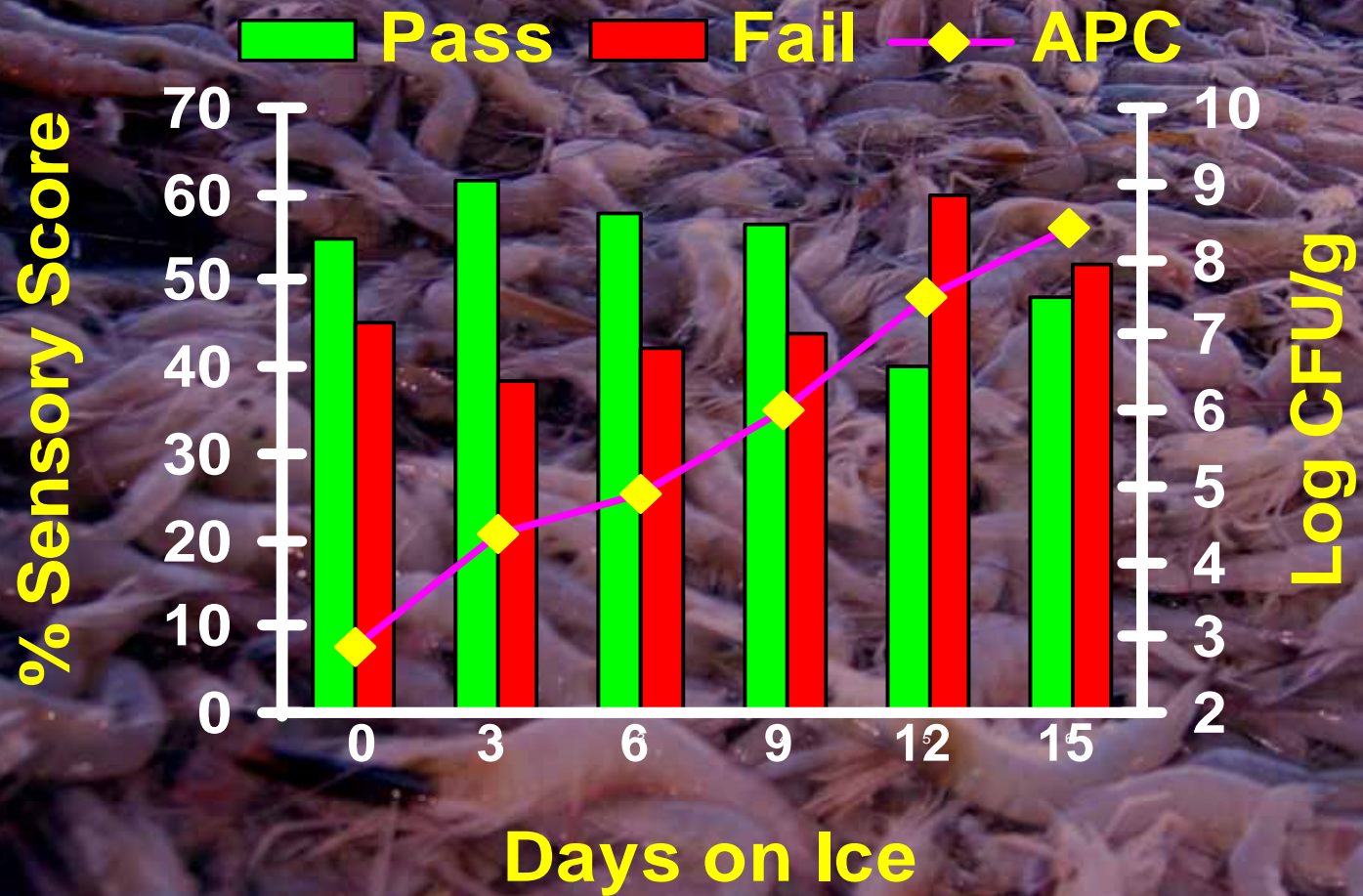
# Results: APC



T = Treated, U = Untreated

