



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Performance
Optimization Initiatives
for DoD Combat
Feeding

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Performance Optimization



- Vision:
 - To provide novel technologies, delivery systems, stabilized bioactive phytonutrients and tested components for optimized Warfighter performance
- Key Technologies:
 - Nanotechnology
 - Glucose Modulation
 - Encapsulation
 - Stabilization
 - Food Science
 - Microbiology
 - Chemistry/Biochemistry



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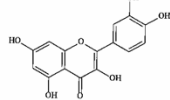


Performance Optimization

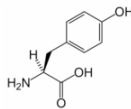


Cochleate

Quercetin



Tyrosine



- **Purpose:**
 - To ensure that the Warfighter is provided proven components to optimize physical & mental performance
 - To develop technologies and products for optimized Warfighter performance
- **Products:**
 - Delivery systems/carriers
 - Data on collaborative human effectiveness studies
 - Components for optimized performance
- **ROI:**
 - Optimized Warfighter Performance
 - Enhanced Cognition
 - Delay in Muscle Fatigue
 - Accelerated Recovery
 - Increased Nutrient Uptake

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Performance Optimizing Nutrients



- **Overall Strategy:**
 - Choose micronutrient ingredients and dosage forms based on underlying animal studies/peer published literature
 - Cooperate on initial human efficacy studies involving USARIEM, NMRC (if applicable) and academia
 - Determine baseline and examine additive effects
 - Evaluate regulatory status of active components

Academic Partners:
 UMASS
 Rutgers
 U South Carolina
 Clemson
 Framingham State

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Performance Optimization Initiatives



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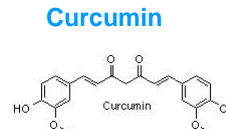
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Performance Enhancing Compounds of Interest

Quercetin – Polyphenolic flavanoid antioxidant abundantly found in plants (onions, apples, etc.); being studied to determine its potential to improve anti-(inflammatory/oxidant) properties to reduce injury/inflammation response.



Curcumin – Phytopolyphenol pigment from turmeric with anti-inflammatory Properties; shown to reduce inflammation response.



Tyrosine - Large neutral amino acid is precursor of neurotransmitters essential for brain stress response; has been shown to mitigate altitude/cold/exercise induced deficiencies in cognitive performance.



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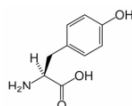
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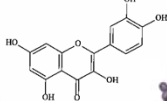
Performing Enhancing Compound (PEC) Delivery Systems



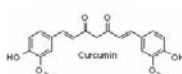
Tyrosine



Quercetin



Curcumin



Purpose:

To determine solubility and partition coefficients of selected PECs, and to screen model food delivery systems based on absorption rates determined by Franz Diffusion tests.

Results/Products:

- Facilitation of supplementation for developmental ration items
- Profiles of solubility for optimized absorption
- Most suitable food delivery systems

ROI/Payoff:

- Reduced injury/inflammation responses from battlefield stresses
- Enhanced performance

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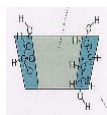
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Nano-Complexes for Functional Micronutrients



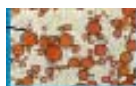
Cyclodextrin



Cochleate



Coacervate/Emulsion



Purpose:

To determine and down-select best nano-complex pairs to overcome insolubility and to increase nutrient uptake using novel nano-technology. To improve absorption and control release.

Results/Products:

- Increased sensory/nutritive quality by adding reduced effective concentrations of bioactive compounds
- Increased protection and stability of micronutrients for ration supplementation
- Advantageous nano-complex pairings for food supplementation

ROI/Payoff:

- Lowered concentrations required for effective absorption = Lowered cost
- Optimized absorption rates = more effective performance benefits

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Characterization of Condensed Tannin Structure and Protein-Binding Efficacy



Epicatechin-containing fruit

Fruit/vegetable extracts contain polymerized epicatechin ("condensed tannins"), which can slow starch digestion by inhibiting α -amylase

Purpose:

To quantify the structure of condensed tannins in fruits/vegetables and to correlate structure with ability to inhibit α -amylase

Results/Products:

- Molecular understanding of polymerized epicatechin functionality
- Guidelines for selection of fruit/vegetable extracts for rations

ROI/Payoff:

- Increased Warfighter satiety
- Guidelines for development of fruit/vegetable extract-containing ration components
- Technology transitioned to Enzyme Modulated Starch Digestion JSN

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Peak Performance Ration Components



Purpose:

Develop and demonstrate phytonutrient fortification technologies to optimize Warfighter performance under combat stress

Results/Products:

- Validated bioactive agents with proven optimization in Warfighter performance
- Nutritional enhanced food bars or buccal delivery systems (chews, lozenges or gum) to mitigate battlefield stressors

ROI/Payoff:

- Extended time to muscle fatigue
- Improved cognitive performance
- Reduced physical recovery time

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Pre/Probiotic Background/ Historical Information



Background:

- Gastrointestinal stress can be a problem for military personnel with the
 - high density and high caloric food requirements in the military food system
- Prebiotic and probiotic technology can potentially resolve these gastrointestinal stress problems
- There is a need to develop a better understanding of the effectiveness of this technology for military food application
- Research will lead to a better fundamental understanding of prebiotic substrate interaction with probiotic bacteria.



