



**Current status of Ultra-Low Oxygen/High-CO₂
(**<1,000 ppm O₂/60-95% CO₂**)
Controlled Atmosphere Systems**

**Presented at 2017 Food Processors' Conference
LSU AgCenter School of Nutrition and Food Sciences**

by

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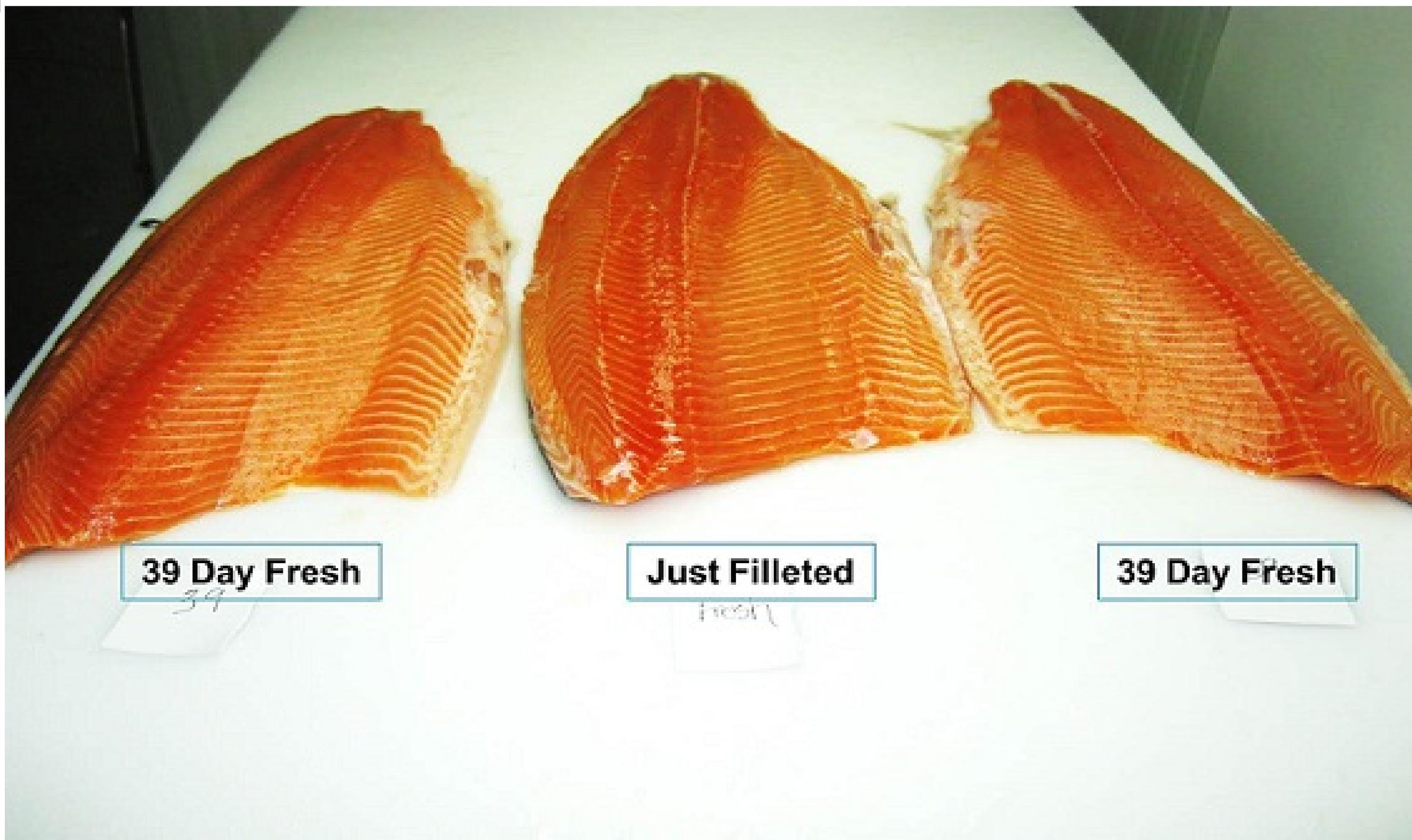


The Future Is Fresh!
Sustainably Fresh!



