

Rethinking Probiotic Stability: New Solutions to Old Challenges

Aptar 
CSP Technologies



Billy Abrams, Senior VP Business Development, Aptar CSP Technologies
Dr. Greg Leyer, Chief Scientific Officer, UAS Labs



Billy Abrams, Senior VP Business Development, Aptar CSP Technologies

Billy has worked at Aptar CSP Technologies for 23 years. He started in Operations, transitioned to Project Management and has been responsible for Business Development for over 15 years. Billy has a BA in Economics from Cornell University and a MBA from the Johnson School of Management at Cornell. He has worked on probiotic packaging initiatives for over 15 years and has commercialized countless projects utilizing CSP's Activ-Polymer™ technology across a range of application fields with major global pharmaceutical, diagnostic and nutritional supplement companies.



Dr. Gregory Leyer, Chief Scientific Officer, UAS Labs

Greg has dedicated his professional career to probiotic advancement making him not only a critical component of UAS Labs but a world-renowned expert, educator and speaker in the field. To continue driving the industry and UAS Labs forward, Greg continues research in the areas of probiotic bioprocess development, application development, and clinical sciences. To-date he has authored or co-authored 24 publications in the areas of probiotic clinical results, application know-how, safety parameters, and holds patents in the field. In addition, he is an active member of both the International Probiotic Association (IPA) and International Scientific Association for Probiotics and Prebiotics (ISAPP). A graduate of the University of Wisconsin-Madison, Greg received his MS and PhD in Food Microbiology and Toxicology studying the pathogenesis of various organisms including *Clostridium botulinum* and *Salmonella typhimurium*. His post-graduate career has since focused on the beneficial effects microbes have on humans.

History of AptarGroup

70

YEARS OF
EXPERIENCE

operating in
dispensing
systems



1940 - 1960

Our founding
companies started in
the U.S. and Germany



1960 - 1980

Pittway Corporation
acquires the legacy
companies and grows the
company



1980 - 2000

The company debuts the
name Aptar and continues
its global expansion.
Aptar becomes a public
company in 1993



Aptargroup

Today, AptarGroup is a
\$2.5 BILLION
COMPANY

with more than
13,200 EMPLOYEES
worldwide organized by

3 MARKET
SEGMENTS

About Aptar CSP Technologies



- Joined AptarGroup August 2018
- Material science specialist delivering innovative, highly-engineered, active packaging solutions
- Headquarters Auburn, Alabama, USA, with global footprint
- + 1 billion components manufactured annually, 4 manufacturing locations worldwide
- + 500 worldwide patents



Auburn, AL USA



Atlanta, GA USA



2018 Expansion - Auburn, AL USA



Niederbronn-Les-Bain, France



Guangzhou, China

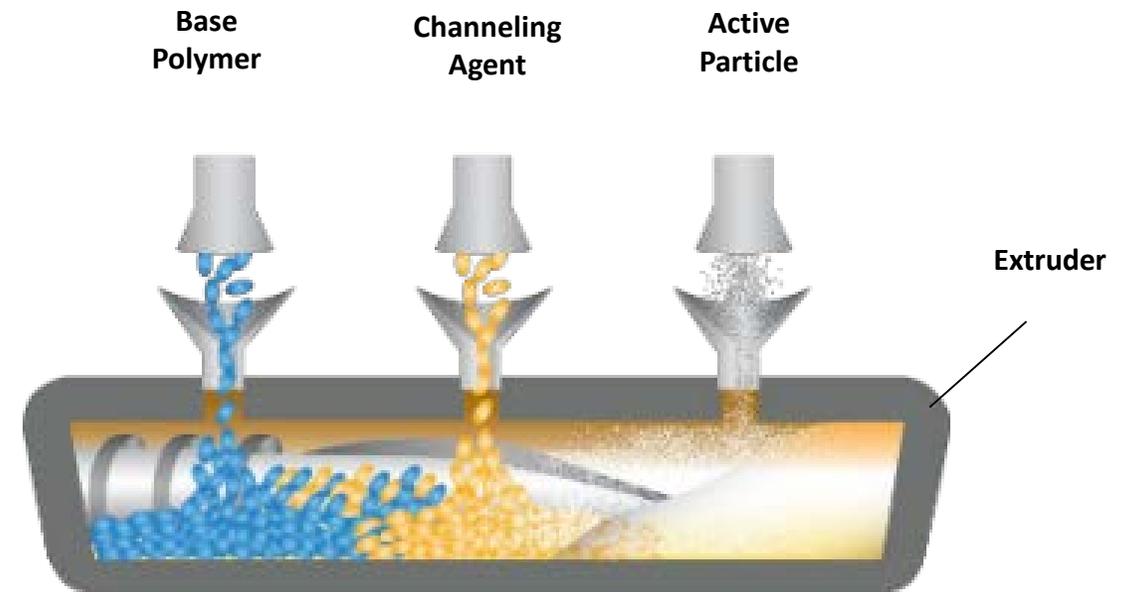
3-Phase Activ-Polymer™ Material Science

3-Phase Activ-Polymer™ Material = Platform Material

Material Science: Adding Chemistry to Polymers

3-Phase Polymers

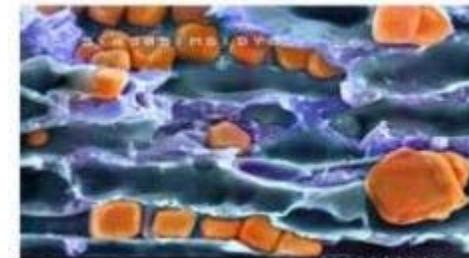
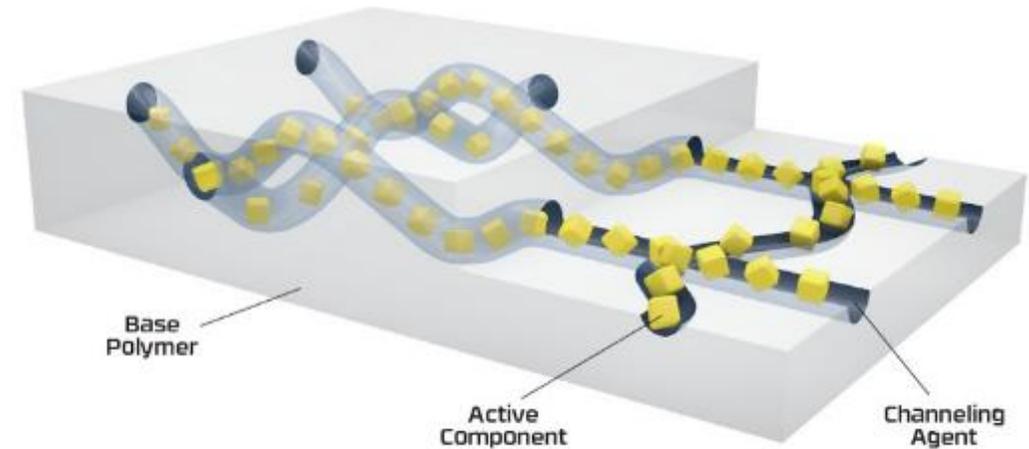
1. Majority Polymer: Base structure component
2. Particle: Adsorbing/absorbing – active component
3. Minority Polymer/Channeling Agent: Immiscible in majority polymer



3-Phase Activ-Polymer™ Material

- Channels created within a polymer allow movement of gases
- “Active” particles are added to the polymer in order to:
 - **Adsorb** or **Absorb** (moisture, gases, reactive impurities, odors, formaldehyde and other volatiles)
 - **Release** (aromas, biocides, nutrients, carbon dioxide)
- **Gas diffusion** is controlled through the channel composition

CSP Activ-Polymer™ Technology



Active Packaging – Putting Chemistry into Polymers

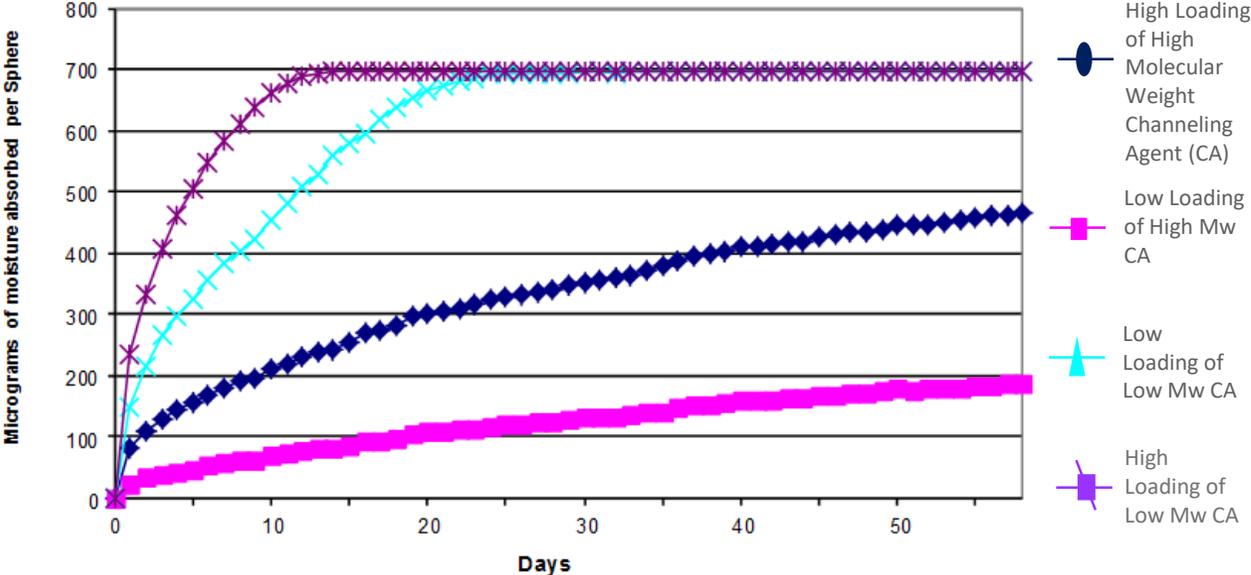


3-Phase Activ-Polymer™ material allows the **control of kinetics** based upon formulation

- Uptake rate can be increased or decreased
- Capacity can be increased or decreased

