UV & Dairy

Current Situation

- The dairy industry has relied on thermal pasteurization for over 150 years. It's expensive, degrades milk's nutrition and makes milk difficult to process in a dairy ingredient factory.

- Milk and whey are currently heated 2-4 times during processing, and each of these steps degrades milk's quality and further processability.

- Valuable compounds, such as lactoferrin, Immunoglobulins and alkaline phosphatase are heavily degraded by heat.

What is UV-C?

- Two adjacent thymine or uracil bases form a thymine or uracil dimer preventing replication.
- Already used to pasteurize water or brine in dairy plants.
- Used in municipal, industrial and recreational water systems for decades.
- Post Covid, used in hospitals and health care facilities everywhere.
- Non-ionizing radiation like infrared and microwaves.

How effective in milk?

- FDA affirmed that our process achieves at least a 5-log reduction in the **most UV resistant pathogen** likely to be found in milk of public health significance.
- More opaque and viscous fluids require more UV dose.
- Entirely cold process, UV pasteurization only increases temperature by 1-2ºC.
- Oxidation of lipids in whole milk remains a challenge

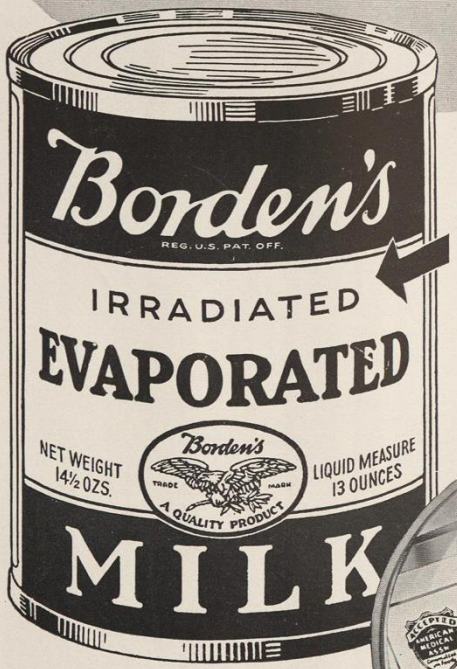
UV is safer than heat

Pathogen	Heat log reduction	UV log reduction
M. a. paratuberculosis	3-4	7.0
Listeria monocytogenes	6.8	10.5 - 16.3
Staphylococcus aureus	13.6	13.5 - 33.7
Cronobacter Sakazakii	12.5	13.5 - 18.9
Shiga-toxin prod. E. coli	30.0	9.6 - 22.4
Campylobacter spp.	> 15	11.6 - 30.6
Yersinia enterocolitica	8.0	22.5 – 30.6
H5N1 (Bird flu)	5.8	7.5

Any harmful by-products?

- In the 1920s and 30s, millions of children in US & EU consumed UV treated milk to cure Ricketts. Steenbock patent royalties funded the start of WARF.
- EFSA already approved UV to extend the shelf life of thermally pasteurized milk and fully evaluated its safety.
- Already completed GRAS, including a rat study
- Many published papers demonstrate safety

Tell them . . *"It's Vitamin D Irradiated!"*

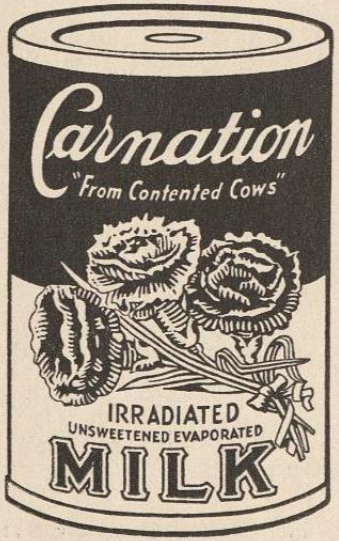


CALL your customers' attention to the word "Irradiated" on the Borden Evaporated Milk label. Notice how they welcome this newest feature in the *quality* Evaporated Milk their families like.

Vitamin D helps build bones and teeth —yes. And it builds something else important, too . . .

VITAMIN D BUILDS SALES!

Borden's Evaporated Milk was the first evaporated milk to be submitted to the American Medical Association Committee on Foods, and the first to receive the seal of acceptance.