Most Profitable Categories for REFRIGERATED, Ultra-Low Oxygen/ High-CO₂ Applications (Transport, Cold Storage, Vending)

- Fresh Fish and Seafood
 - FDA will not allow vacuum packaging
 - Even if Vacuum packaging were safe, it is not a viable technology for further distribution beyond the package due to inadequate shelf life remaining
 - Ship fresh by ocean or surface instead of air freight
 - Inventory fresh (instead of frozen)
- Preservative-Free, Fresh-Cooked Meals and Entrees
 - FDA will not allow vacuum packaging
 - Consumers want fresh (not frozen) but, shelf life in air is very short.
 - Inventory in Ultra-Low Oxygen/High-CO₂ cold storages and sell in smart Vending meal centers that prevent spoilage losses.



39 Day Fresh
39

Just Filleted
fresh

39 Day Fresh

Scientist: GFF 30-day claim must be taken 'with pinch of salt'

 Eva Tallaksen

Published - April 26, 2011 - 13:02 GMT

Global Fresh Foods' promise of 30 days of freshness should be taken with a pinch of salt, said one Norwegian researcher -- but GFF disagrees.

Morten Sivertsvik, research manager at Norway's Nofima institute, said its claims should be taken with a pinch of salt.

"We have carried out a huge amount of storing experiments of fresh salmon and there is no scientific proof among published articles that you can achieve 30 days of freshness with a good quality at the end of such a shelf life, even with temperatures of around minus 1 degree Celcius and by removing oxygen and adding carbon dioxide [as GFF does]," Sivertsvik told IntraFish.

Media such as IntraFish should have been better at contesting GFF's claims, he said.

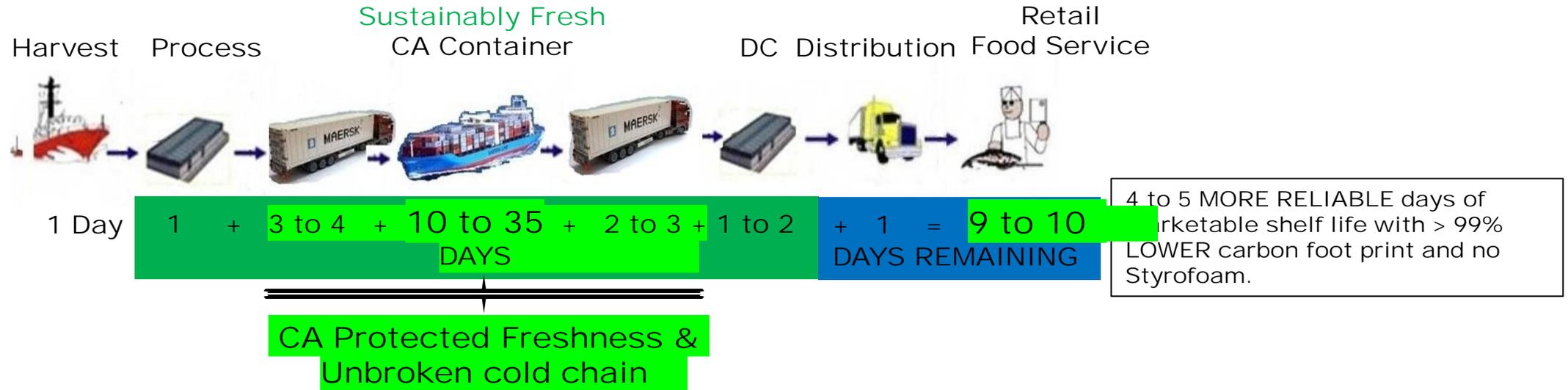


2012 – Fresh-Chilled Farmed Salmon Fillets were shipped by ocean from Chile to Tokyo, demonstrating power of this major technological Breakthrough.