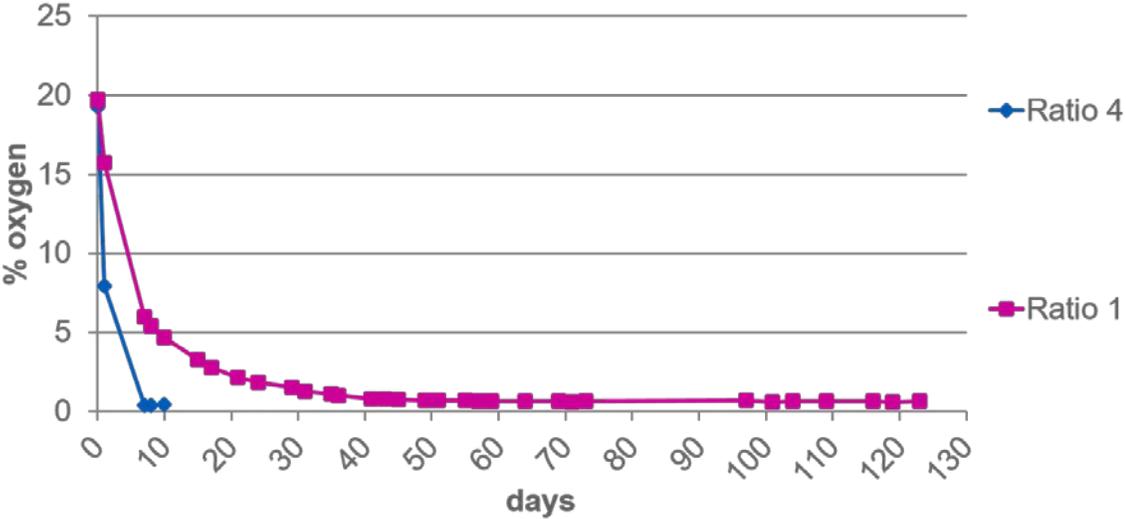
Customized Absorption Rates

ACTIV-TAB Sphere (0.00565gram) Rate of Absorption at 10% RH and 72 °F.
(Desiccant percentage and Polymer remain constant for each formula)



Oxygen Scavenging Customization

M0047
(Ratio represents =Total capacity of piece/available oxygen volume)
Oxygen absorbed per gram of film=30cc

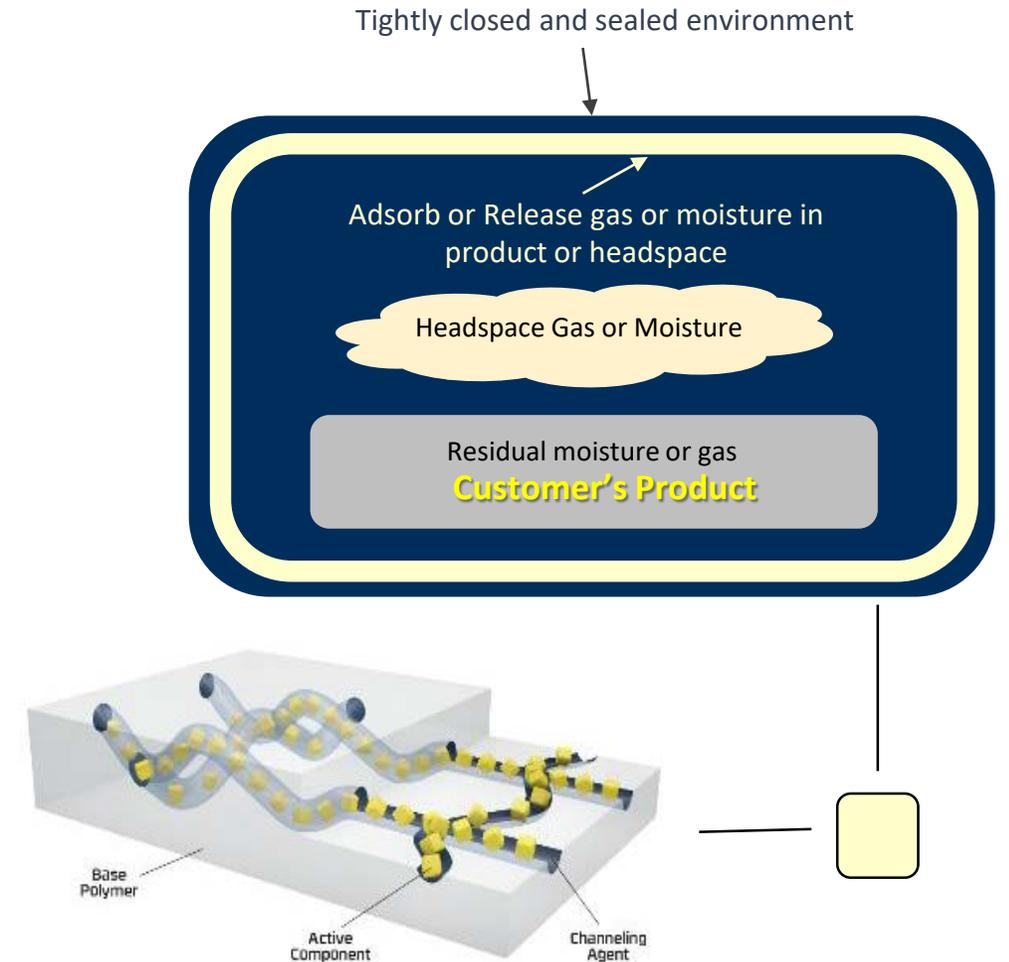


Active Packaging – Putting Chemistry into Polymers

Tightly Sealed Environment

Utilizing **3-Phase Activ-Polymer™** technology requires a **tightly sealed environment**

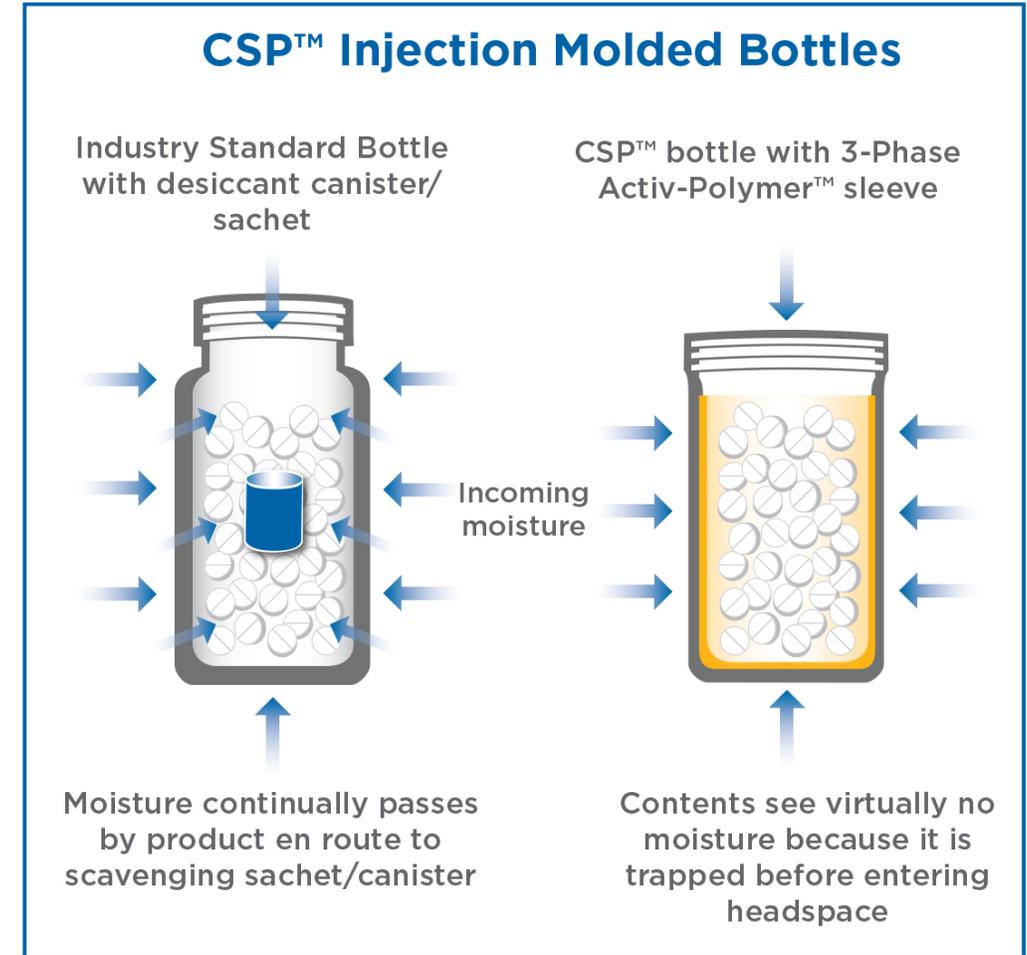
- Chemistry required determined
- Gas or moisture transmission rates are reviewed
- Focus on seals associated with package
- Amount of **3-phase material** required will depend on how **tight** of an **environment** it will be placed in



Technology Applications

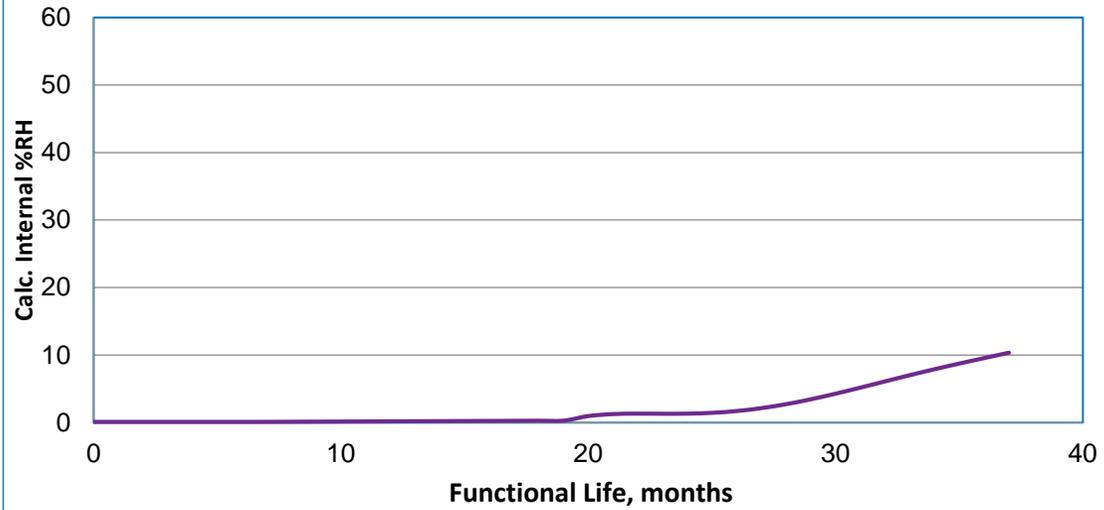
CSP™ Injection Molded Flip-Top Vials & Bottles

