USDA
United States Department of Agriculture

Interventions for Shell Eggs

David Geveke

U.S. Department of Agriculture, Agricultural Research Service,
Eastern Regional Research Center, Wyndmoor, PA

ARS/FSIS Food Safety Meeting, February 22, 2017, NCTC, Shepherdstown, WV

USDA
United States Department of Agriculture

The Riskiest Foods Regulated by the U.S. FDA

Food Category	Rank
Leafy Greens	1
Eggs	2
Tuna	3
Oysters	4
Potatoes	5
Cheese	6
Ice Cream	7
Tomatoes	8
Sprouts	9
Berries	10

(Klein et al., 2009)

Egg Risks

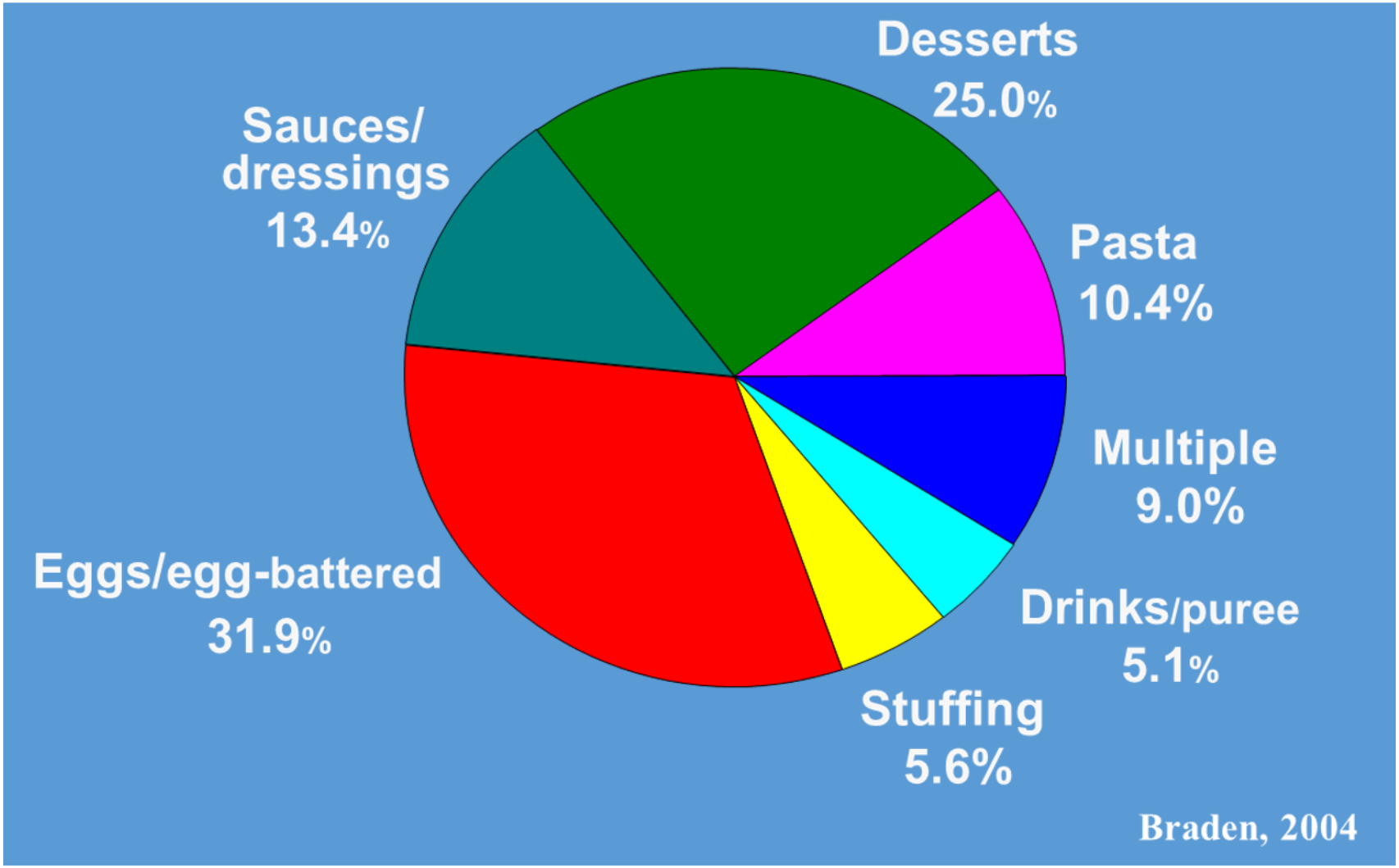
352 outbreaks from 1990 -2006 were linked to eggs