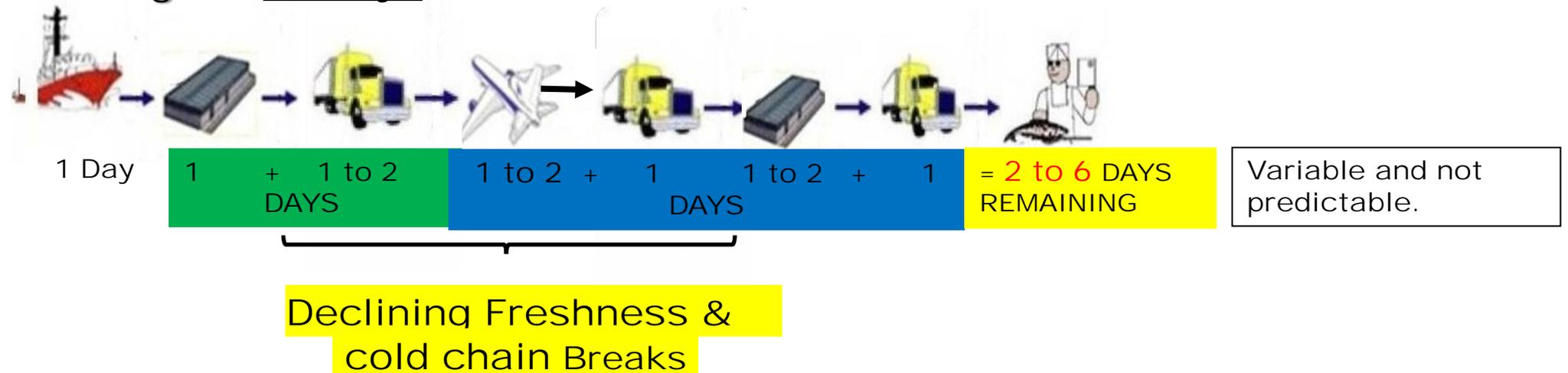
- 42-day fresh Chilean salmon fillets, shipped by ocean freight to Tokyo were consumed raw (as sashimi) by Japanese experts and declared indistinguishable from 6-day fresh, air freighted Norwegian salmon.
 - Mr. Hiranori Mitsuhashi, Camanchaca, Japan's President was quoted as follows - *"I ate the raw salmon and it was as good as fresh salmon shipped by air from Norway"*.. (Email: hashi-m@camanchaca.jp).
 - Samples from shipment also passed Japanese regulatory microbiological count requirements for imported fresh fish.

Freshness Comparisons (Chile to U.S.)

→ **Ocean freight** = 40+ Days (enabled by **Sustainably Fresh CA Containers**)



→ **Air freight** = 14 Days



Sustainably Fresh - Ultra-Low Oxygen/High-CO₂ Ocean Freight Also Enables Paper-Based Packaging With Lowest Carbon Footprint & Packaging Waste

- Airfreight produces 99 times more carbon emissions than ocean freight.

Annual CO2 emissions based on shipping 150 million lbs via <i>SFF</i> instead of air freight from Chile to U.S.	
Puerto Montt processor projected CO2 emissions (pounds of CO2 via air freight)	1,798,008,740
Sustainably Fresh Foods CO2 emissions (pounds of CO2 via SFF and ocean freight)	19,208,640
Barrels of Oil saved annually	2,218,322

- Global pollution by Styrofoam & other non-biodegradable food packaging



Tokyo Fish Market

- Airfreighted perishables are shipped in "Styrofoam" boxes that end up as non-biodegradable land & ocean waste streams.
- With a 100% refrigerated supply chain, can ship in recyclable corrugated boxes and paper instead of plastic.



2016 - Fresh Pork Shipped Without Vacuum Packaging

BluWrap and Danish Crown shipped fresh pork from Denmark to Australia by ocean in Ultra-Low Oxygen/High CO₂ (instead of vacuum packaging).