- **CSP™ Flip-Top Activ-Vial™** with integrated 3-Phase Activ-Polymer™ sleeve
- Patented “Close In The Mold” Technology Ensures **Moisture-Tight Seal**
- Maintains seal integrity throughout shelf life and consumer use life
- Child-Resistant/Senior-Friendly Closures



CSP™ Vials Calculated RH Maintained (64ml and 110ml)

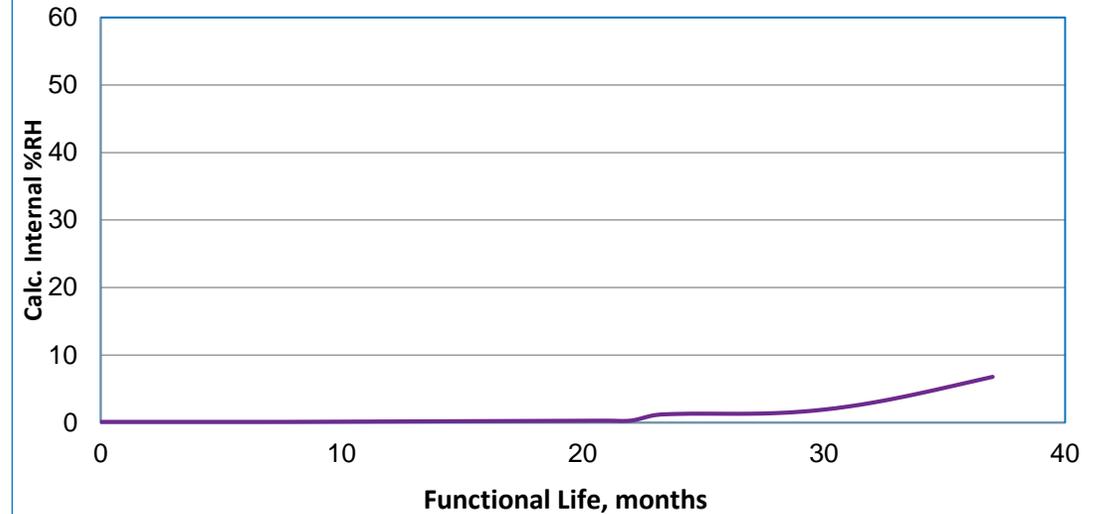
Calculated % RH Maintained in 64mL Vial vs. Time 25°C and 60% RH



- Data based on empty containers. Addition of product may impact %RH
- Data based on CSP's internal testing of bottles for foil seal integrity.
- Based on minimum capacity and maximum moisture ingress per container

— 64mL Vial

Calculated % RH Maintained in 110 mL Vial vs. Time 25°C and 60% RH



- Data based on empty containers. Addition of product may impact %RH
- Data based on CSP's internal testing of bottles for foil seal integrity.
- Based on minimum capacity and maximum moisture ingress per container

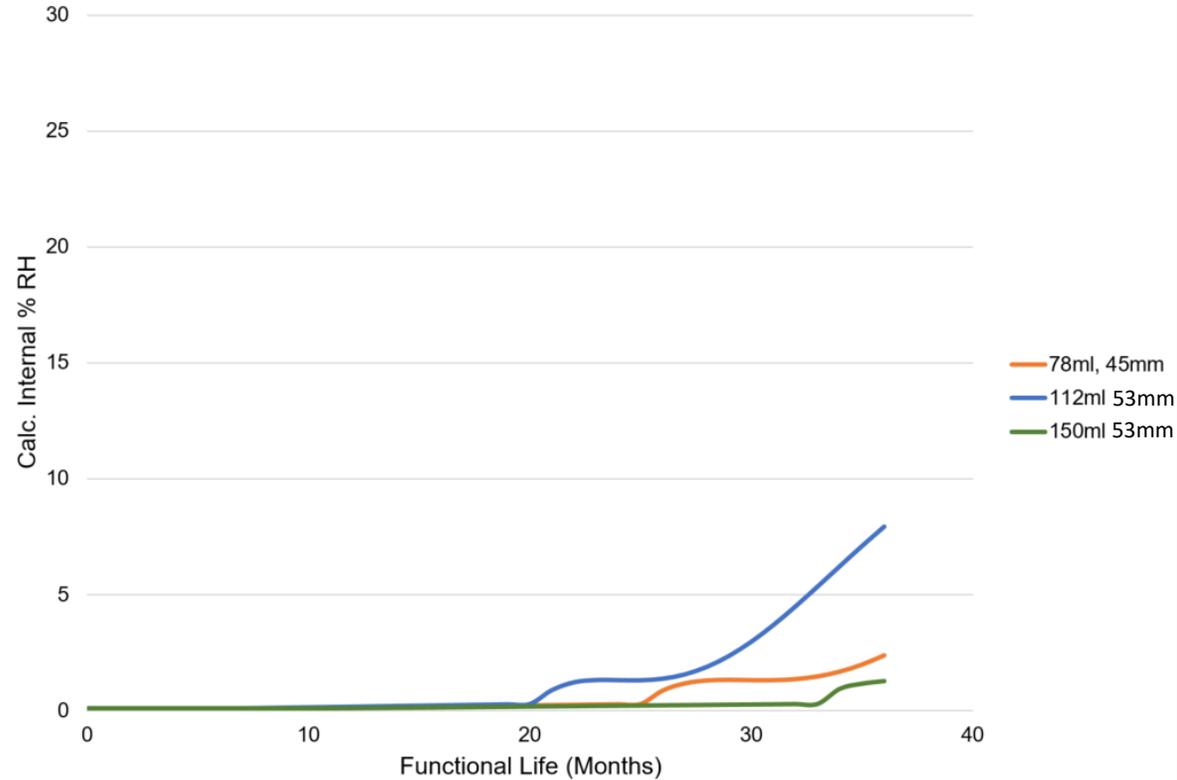
— 110mL Vial

CSP™ Bottles Calculated RH Maintained

With Induction Seals Applied

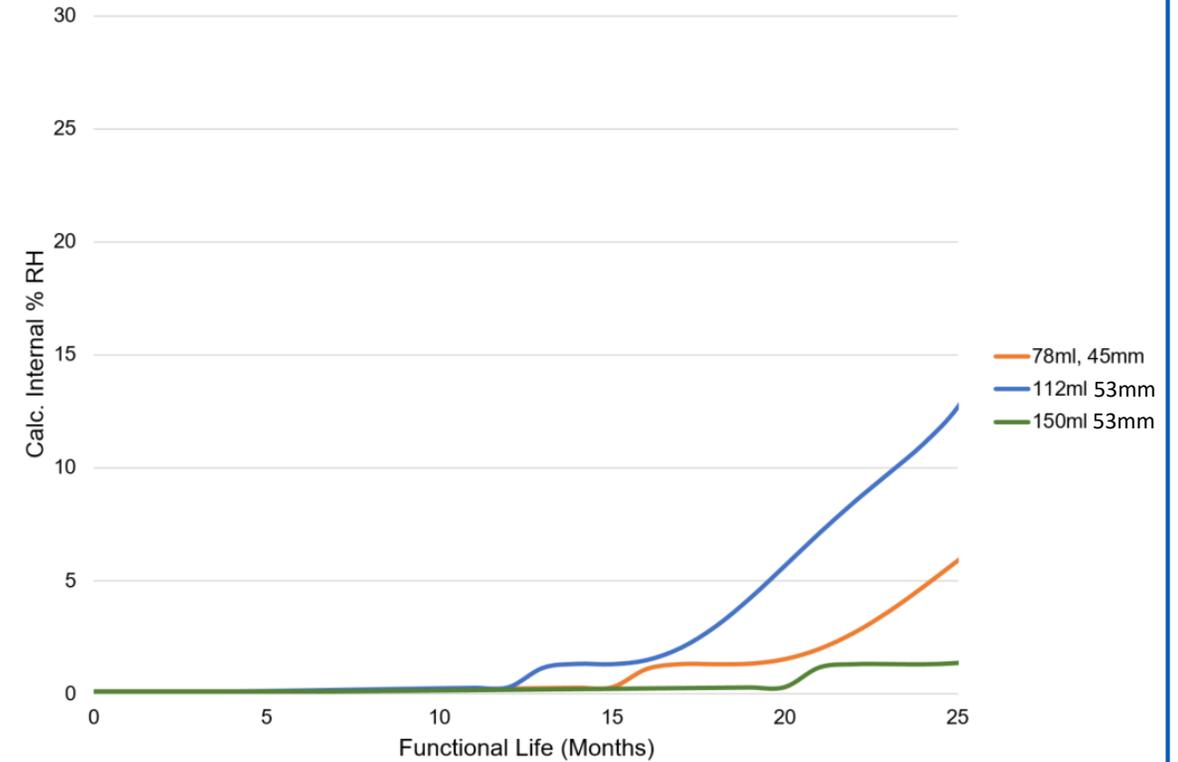
(78ml, 45mm; 112ml, 53mm; 150ml, 53mm)

Calculated Percent RH vs. Time at 25°C/60%RH



- Data based on empty containers. Addition of product may impact %RH.
- Data based on CSP's internal testing of bottles for foil seal integrity.
- Based on minimum capacity and maximum moisture ingress per container.