Vast majority were associated with *Salmonella* (Klein et al., 2009)

Combination *Salmonella* nontyphoidal / Egg dishes ranked #1 Public Health Burden (by Hospitalizations) (Batz et al., 2004)

USDA
United States Department of Agriculture

Confirmed Vehicles that are Egg-associated



Could it Happen to You?

- 1 in 10,000 to 20,000 eggs are contaminated (Ebel and Schlosser, 2000)
- 77 billion eggs produced in the United States per year
- 1 in 20,000 ⇨ 3.8 million contaminated eggs per year

Populations At-Risk

Approximately 20% of the population is highly susceptible to salmonellosis

Pregnant women, infants and young children, the elderly, and the immunocompromised

Percentage expected to rise significantly because of increases in lifespan and immunocompromised

(Gerba et al., 1996)

2010 Iowa *Salmonella* Outbreak

- 1900 people in 12 states reported *Salmonella* illness
- 550 million eggs recalled
- $7 million in fines and 3 month jail sentences

Site of Contamination

- 81% of contaminations are internal (albumen, vitelline membrane, yolk)
- 19% of contaminations are external (shell)

(USDA-FSIS, 2005)

CDC Tips for Preventing *Salmonella*

- "People should not eat raw or undercooked eggs"
- "Wider use of pasteurized egg in restaurants, hospitals, and nursing homes is an important prevention measure"

www.cdc.gov/salmonella/general/prevention.html (2015)

Need for Intervention

- If all U.S. eggs were pasteurized, the annual number of illnesses would be reduced from 130,000 to 19,000.

  (Schroeder et al. 2006)

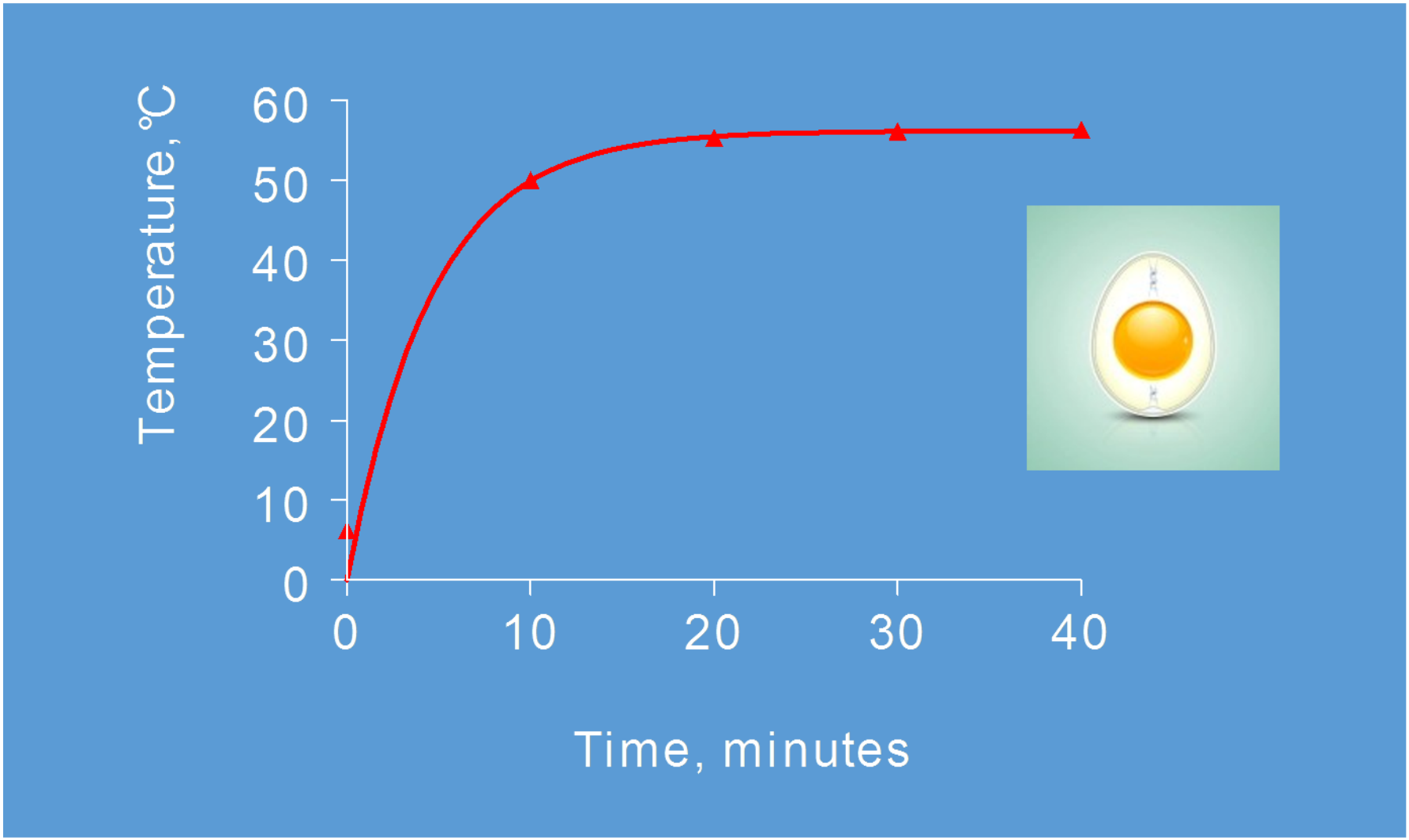
- Presently, less than 3% of eggs are pasteurized