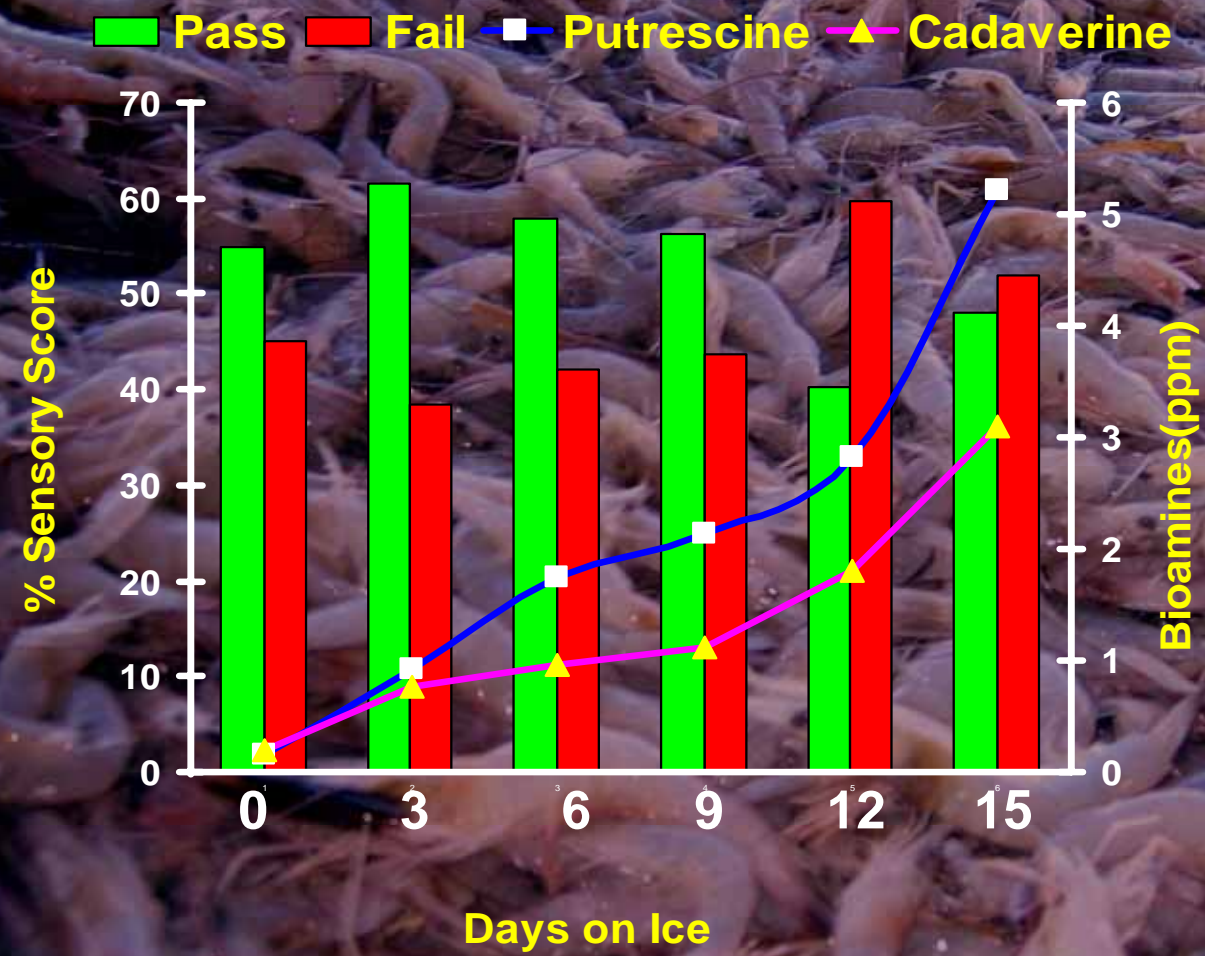
## Aerobic Plate Counts (APC)