Calculated Percent RH vs. Time at 30°C/75%RH

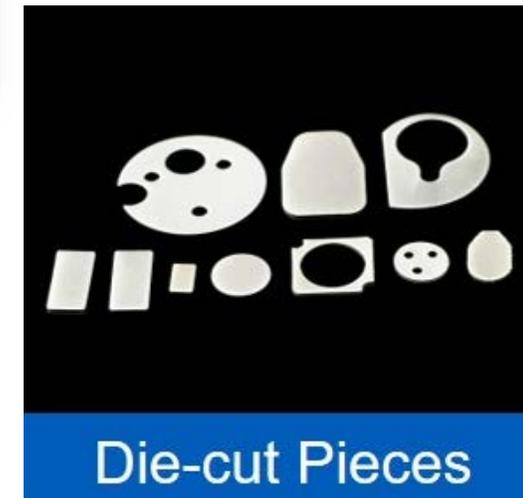
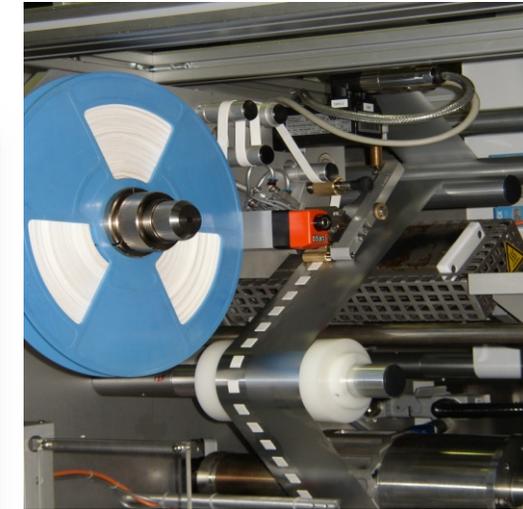
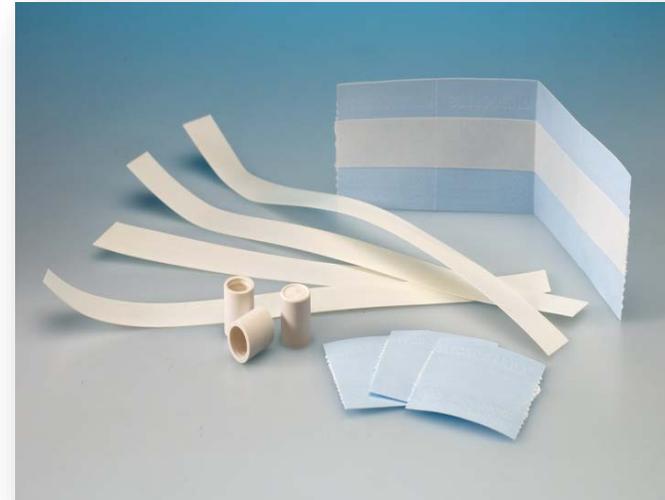


- Data based on empty containers. Addition of product may impact %RH.
- Data based on CSP's internal testing of bottles for foil seal integrity.
- Based on minimum capacity and maximum moisture ingress per container.

Technology Applications

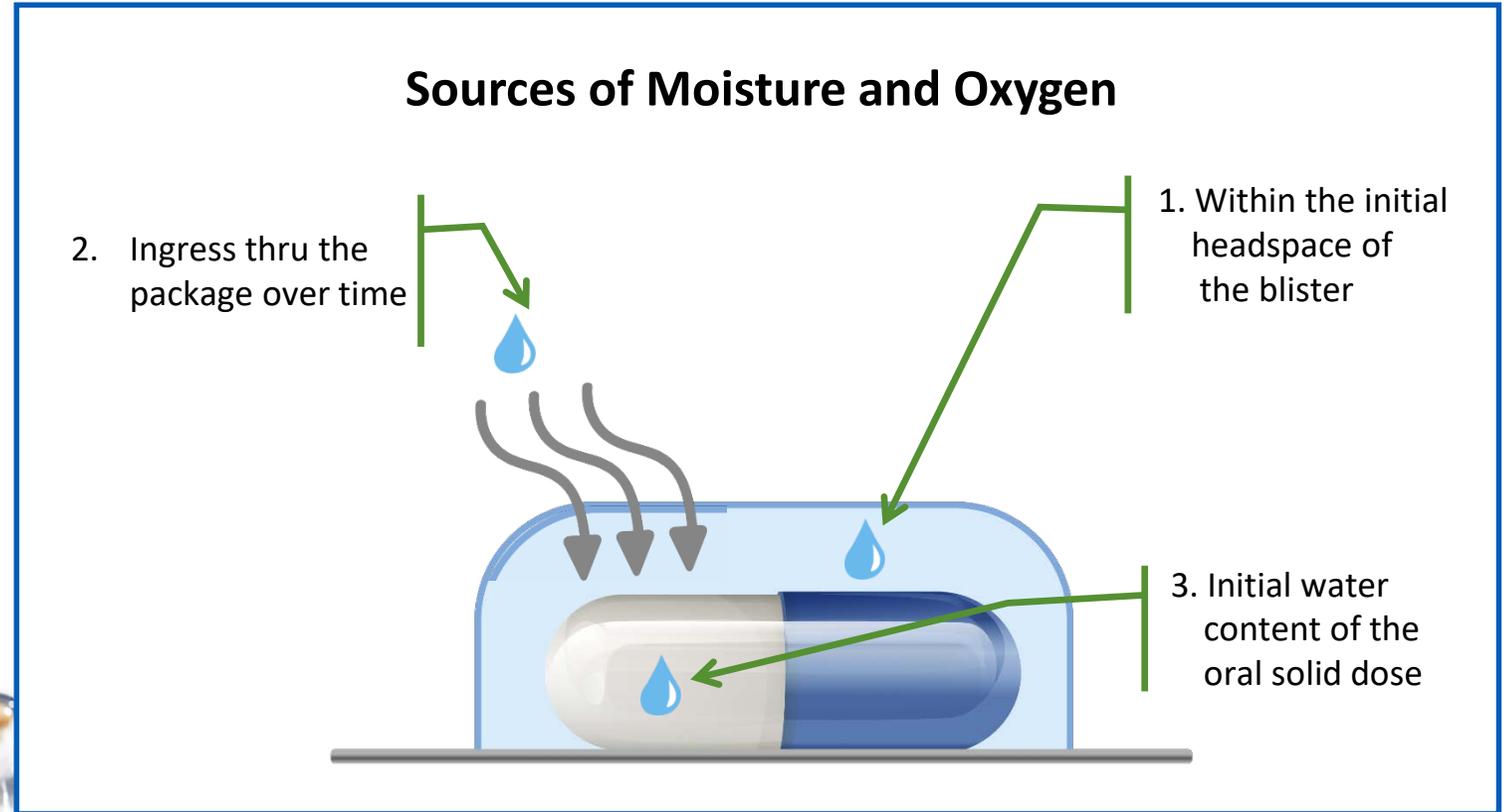
3-Phase Extrusion Film – Activ-Film™ Material

- Applied via “heat-staking” or with adhesive
- Manufactured at 0.3-1.2mm thickness
- Continuous film or die cut available
- Applied seamlessly to interior of package
- Heat staking & labeling solutions by industry known integrators
- Compatible with Stick Packs, Sachets, Blister Packs, ...



Activ-Blister™ Solutions

- Incorporating 3-Phase Activ-Film™ into blister packaging solutions
- 3-Phase Activ-Film™ is heat staked to foil
- Protects product from moisture, oxygen, CO₂, reactive impurities and odors
- **Active headspace protection** achieved without adding cost (e.g. gas flush/purging, secondary packaging, or refrigeration)
- **Size reduction** → move from cold-form foils to thermoforms for a smaller blister footprint, **40-60% smaller**

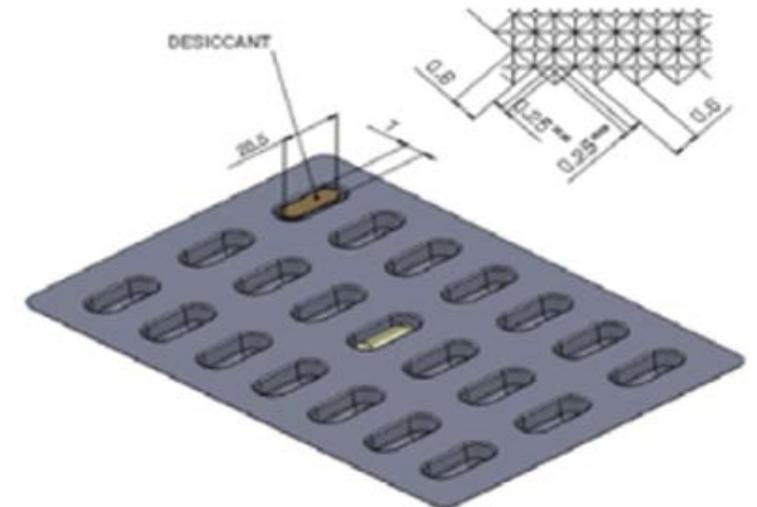


Activ-Blister™ Solutions

Results compared to Aclar-type thermoformed blisters

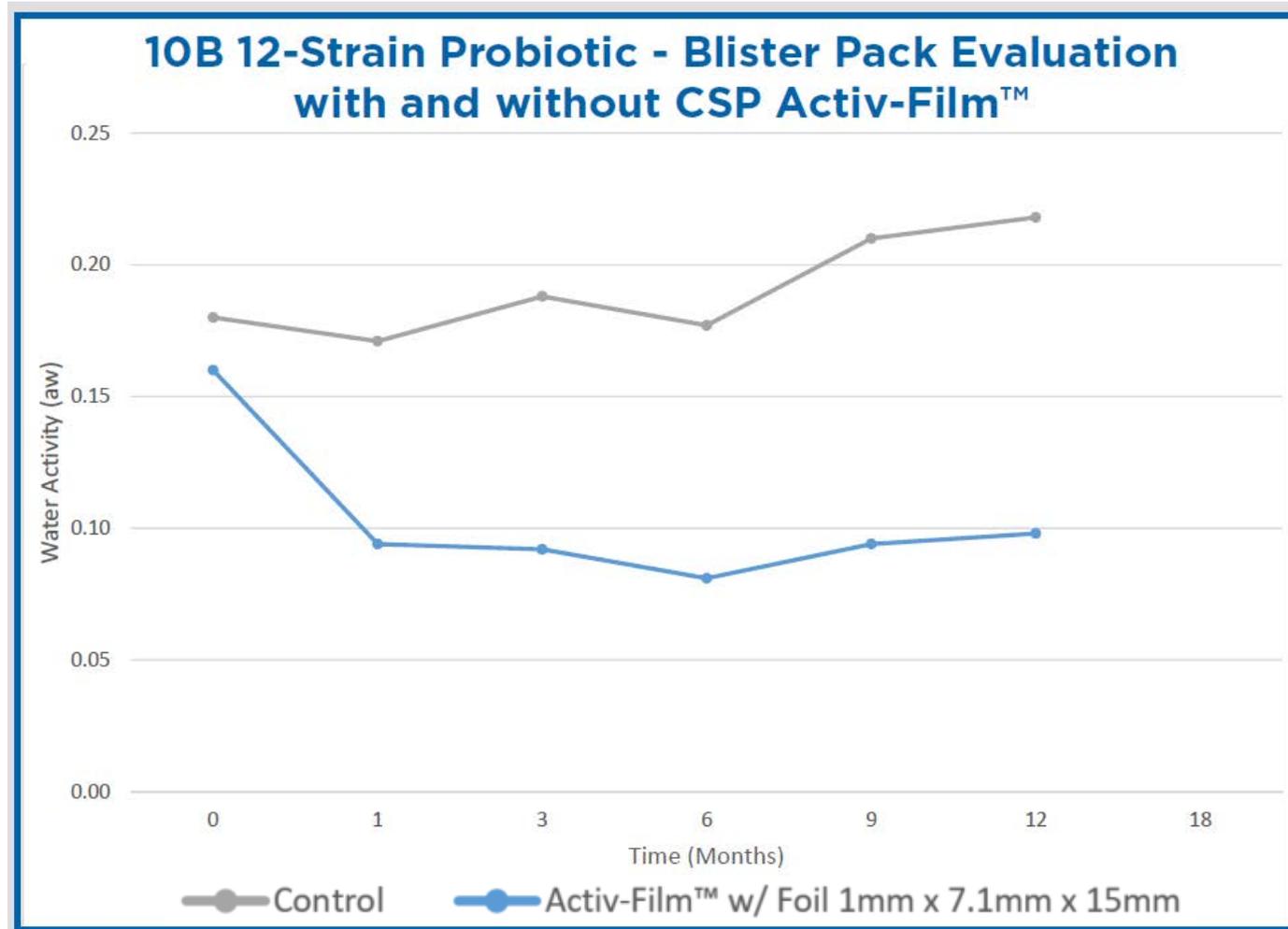
Aclar® type	Temp/RH (°C/%RH)	Days to saturation
Rx160	25/60	209
Rx160	30/65	71
Rx160	40/75	21
UltRx2000	25/60	370
UltRx2000	30/65	220
UltRx2000	40/75	71
UltRx6000	25/60	1036
UltRx6000	30/65	647
UltRx6000	40/75	209