"FROM CONTENTED COWS"

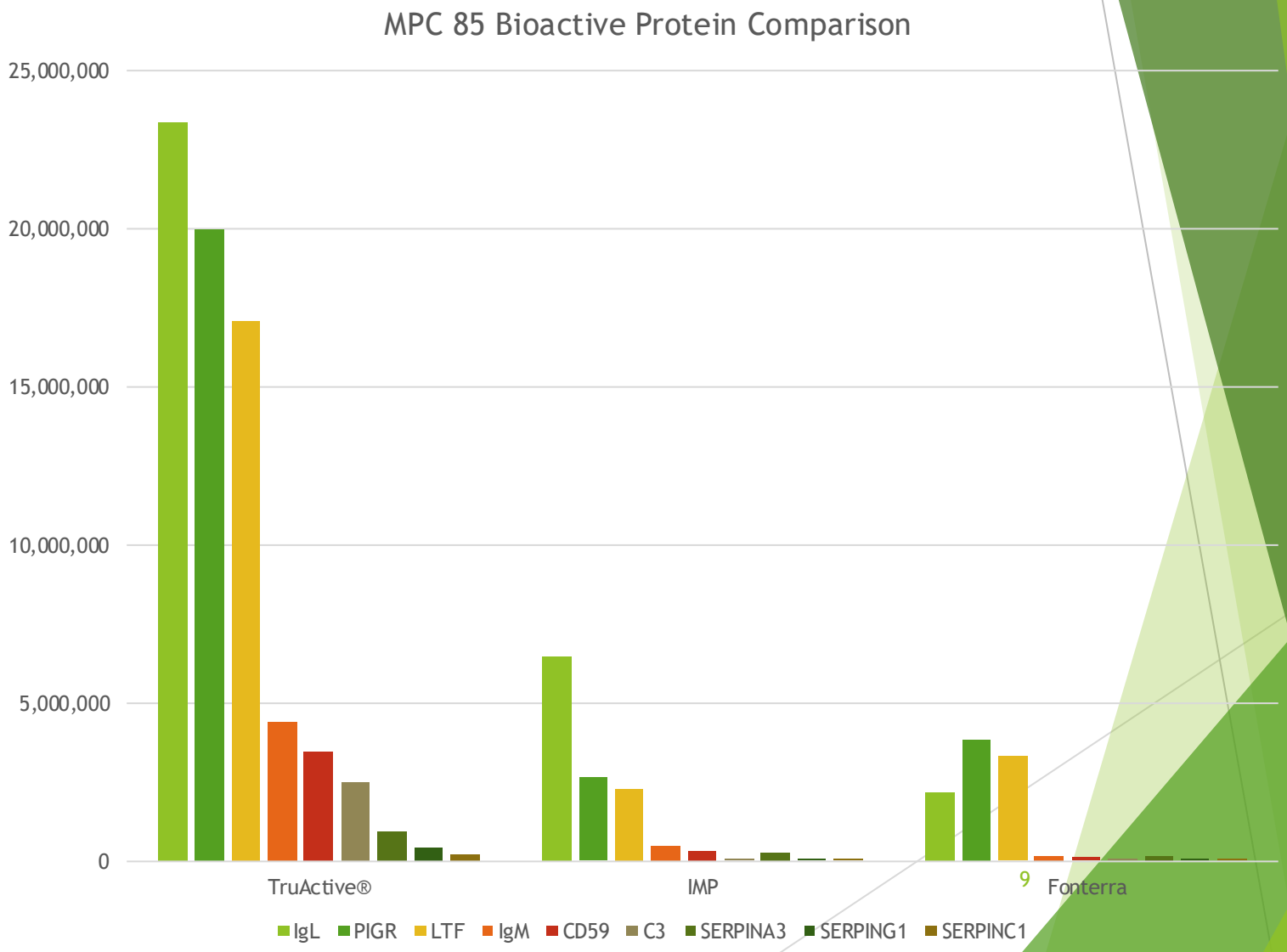
What are the Benefits?

- UV adds more value to the dairy industry than any other application as **only** milk contains high concentrations of bioactive proteins.

- Dairy products produced with our UV technology have been clinically proven to:
  - **Restore elderly immune** function.
  - **Protect children** from developing asthma, eczema and food allergies
  - **Repair leaky gut** – linked to many chronic diseases
  - **Improve athletic performance and recovery** – including reducing ”Olympic Village Fever”

- These are **HUGE** health issues that milk improves.

UV retains far more bioactive proteins



Bioactive Proteins

- IgL & IgM - crucial for the adaptive immune system to recognize and neutralize foreign antigens by activating the complement system.
- PIGR - protein that transports antibodies (specifically IgA and IgM) across epithelial cells, particularly in the gut.
- LTF – protein with antimicrobial, antiviral, antioxidant, and immunomodulatory properties.
- CD59 - glycoprotein that protects cells from complement-mediated attack
- C3 - crucial protein in the immune system's complement system that helps destroy pathogenic bacteria and viruses
- Serpin - regulating blood coagulation, inflammation, and the immune response

- Synergistic effects clinically proven more effective than individual compounds.

Allergy Prevention

- ALEX, PASTURE and GABRIEL studies
  - Multiple European studies demonstrated raw milk consumption (not farm exposure) had the greatest protective effect.