Commercial Process - 60 Min. Hot Water Immersion

courtesy National Pasteurized Eggs

USDA
United States Department of Agriculture

Come up Time of the Yolk



Problems with Commercial Process

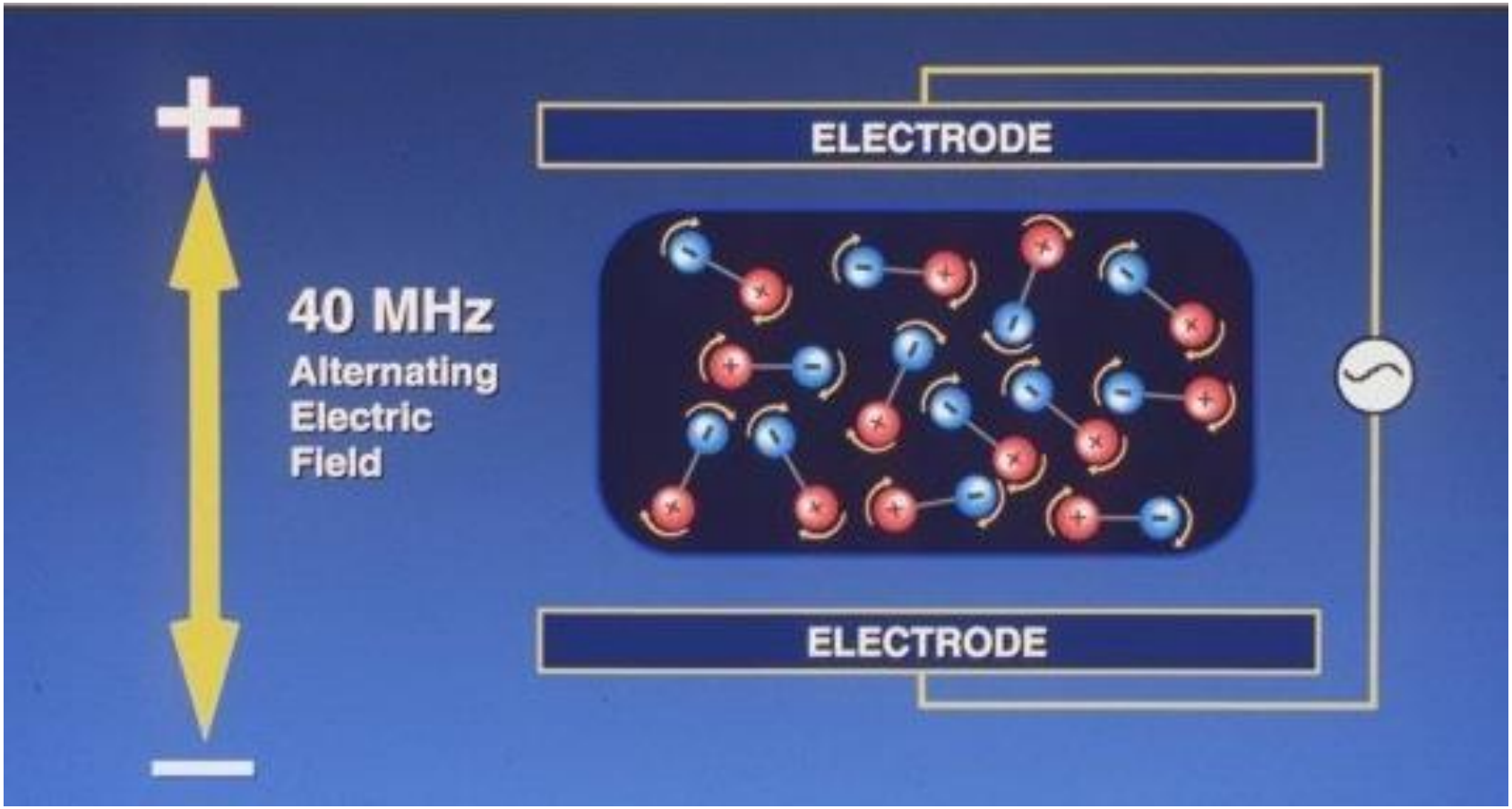
- Damages egg white appearance and functionality
- Adds more than $1.50 per dozen eggs (Sinclair, 2012)