Assume ~6.6mm x ~13mm x 1mm piece for
Size 0 capsule



Probiotic Capsule Water Activity

(Standard PVC.PvdC Blister Packaging vs. Activ-Blister™ Packaging with CSP Activ-Film™)



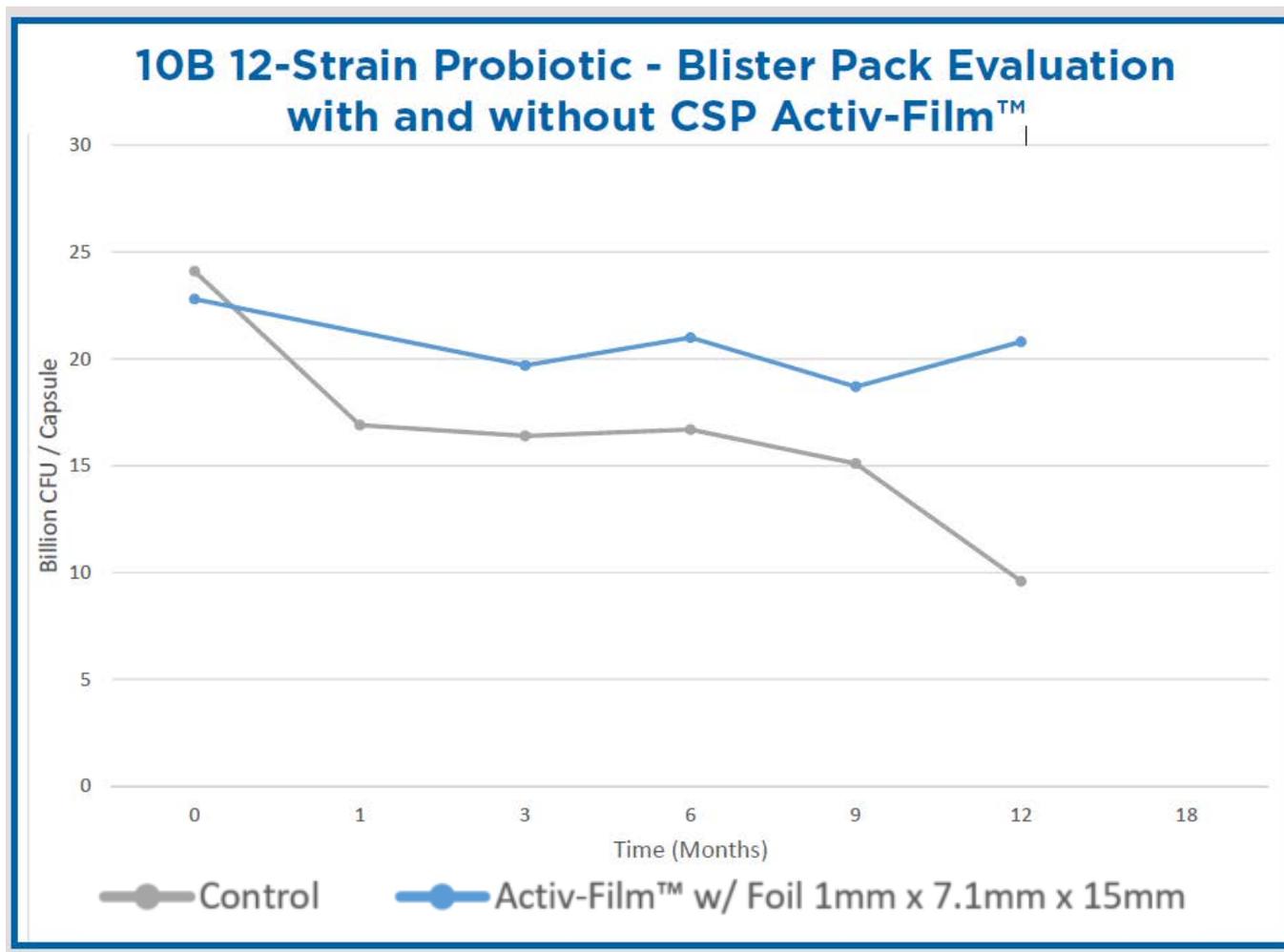
Storage Conditions:
22°C ± 2°C
40% ± 5% RH

Data courtesy of



Probiotic Capsule Potency

(Standard PVC.PvdC Blister Packaging vs. Activ-Blister™ Packaging with CSP Activ-Film™)



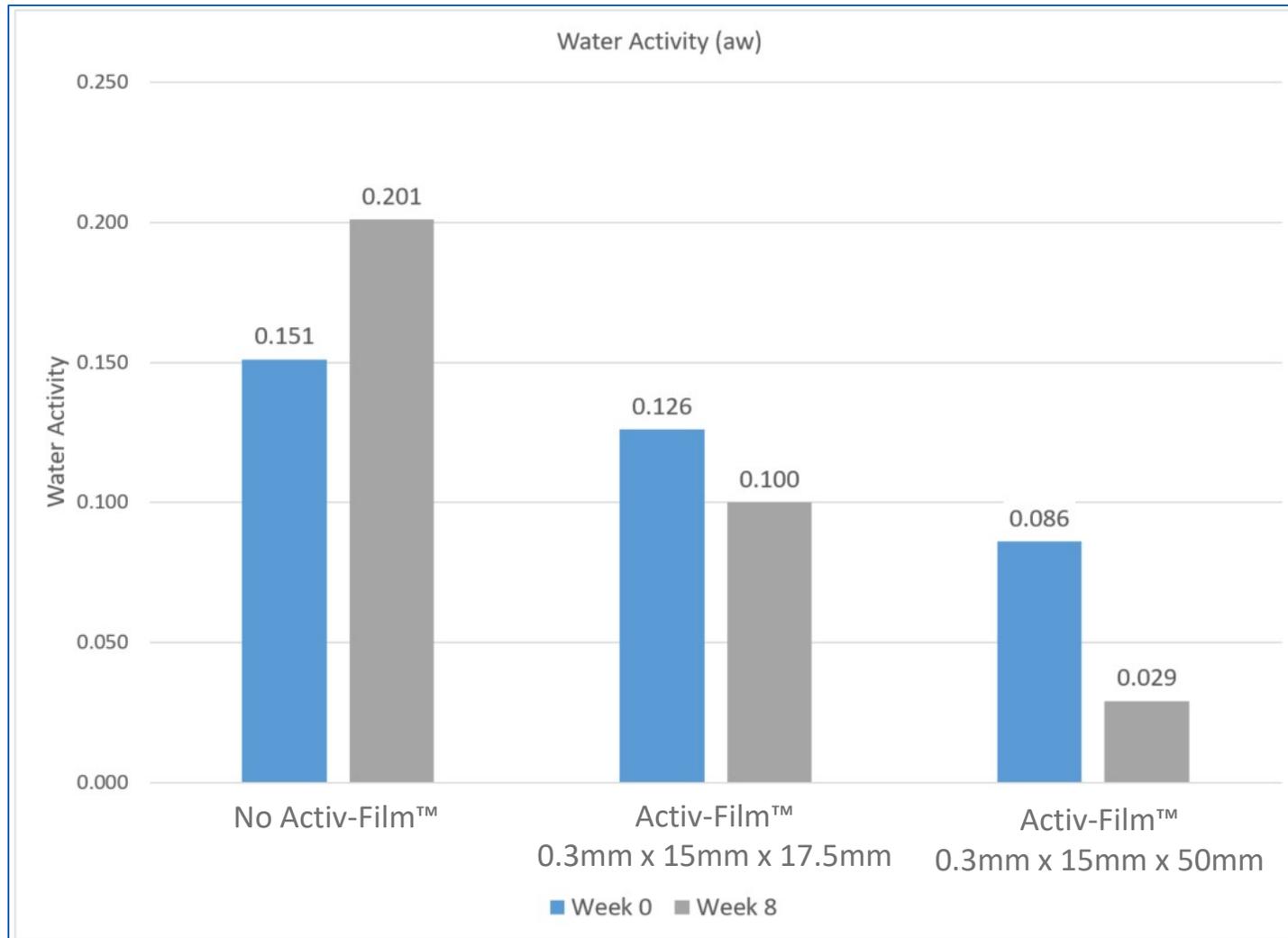
Storage Conditions:
22°C ± 2°C
40% ± 5% RH

Data courtesy of



Probiotic Stick Pack Water Activity

(CSP™ Activ-Film™ vs. No Activ-Film™, Ambient Conditions)