- https://www.sciencedirect.com/science/article/abs/pii/S2213219819309560

- The Mayo Clinic completed a mouse-model peanut allergy prevention trial demonstrating UV WPC 80 provided a protective effect.

- These studies demonstrate that the bioactive proteins preserved by UV should reduce the number of children who develop asthma, skin and food allergies.

MAYO CLINIC

EFFECTS OF UV-TREATED WHEY ON DEVELOPMENT OF ALLERGIC DISEASES IN MOUSE MODELS

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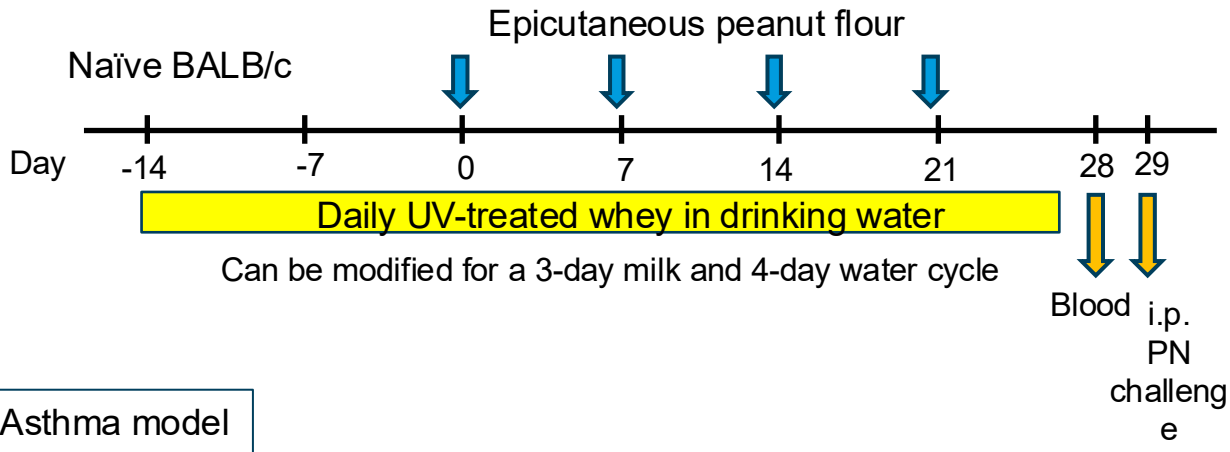
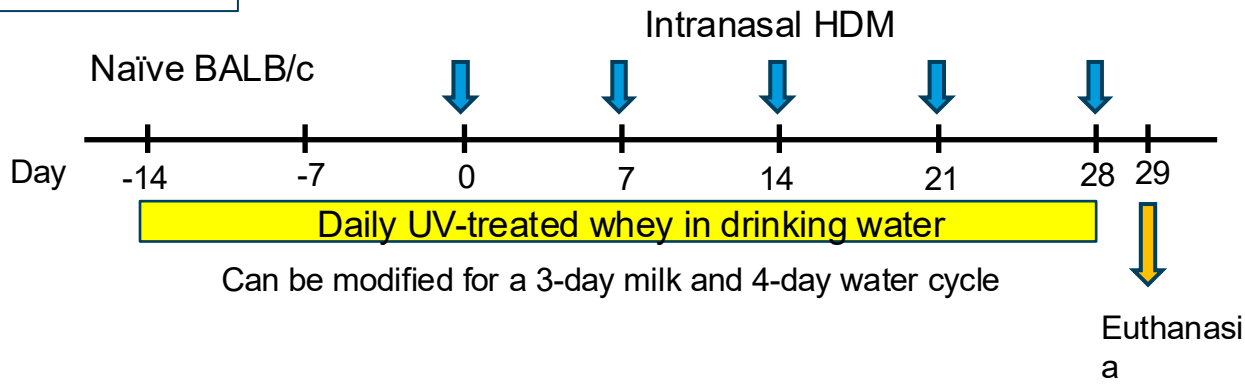
Prevention experiments

Food allergy model



Body weight
Rectal temperature
Clinical symptoms
PN-specific IgE/IgG1

Asthma model



Body weight
BAL cell differentials
Lung cytokines
Lung pathology (H&E, PAS)
HDM-specific IgG and isotypes
AHR

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Immunosenescence

- UC Davis Clinical Trial
  - Elderly vaccine antibody development. 28 subjects were given 7.5 gm of MPC 85 or soy protein – determined Tetanus antibody levels after 8 weeks of intervention. 120% increase – A 2010 study of pasteurized whey protein found 17% increase compared to same soy protein.

- https://doi.org/10.3389/fimmu.2018.02254

- Restored immune function in the elderly - similar mechanism to immune function initiation in infants.