# Results: Untreated Odor vs APC



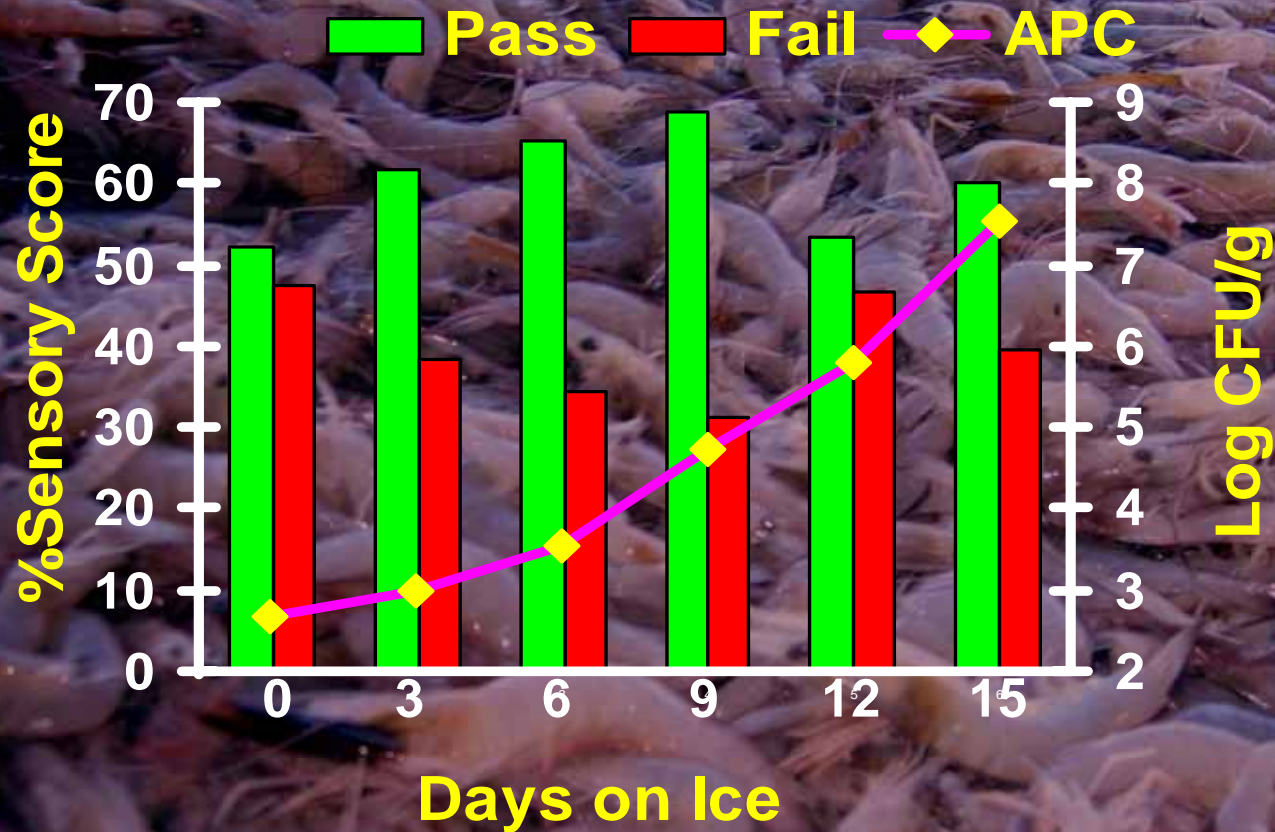
Untreated

# Results: Untreated Odor vs Bioamine



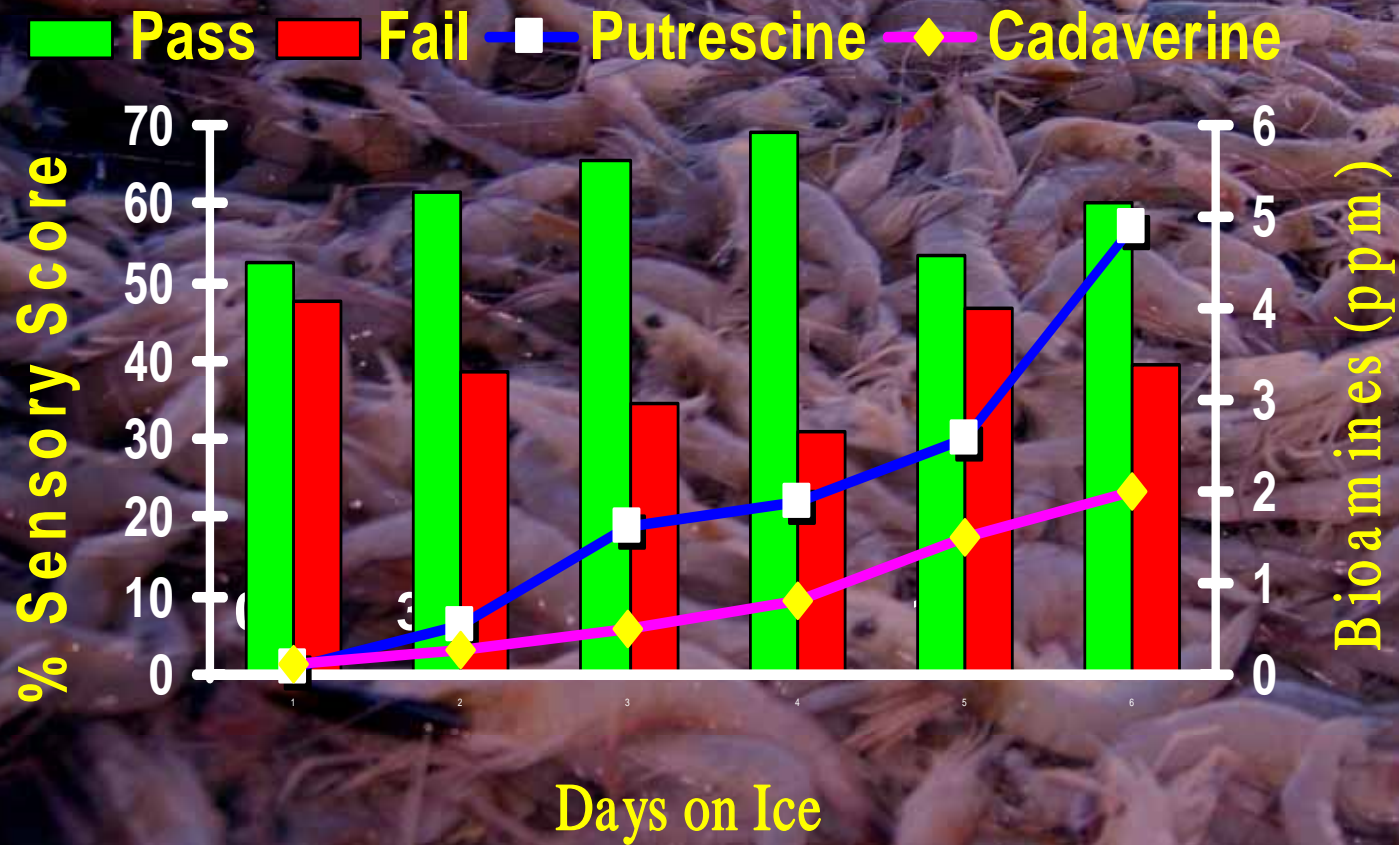
Untreated

# Results: Treated Odor vs APC



Treated

# Results: Treated Odor vs Bioamine



Treated



## Phase III: Conclusions

- Delayed log phase leading to lower microbial levels in treated peeled shrimp
- No negative oxidation effects observed.
- Bioamine production increased as microbial loads increased
- Bioamine production not affected by treatment



## Phase III: Conclusions

- Untrained consumers reported failures at higher bioamine levels as compared to FDA
- Untrained consumers indicated that on longer days failing odors were reduced for treated shrimp
- It is difficult to correlated APC, bioamine levels and sensory scores



## Summary

- **Ozonated water treatment, optimized for commercial application was determined**
- **Ozonated water treatment resulted in decreased microbial levels without producing undesirable oxidation**
- **In general higher concentrations and higher times produced more bacterial kills**



# Summary

- Important to measure ozone concentrations at point of application
- In commercial applications water quality, temperature and off-gassing need to be controlled
- Optimal treatment was 3 ppm soak for 60s
- Optimal treatment increased shelf life by 4 days when peeled shrimp was stored on ice.



# Summary

- **Sensory scores from untrained consumers indicated important results but no strong correlations**



## Future Work

- Water filtration and temperature controls inline with ozone generators can be investigated
- Safe commercial soak tanks can be designed
- The use of this optimized treatment in commercial peeling operations can be investigated
- Rapid quality indicating systems for peeled shrimp based on bioamine sensors and texture can be developed

# Acknowledgement



## Funding

- NFI Scholarship Fund
- LA Sea Grant College Program  
(NOAA Grant No. NA16RG2249)

## Support

- Dr. Jon Bell
- Dr. Marlene Janes
- Dr. Witoon Prinyawiwatkul
- Dr. Zhimin Xu
- Air Liquide America, LLC.
- Del Ozone, Inc.
- Paul Piazza & Son, Inc.

# Questions