Alternative Intervention Methods

- Irradiation: Damages functionality
- Ozone: Time consuming
- Cryogenic Cooling: Expensive
- Radio Frequency: Fast, gentle & inexpensive

USDA
United States Department of Agriculture

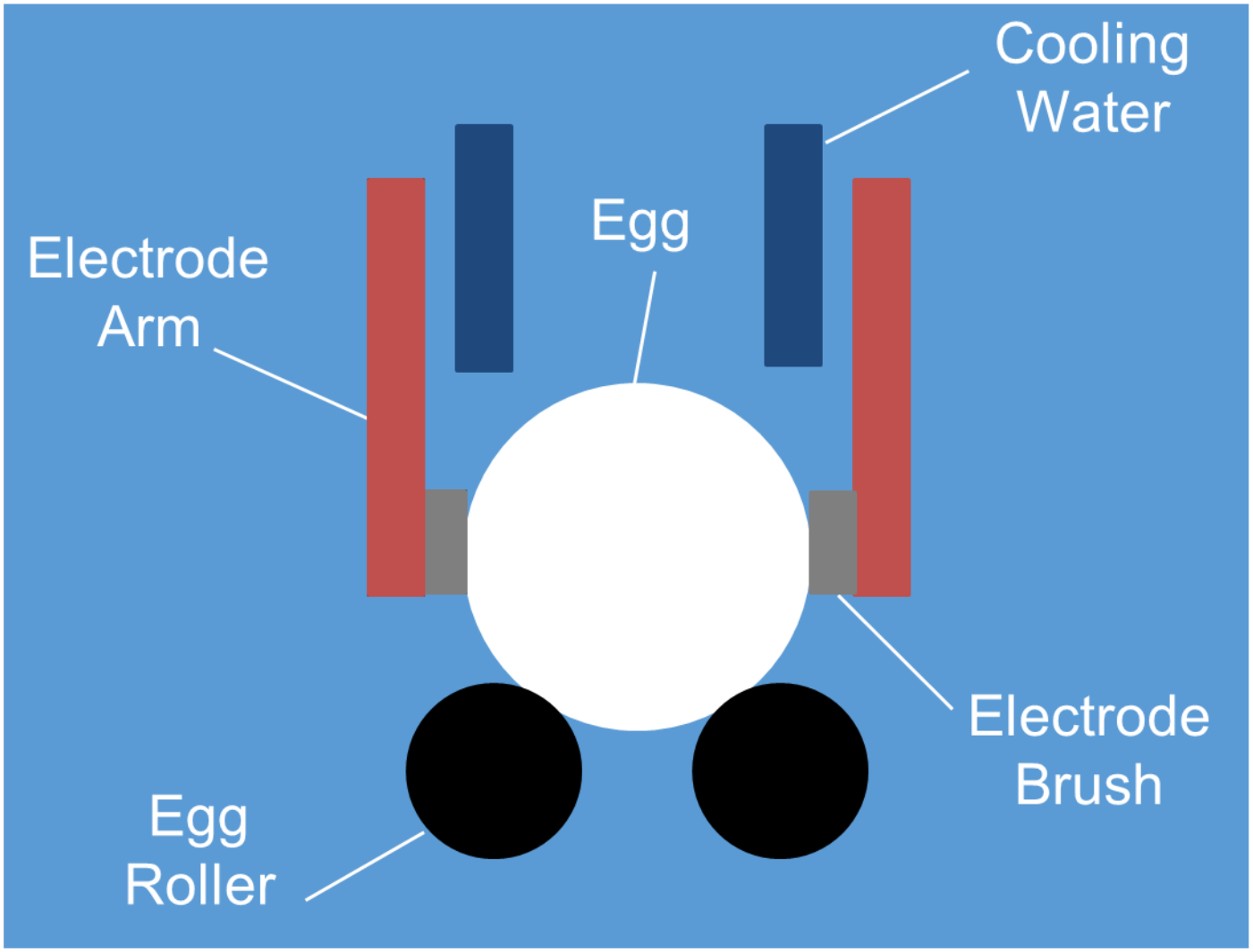
How Radio Frequency Heating Works



courtesy Radio Frequency Co.

USDA
United States Department of Agriculture

RF Apparatus (US Patent 8,973,492)