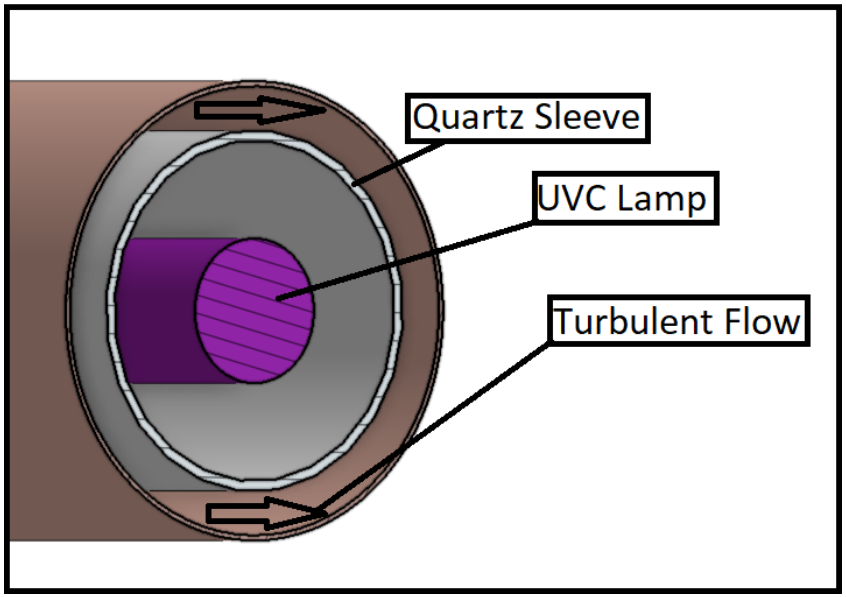
Leaky Gut

- VA Hospital
  - Researcher studying alkaline phosphatase's ability to improve epithelial cell wall junction integrity tested TruActive WPC 80 and found far superior results.
  - We contend synergies between milk's bioactive proteins likely account for the increased benefits.
- VA Hospital is now extending to a multi-site investigation.

Energy & Production Savings

- Up to 90% energy savings compared to steam and electricity for pasteurization.
- Un-denatured proteins lower viscosity, which improves membrane separation
- Higher solids after RO enables lower temperature spray drying.
- Large savings in CIP chemicals and water as fouling is eliminated.

Turbulator



UV most effective on thin films and with high turbulence

Production UV System

- Since 2016, Tamarack's UV systems met Coca-Cola's rigorous standards.

- CCP – UV sensor on each lamp digitally recorded along with flow rate. Cut in / Cut out and divert automated. All can be sealed and validated by state inspectors. Analogous to current procedures.

Applicable to Many Dairy Processes

- Whey production – after cheese production and before or after filtration. Acid casein.
- Lactoferrin production – can pasteurize raw milk or Lactoferrin after extraction. Already approved!
- Colostrum – 70% of IgG degraded by pasteurization. Nearly complete retention with UV. Filed with FDA.
- Brine solutions – eliminate bacteria and yeasts with filtration for cheese production
- Whole and skim milk for cheese production – taste will be more complex as native bacteria will enhance diversity.

US Regulatory Status

FDA issued a **no objection letter** authorizing our specific UV equipment and process as legal pasteurization of raw skim milk.

The **Better Food Disclosure Act** will allow UV to utilize the GRAS approval route, or we will file a Food Additive Petition for each dairy ingredient – skim milk, whole milk, whey, colostrum, etc.

Filed for a **Prior Use Exemption** based on 1920s and 30s use to sterilize milk – same intended use.

Started process to amend the Pasteurized Milk Ordinance (PMO) – phosphatase test standards of identity

Phosphatase Test

- Milk is the **only food** where regulations require confirming damage to the food to ensure its safety.
- There must be a better way.
- No other thermally treated product has “markers” to ensure safety. Jams, sauces, juices, syrups, etc.

PMO and Alternatives

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  - Provided further, that nothing shall be construed as barring any other process found equivalent to pasteurization for milk and milk products, which has been recognized by FDA as provided in Section 403 (h)(3) of the FFD&CA.

- Phosphatase test
  - UV doesn't damage this nutritionally valuable enzyme.

Phosphatase**	Less than 350 milliunits/L for fluid products and other milk products by approved electronic phosphatase procedures

Summary

- Tamarack's UV pasteurization is:
- 1) Safe - Exceeds thermal pasteurization's safety, no harmful by-products.
- 2) Sustainable – Reduces energy, CIP chemical and water usage. Nearly eliminates fouling.
- 3) Enables highly valuable nutritional benefits.
- 4) HACCP capable and compliant with state regulations and requirements.
- WPC 80 samples available for research!