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Understanding Prebiotic and Probiotic Interactions



What are probiotic bacteria?

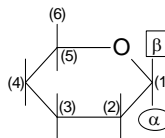
- Live microbial organisms, namely *Lactobacillus spp.* and *Bifidobacterium spp.*, that survive the gastrointestinal tract and persist in the colon. These probiotic bacteria provide some beneficial effect to host.

What is a prebiotic?

- Food component, usually an oligosaccharide, which evades digestion by mammalian enzymes in the upper gastrointestinal tract
- Substrate, through hydrolysis, for selective growth of beneficial indigenous organisms (probiotic bacteria) in colon

Prebiotic Strategy: direct incorporation into diet and/or to stabilize probiotic bacteria incorporated into military food products to provide relief to gastrointestinal stress in the field

Anatomy of a natural sugar



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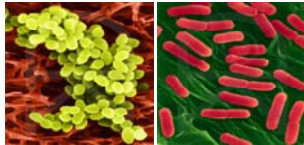
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Probiotics in Military Rations



L. reuteri
inhibiting
growth of **S. aureus**



Purpose:

Develop technology to incorporate live probiotic bacteria in multiple shelf stable ration components while maintaining viability for 2 years

Results/Products:

- Validated dosage and efficacy studies on specific probiotic strains
- Shelf stable ration components containing viable probiotic at time of consumption

ROI/Payoff:

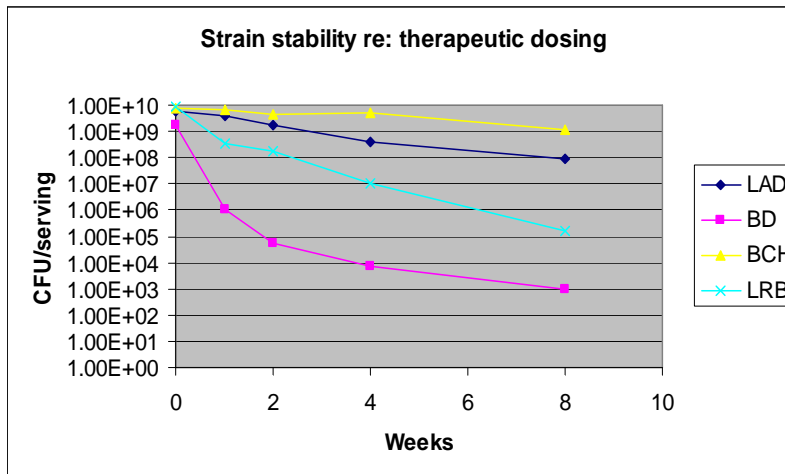
- Increased ability to fight infection due to immune enhancing properties of probiotics
- Reduction in lost time / increased ability to perform duties
- Improved overall health/GI function of the Warfighter

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4 Strain Study in Powdered Vanilla Pudding at 37°C



LAD= Lactobacillus acidophilus From Danisco
BCH= Bifidobacterium from CHR Hansen

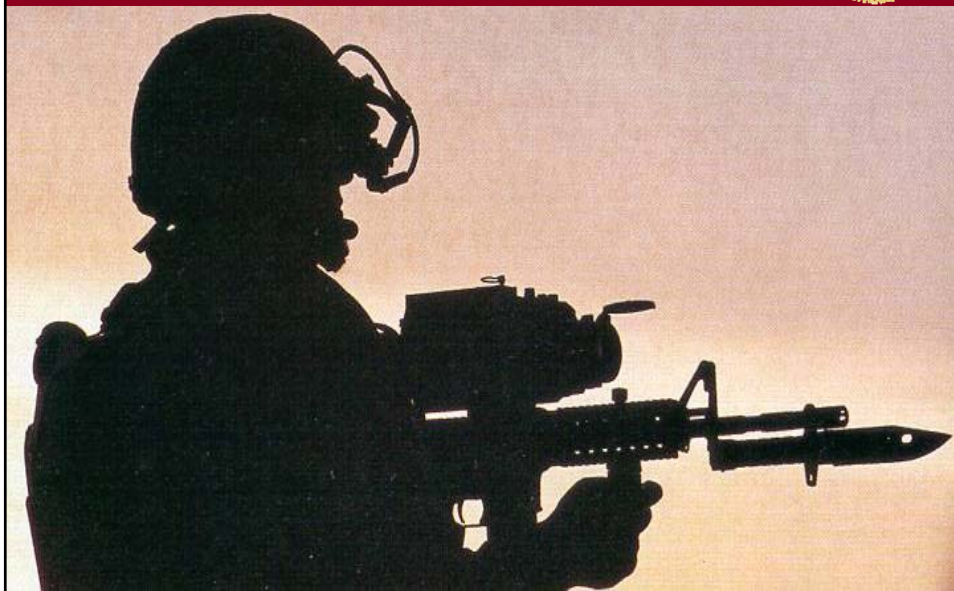
BD=Bifidobacterium from Danisco
LRB= Lactobacillus reuteri from BioGaia

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Questions?



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