RF Apparatus

RF Equipment and 2-Step Process

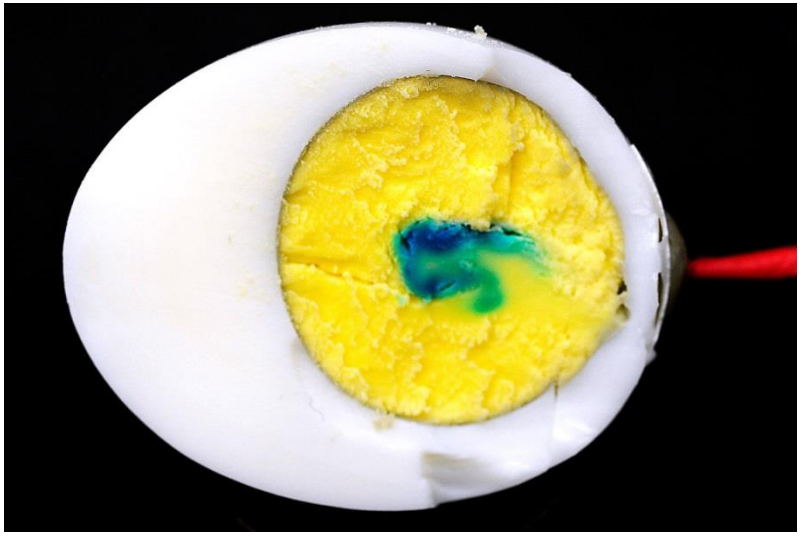
- RF power supply - 1 kW, 60 MHz
- 2-step process:
  - Heat the egg 6 min using RF
  - Heat the egg for an additional 15 min in 56.7 °C water

Temperature Measurements

- Temperature distribution of model food measured using FLIR camera
- Maximum egg temperature determined by inserting a type K thermocouple