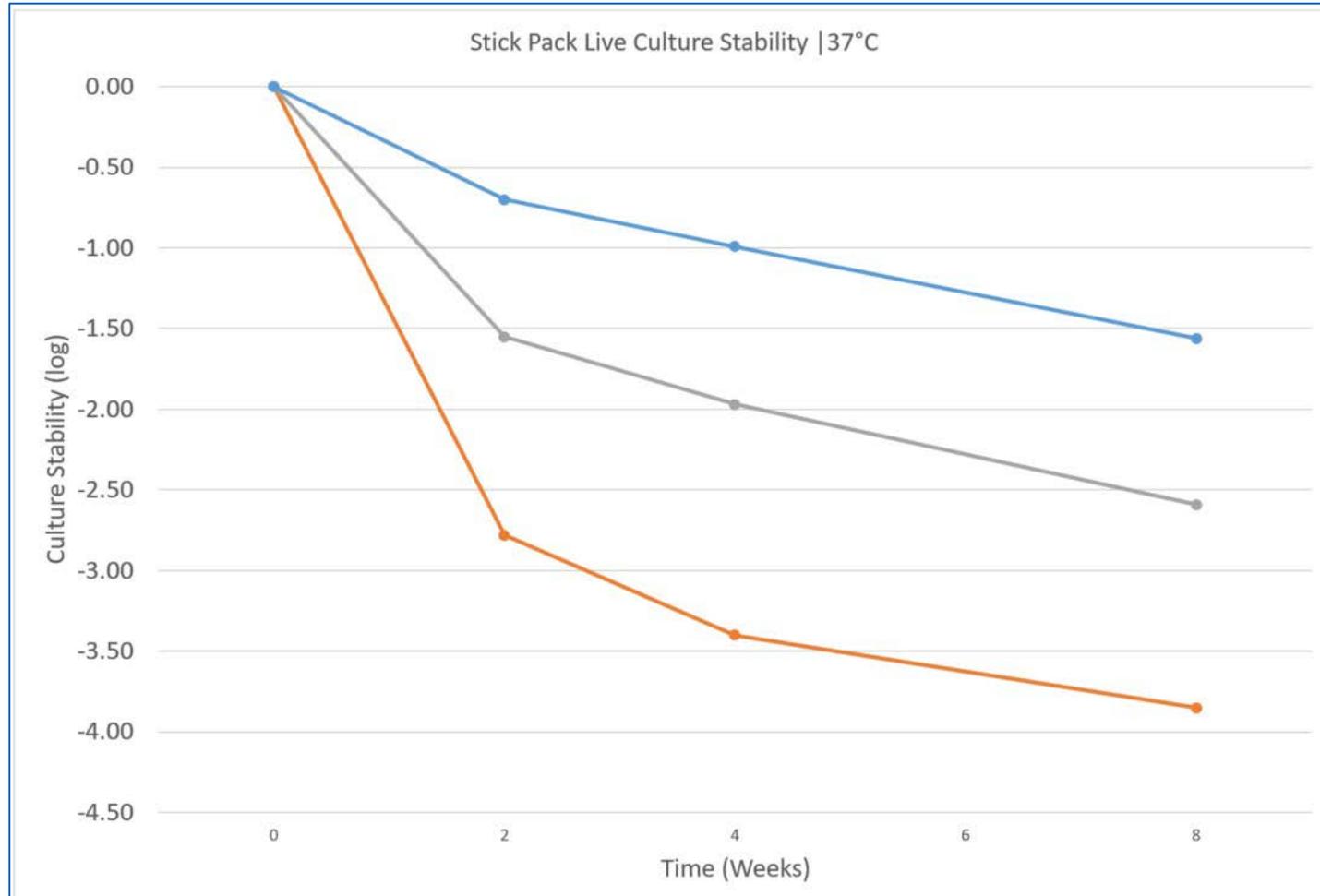


Data courtesy of



Probiotic Stick Pack Stability

(CSP™ Activ-Film™ vs. No Activ-Film™)



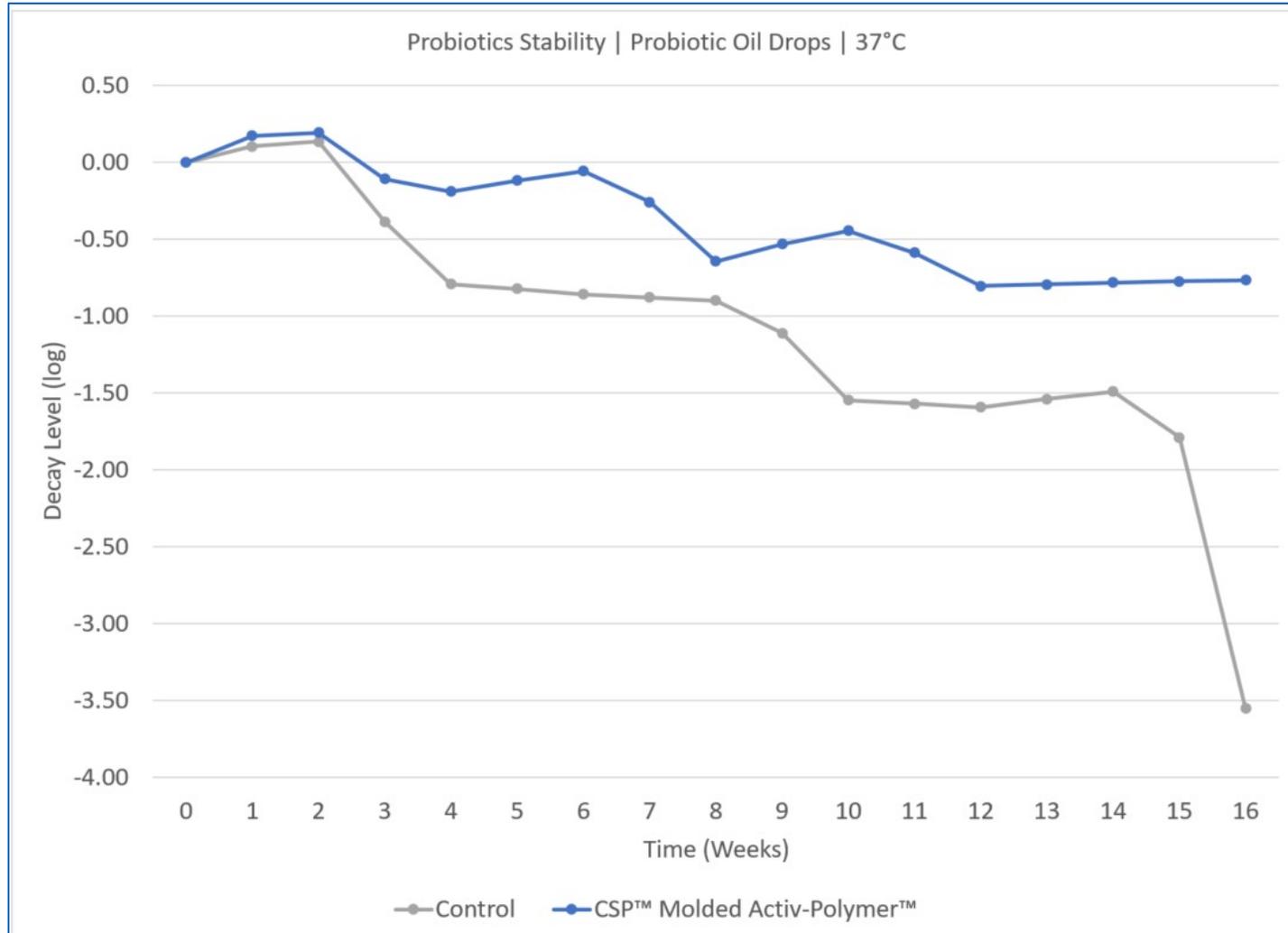
- No Activ-Film™
- Activ-Film™
0.3mm x 15mm x 17.5mm
- Activ-Film™
0.3mm x 15mm x 50mm

Data courtesy of



Probiotic Oil Drops Stability

(CSP™ Molded Activ-Polymer™ vs. Control)



CSP™ Molded Activ-Polymer™ in graph uses 1 Tablet:

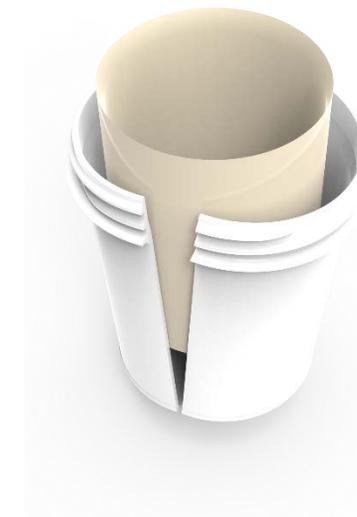
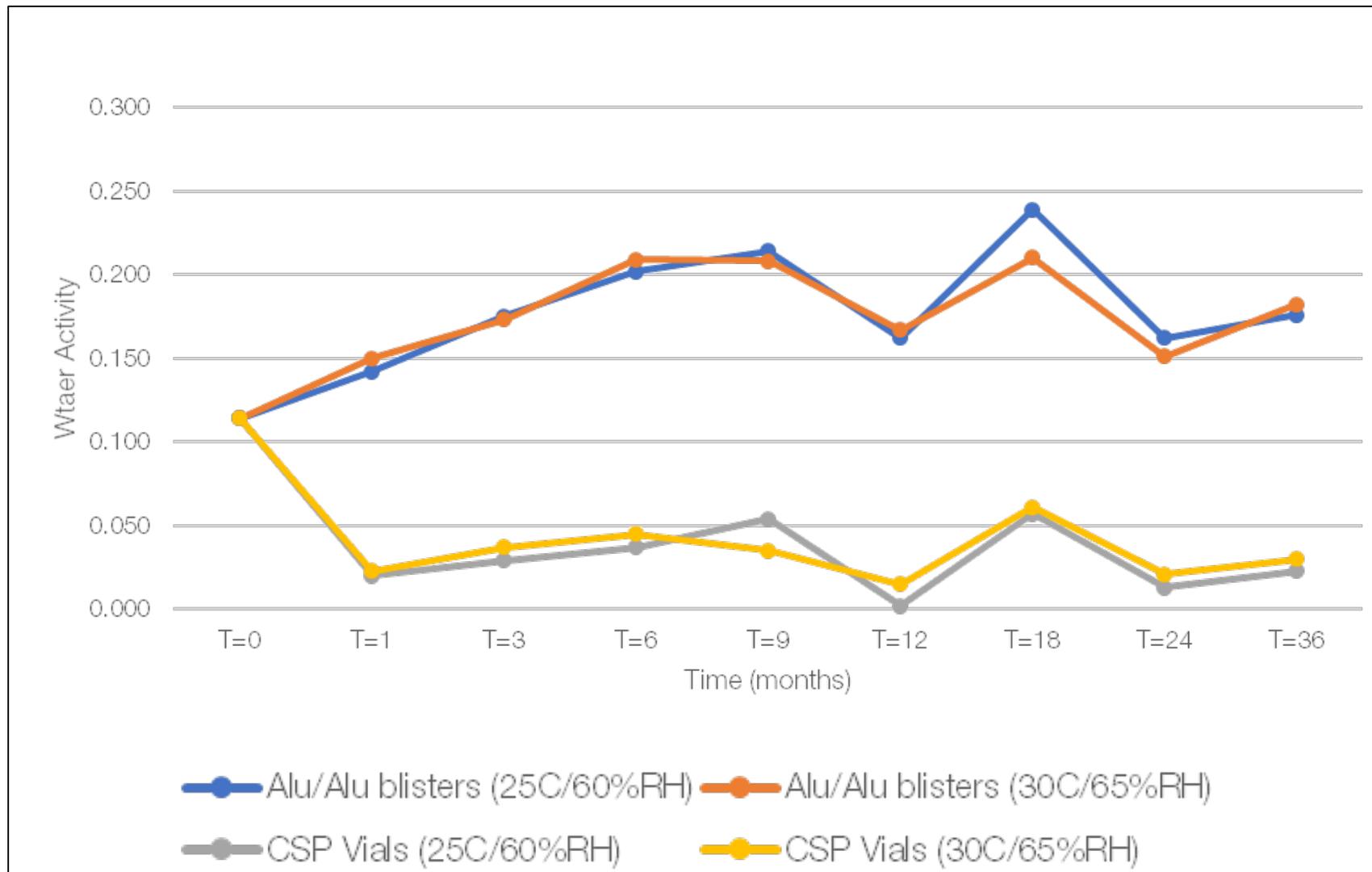
- 3mm thick x 8mm OD
- 0.2 gram