“The pork shipped using the BluWrap packaging technology looked identical on the day of opening as it was the day we packed it, despite being 56 days in transit without any ice or freezing,” said Tom Petersen, senior manager of quality production, Danish Crown who attended the opening in Australia. **“Our Australian customer was extremely pleased with the color, texture and yields on the product throughout the entire process. This truly looks like a technology that will gain traction in the pork industry.”**

Requirements for maximum natural fresh shelf life

Chill + high CO₂ + ultra-low O₂ + refrigeration

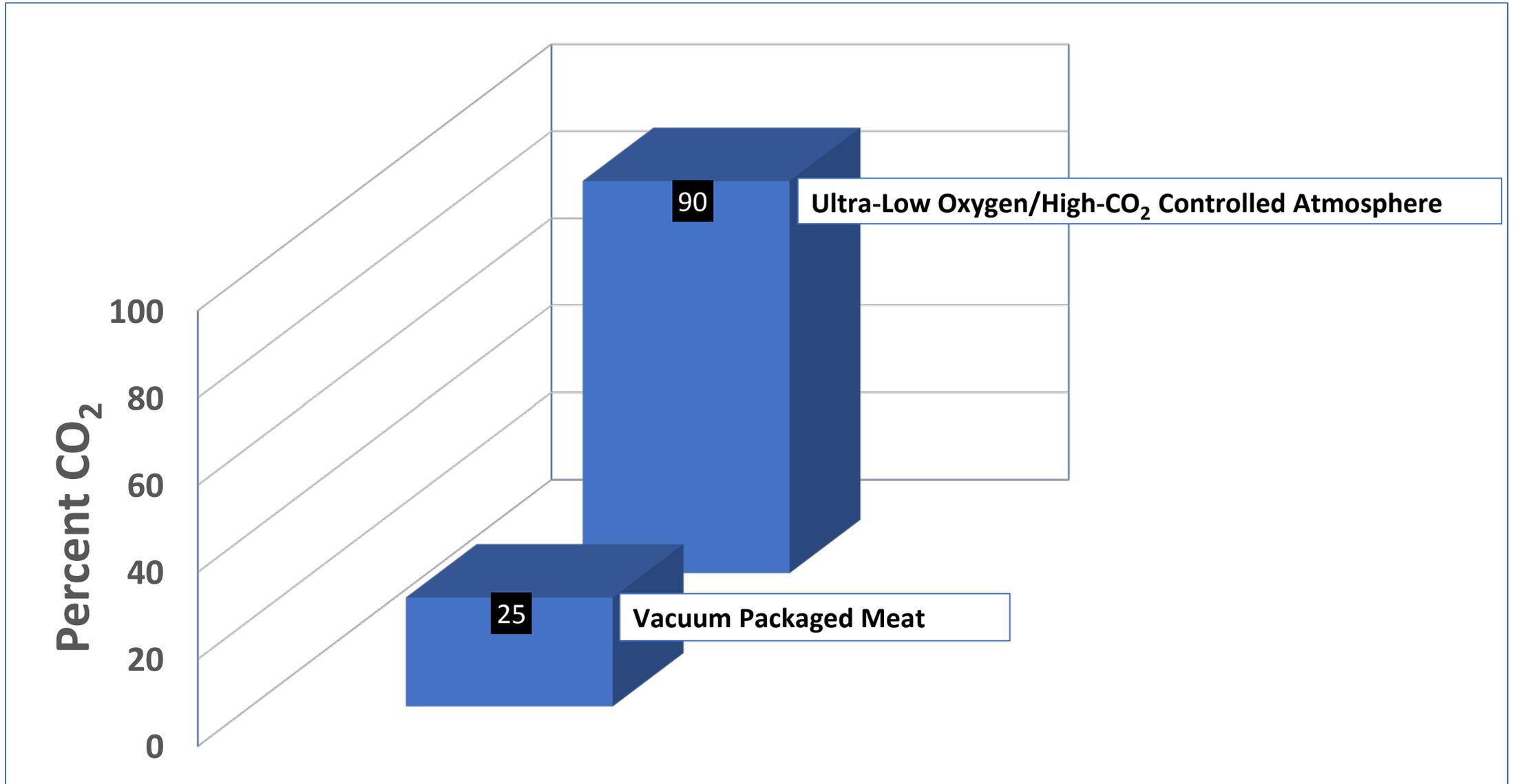
1. Chill perishables down to -1.0C (30F) before packing.
2. High CO₂ + proper refrigeration stops microbial spoilage but does not stop oxidation of colors and fats.
3. Ultra-low oxygen + proper refrigeration prevents oxidation of colors and fats.
 - patented conversion of oxygen to water by fuel-cell integrated refrigeration system = most cost effective, food-safe and reliable oxygen management means.