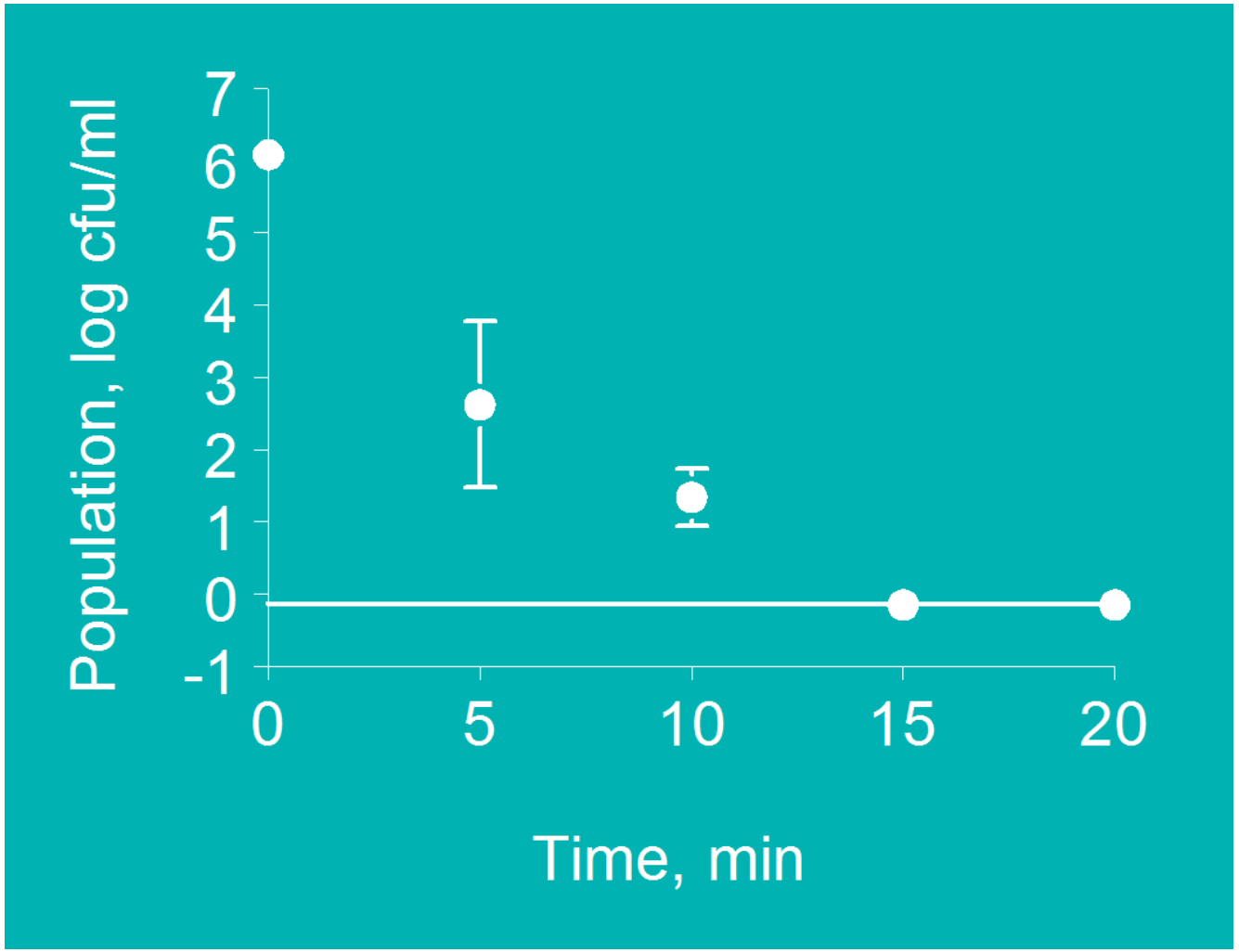
USDA
United States Department of Agriculture