Data courtesy of



Probiotic Capsules – Water Activity

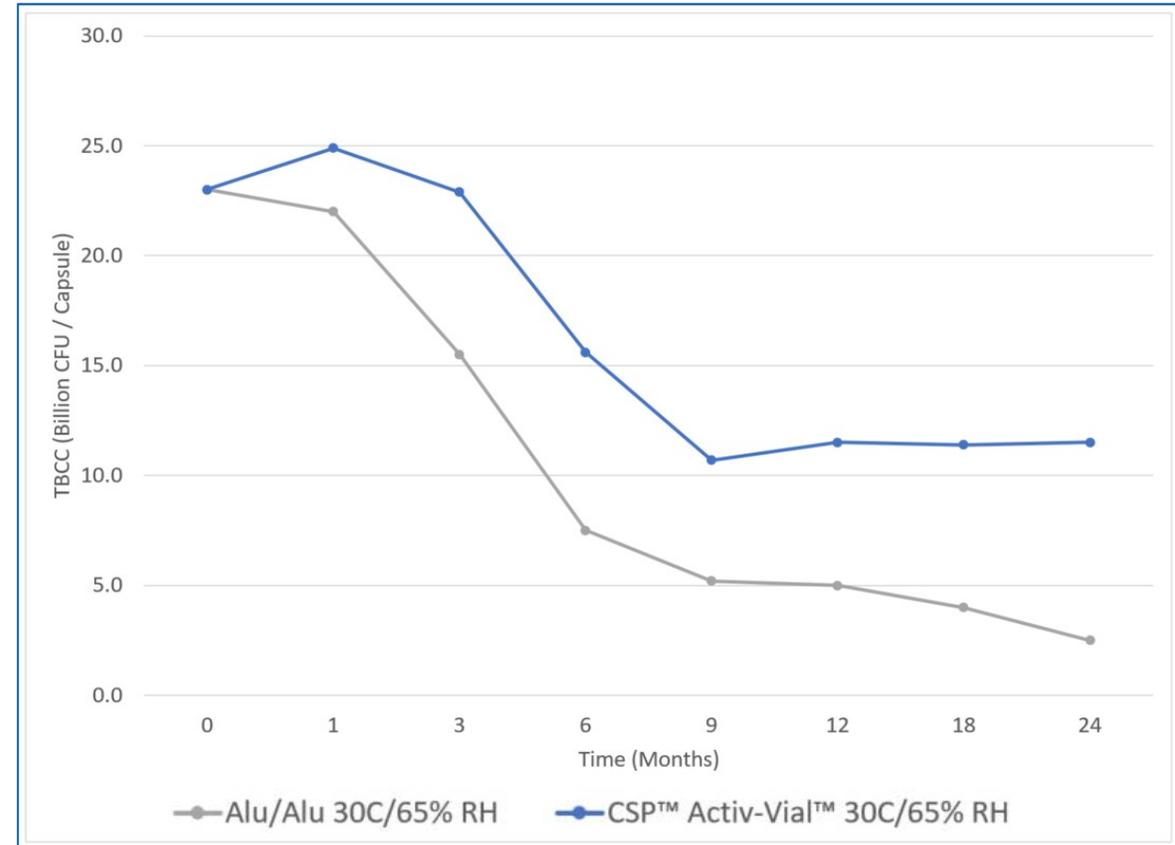
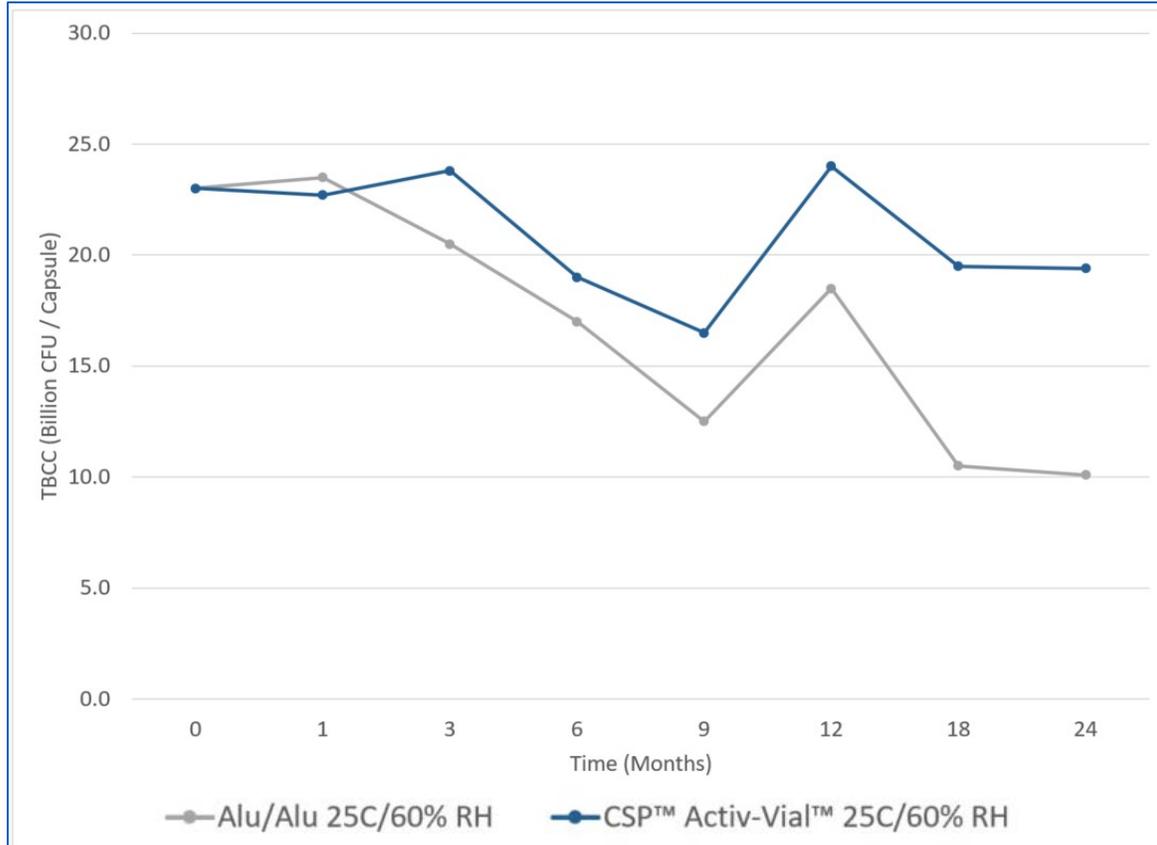
(CSP™ Activ-Vial™ vs Alu/Alu Blisters)



Study performed in partnership with UAS Labs, a leading probiotic manufacturer.