RESULTS

- > 50 days-fresh Atlantic Salmon fillets vs. < 15 in "air" - (*commercial proof via Global Fresh Foods*)
- > 90 days fresh precooked entrees and meals vs. <9 in "air" - (*expectation*)
- > 90 days fresh "case ready" meats vs. <10 in Modified Atmosphere Packaging (MAP) - (*expectation*)
- > 180 days fresh commodity/primal cut meats (without vacuum packaging) - (*expectation*)

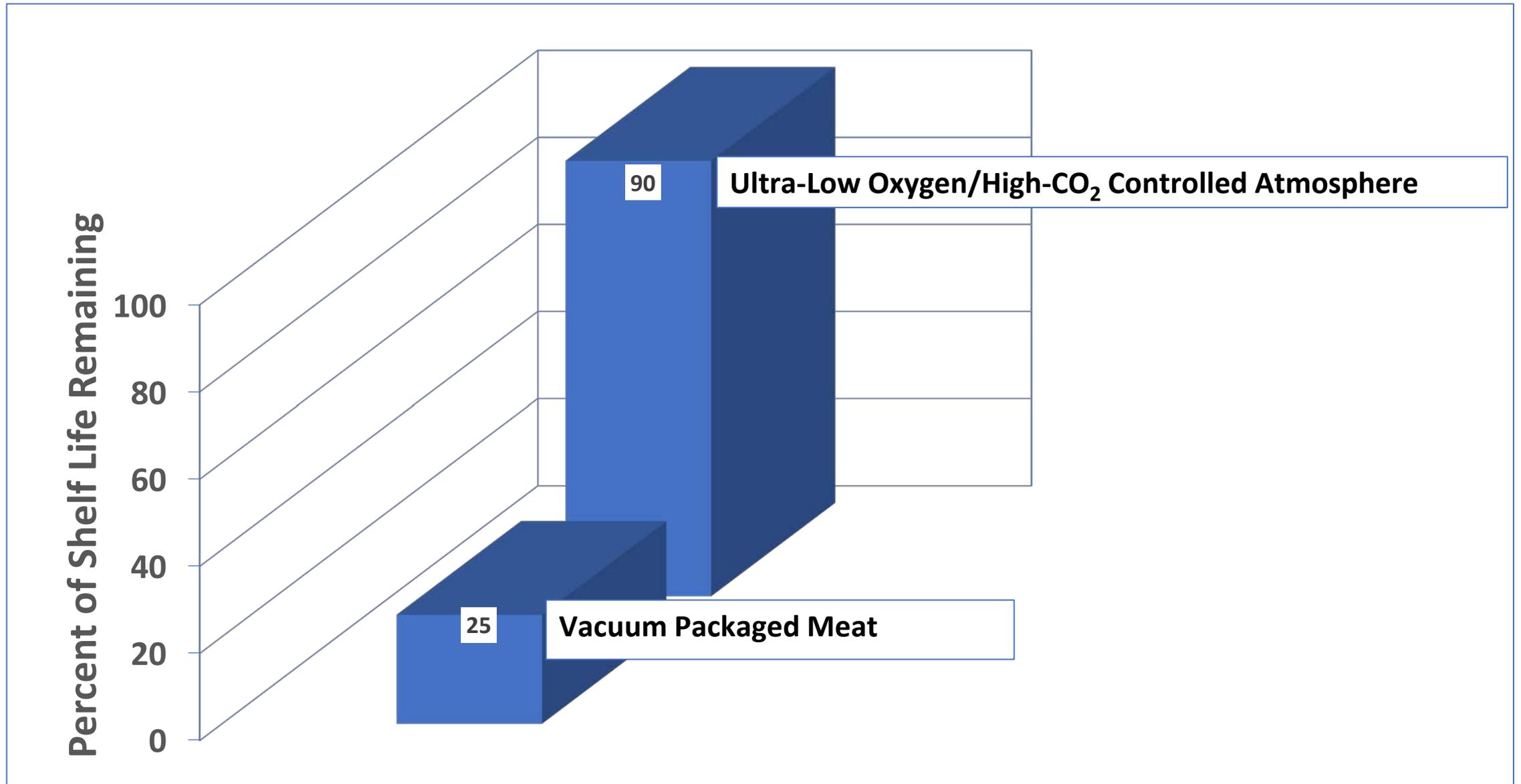


CO₂ LEVEL Comparison Between Vacuum Packaging & Ultra-Low Oxygen/High-CO₂ Controlled Atmosphere





SHELF LIFE Comparison after removal from Vacuum versus Ultra-Low Oxygen/High-CO₂ Environments





History of Ultra-Low Oxygen/High-CO₂ Controlled Atmosphere Applications (1970s)

- 1975 – Bell’s graduate work at UC Davis (sponsored by Sea Grant) teaches him how critical eliminating oxygen exposure is for preventing “browning” of tuna loins.
 - 1975 – During his graduate work Bell also **witnesses** research (sponsored by **TransFRESH Corporation**) on the application of high-CO₂ to extend the fresh shelf life of red meats.
- 1978 – Bell (**now working for TransFRESH Corporation**) manages the first commercial shipments of fresh Alaskan Salmon by ocean in high-CO₂ atmospheres.
- 1979 – Bell begins search for ways to eliminate oxygen from refrigerated, high-CO₂ environments.



History of Ultra-Low-Oxygen/High-CO₂ Controlled Atmosphere Applications (1980 - 2000)

- 1985 – Bell/TransFRESH start collaboration with technology company to build first oxygen removal system for refrigerated ultra-low oxygen/high-CO₂) CA environments.
 - based on electrochemical systems for extracting oxygen from seawater on nuclear submarines (Giner Inc.).