Inoculation with *Salmonella* Typhimurium

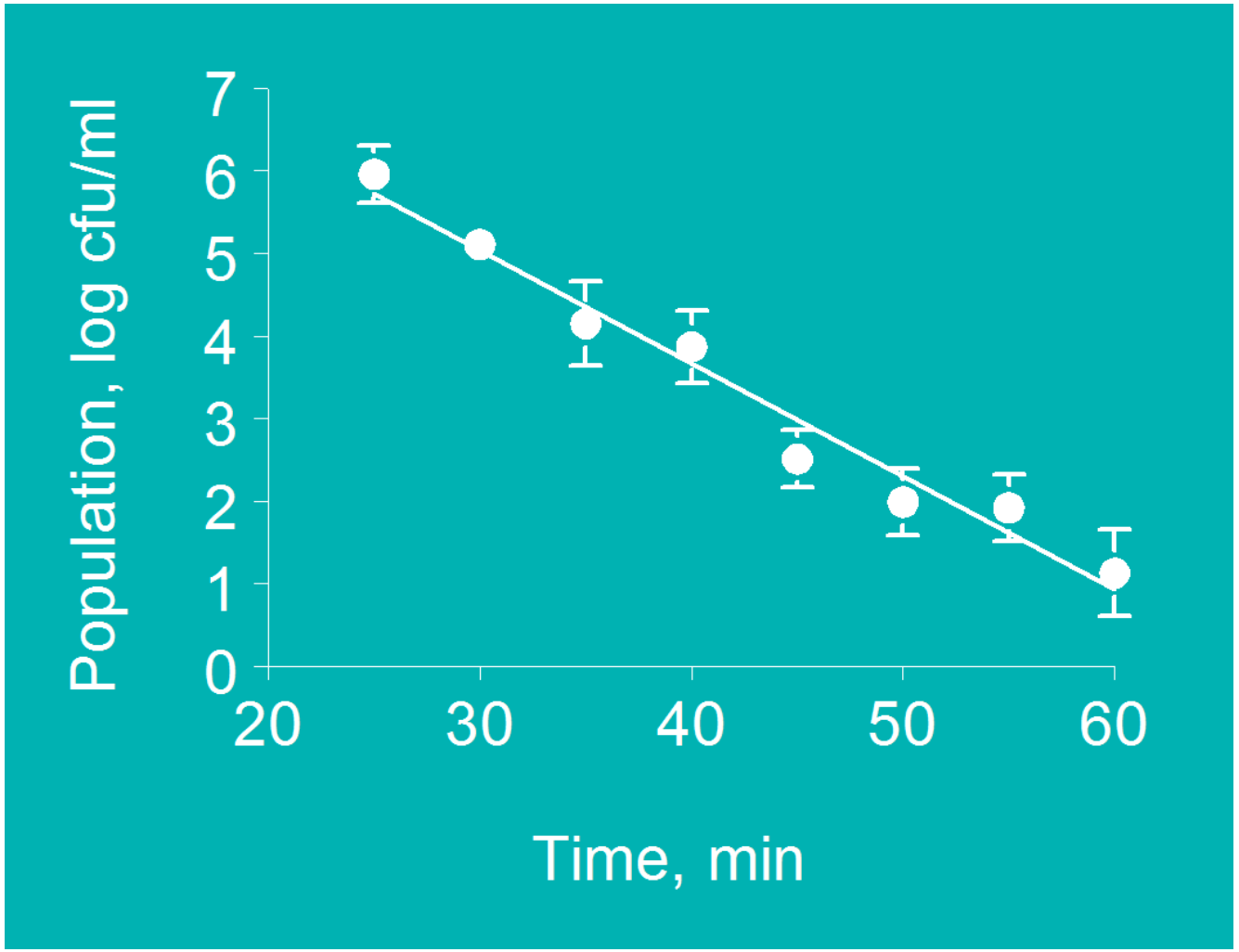


USDA
United States Department of Agriculture

Results: 6 min RF + Hot Water



Results: Hot Water Only



USDA
United States Department of Agriculture

Results - Visual

RF (right) maintained fresh egg white appearance compared to hot water (center)