Probiotic Capsules – Strain Potency

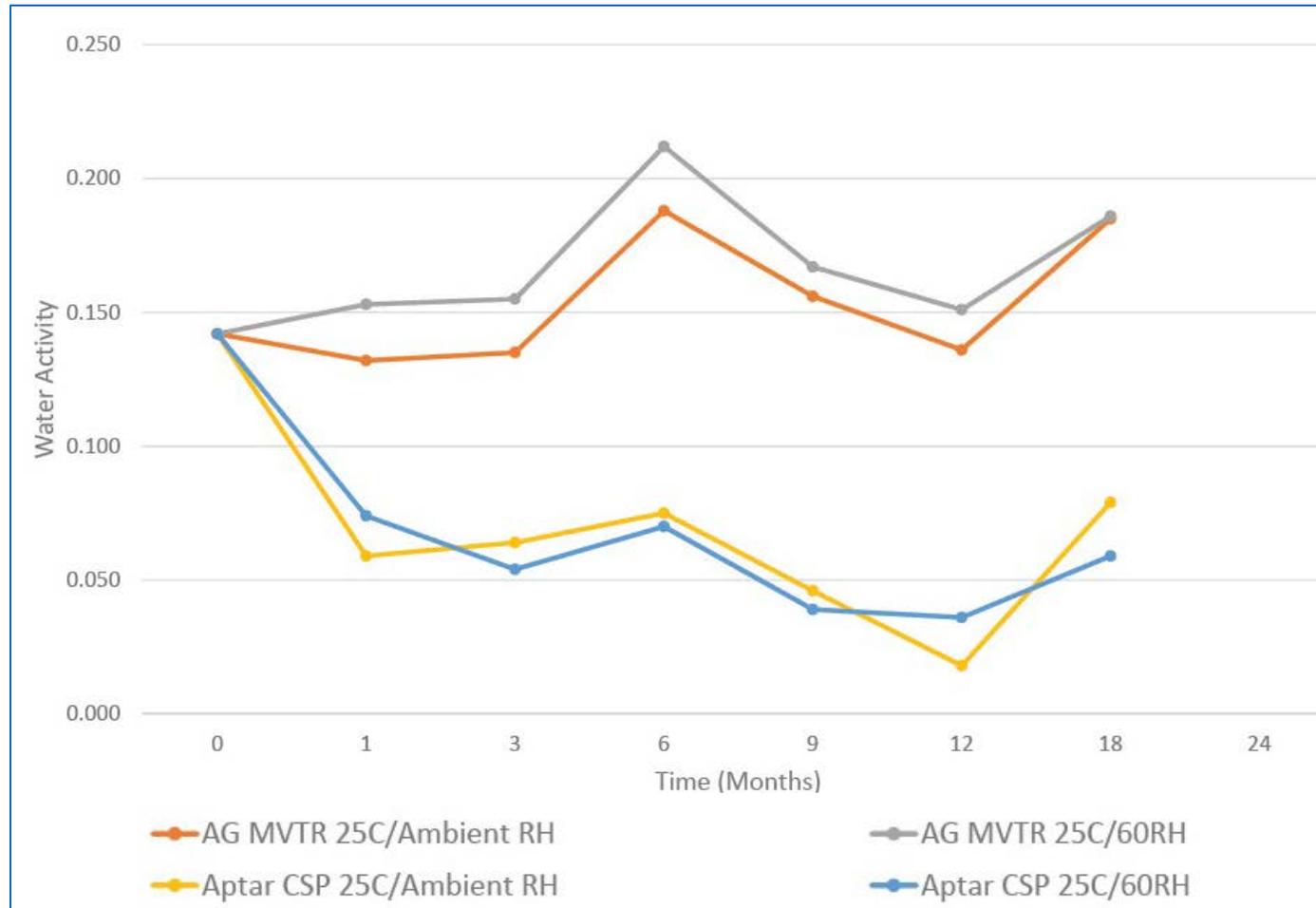
(CSP™ Activ-Vial™ vs Alu/Alu Blisters)



Study performed in partnership with UAS Labs, a leading probiotic manufacturer.

Water Activity in Probiotics + Cranberry

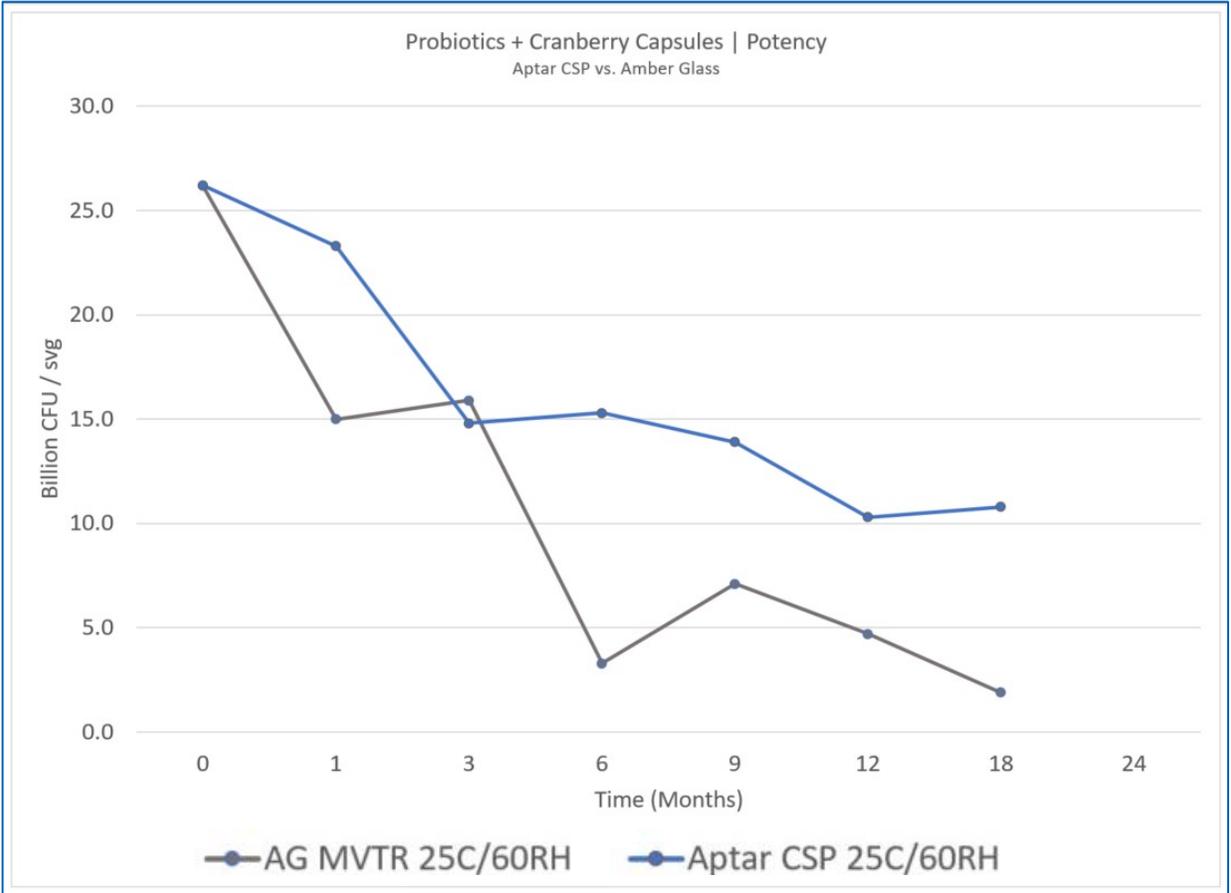
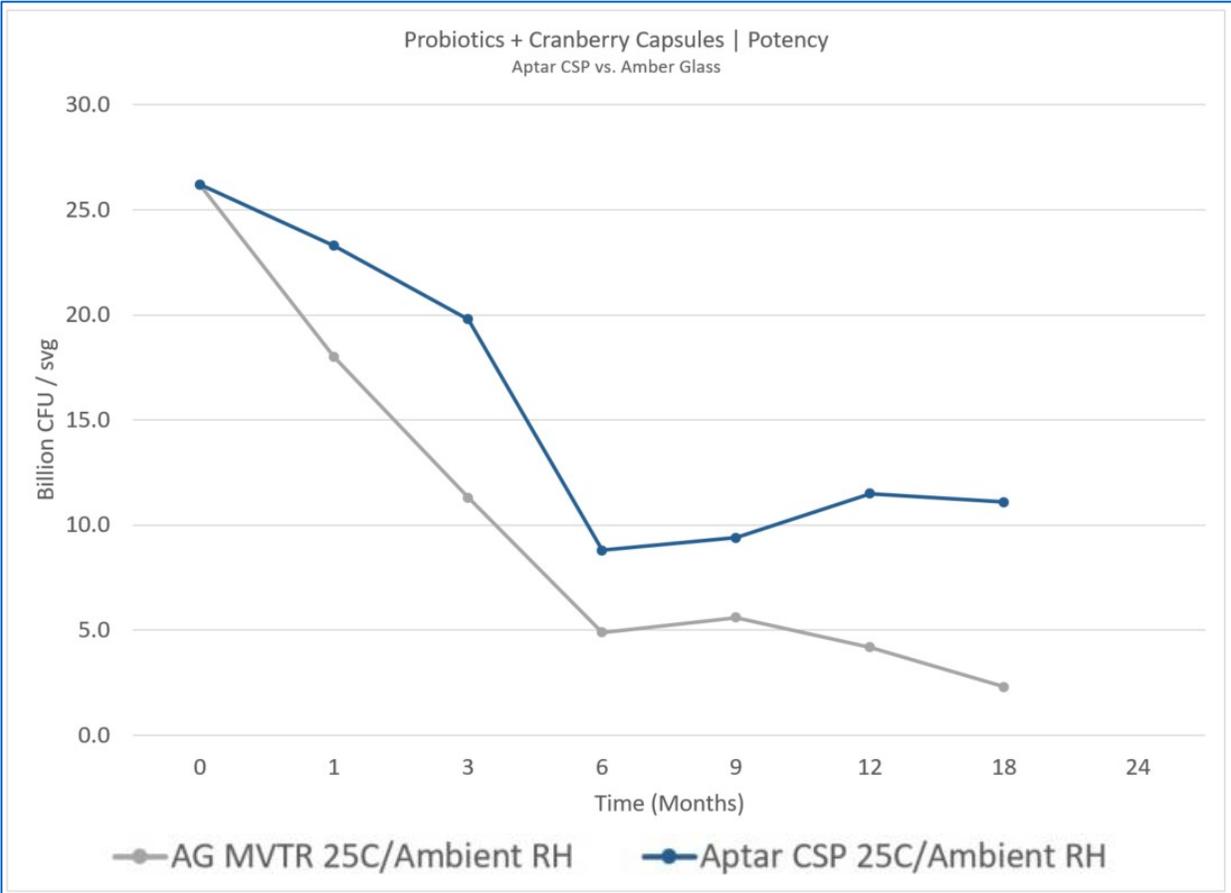
(CSP™ Activ-Vial™ vs. Amber Glass with Desiccant)



Study performed in partnership with UAS Labs, a leading probiotic manufacturer.

Potency of Probiotics + Cranberry Capsules

(CSP™ Activ-Vial™ vs. Amber Glass with Desiccant)



Study performed in partnership with UAS Labs, a leading probiotic manufacturer.

Probiotic Testimonials

- “It is an enabling technology and it ensures quality when factors outside our control are included.”
- “We can sell lactic acid bacteria into hot regions we could not before.”
- “We can feel confident that all the direct to consumer shipments from internet orders are arriving to the customer in the best possible shape, even when Amazon and others ship in the middle of the summer without ice packs.”
- “It has allowed us to launch some products not possible before because we are confident it will actually dry the product during shelf life when a high Aw ingredient might be mixed with the bacteria in a capsule, for example.”
- “CSP enabled us to transition out of the cooler and into Shelf Stable packaging.”