- 1990's – Electrochemical Prototype is successfully tested in refrigerated shipping containers with first successful shipments of fresh-farmed Atlantic salmon fillets from Chile to the U.S. in history.
 - However the prototype system was too complex and power-hungry for commercial viability

Other Fresh Priorities in the 80's & 90's





History of Ultra-Low Oxygen/High-CO₂ Controlled Atmosphere Systems (2006 - 2016)

- 2006 - Bell cofounds Global Fresh Foods with *Dave Schanzer
 - **currently CEO of Plumrose USA*
 - Global Fresh Foods is now a “Venture Company” called BluWrap (<http://bluwrap.com/>) and continues to operate this technology globally.
- 2012 – Global Fresh Foods successfully conducts first commercial shipments of Fresh-Farmed Chilean Atlantic Salmon to U.S. and Japan.
 - Bell is granted patent for removing oxygen from high-CO₂ environments contained in flexible packages using fuel-cell-based technology.
- 2012 - Bell recruits professional CEO to operate Global Fresh Foods/BluWrap.

BluWrap Fuel Cell Technology

The Problem:

Oxygen and temperature threaten freshness of seafood

The Solution:

BluWrap uses fuel cells to reduce oxygen and refrigerated containers to keep product cool – extending the shelf life for salmon up to 50 days



Prototype of fuel cell technology



Product packaged in pallet units

High CO2 Packaging Headspace Critical





History of Ultra-Low Oxygen/High-CO₂ Controlled Atmosphere Systems (2006 - 2016)

- 2014 Bell is granted first patent for removing oxygen from rigid mechanically refrigerated systems, including refrigerated shipping containers, cold storages, vending machines, refrigerators, etc.
- 2016 –Bell partners with engineering firm to build first commercial prototype **Sustainably Fresh** refrigerated shipping container.

Sustainably Fresh - Fuel-cell-integrated CA Refrigerated Container