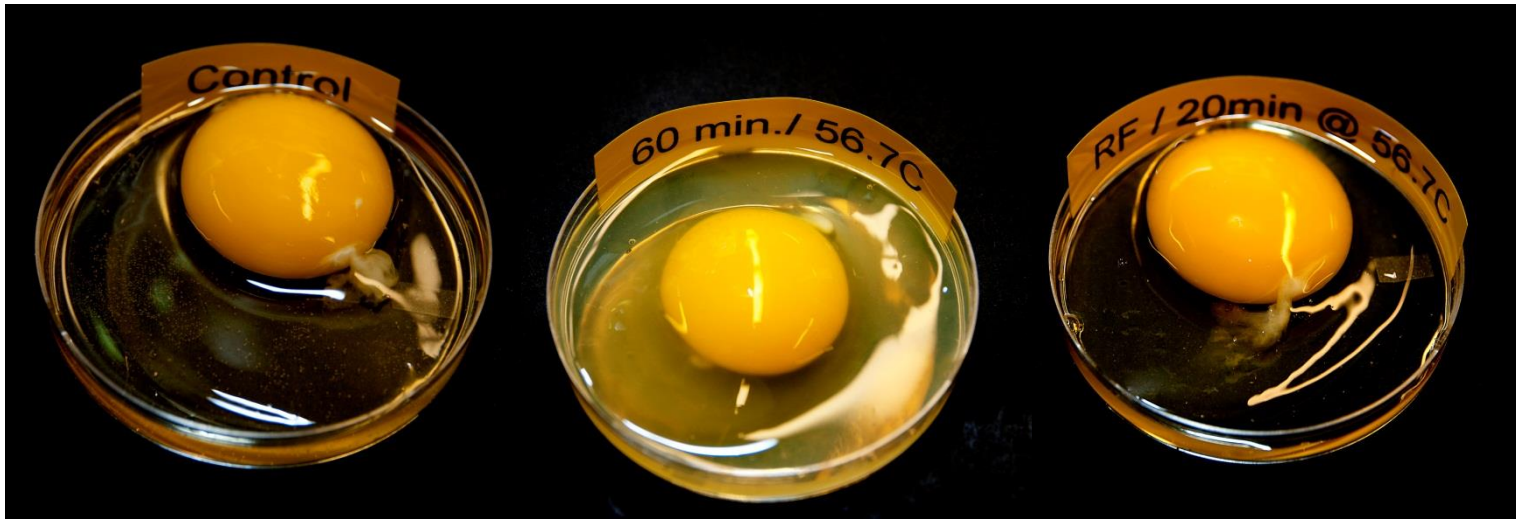
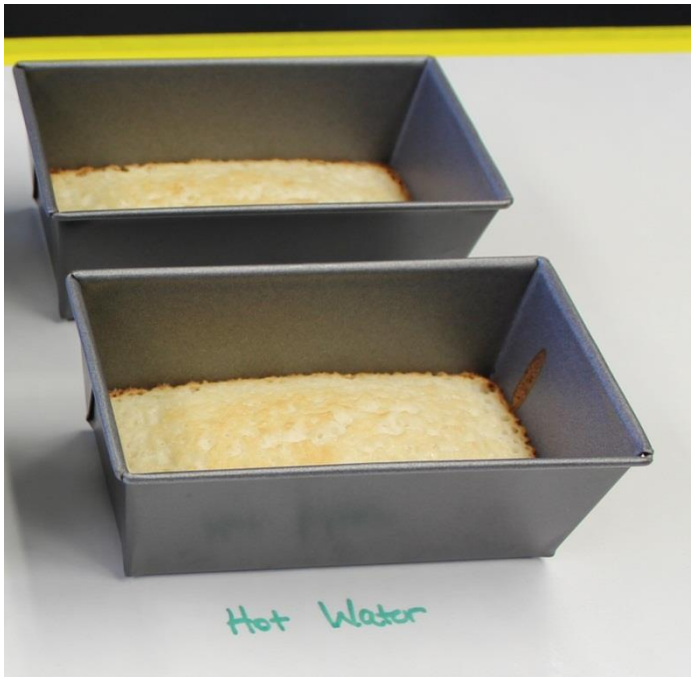


photo by Joseph Sites

Results - Angel Food Cakes

RF maintained more functionality (left) compared to hot water (right)



USDA

United States Department of Agriculture

Cooperative Research and Development Agreement

USDA
United States Department of Agriculture

24-Egg RF Unit

photo by Joseph Sites and Peggy Greb

Plans

- Test other frequencies
- Estimate equipment costs
- Continue scaling up

Conclusions

- 5 log (99.999%) inactivation of *Salmonella*
- RF pasteurization is 65% faster (processing time is 21 min vs. 60 min for commercial hot water process)
- Maintains the appearance of the egg white and preserves more of its functionality
- Should increase the percentage of eggs being pasteurized, thus preventing thousands of foodborne illnesses annually

Acknowledgements

- Mr. Andrew Bigley (ARS - ERRC)
- Mr. Christopher Brunkhorst (Princeton University)
- Dr. Deana Jones (ARS - RRRC)
- Mr. Joseph Sites(ARS - ERRC)
- Mr. Eric Tilman (ARS - ERRC)