A MULTI TARGETED DIETARY SUPPLEMENT AS A POTENTIAL COUNTERMEASURE FOR PROLONGED, DEEP SPACE EXPLORATION

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INTRODUCTION

- Deep space exploration, particularly to the Moon and Mars, are currently major goals of NASA
- Long-term space flight presents unique challenges - microgravity, social isolation, altered circadian rhythm and radiation
- Oxidative stress has been implicated as a crucial factor in space environment induced injury
- Elucidating these detrimental effects on the central nervous system and brain is a primary objective
- Countermeasures to offset neurological damaged and cognitive deficits are paramount
- We have developed a multi targeted dietary supplement (MTDS) designed to simultaneously ameliorate oxidative stress, inflammatory processes, energetic shortfalls, and membrane and mitochondrial deterioration

STRESSORS

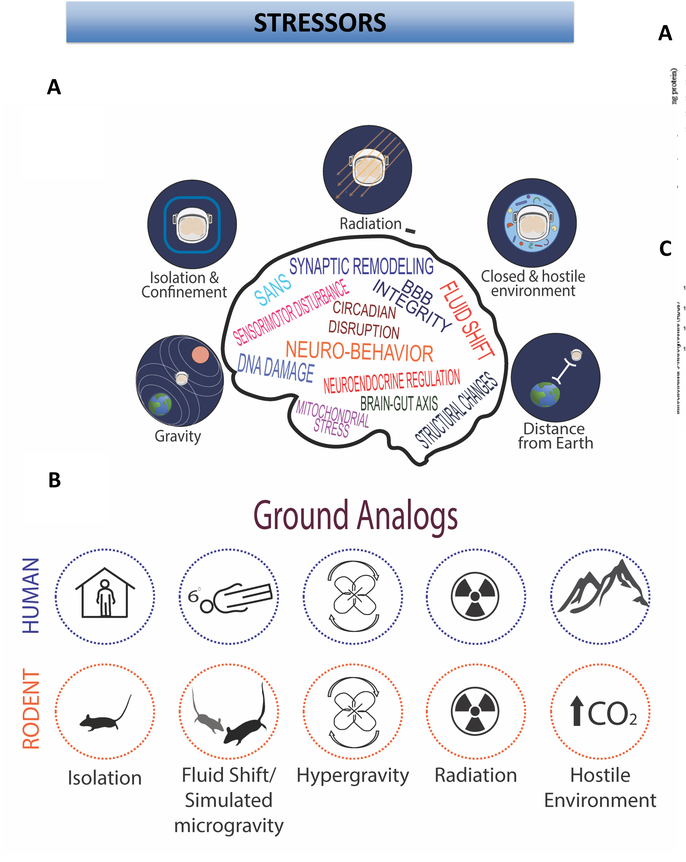


Fig 1. Overview of spaceflight hazards and ground-analog models used to study these hazards. The various hazards in the spaceflight environment including, altered gravity, isolation and confinement, radiation, closed and hostile environment, and distance from earth, affect the health of the central nervous system (A). Ground analogs are used to simulate some of these hazards on Earth and study their impacts on physiology and behavior (B)[1].

AGE ACCELERATED MICE

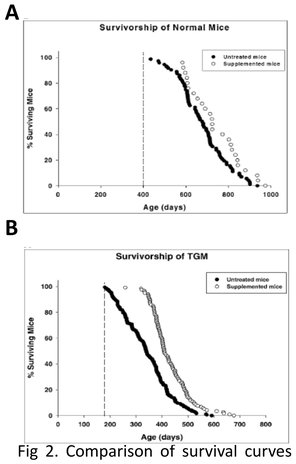


Fig 2. Comparison of survival curves for untreated and supplemented transgenic growth hormone mice (TGM) (A) and normal mice (B)[2].

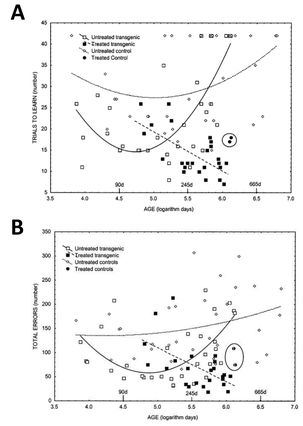


Fig 3. Number of trials required to learn (A) and total errors committed (B) by TG and age-matched normal control mice in an eight-choice maze across lifespan[3].

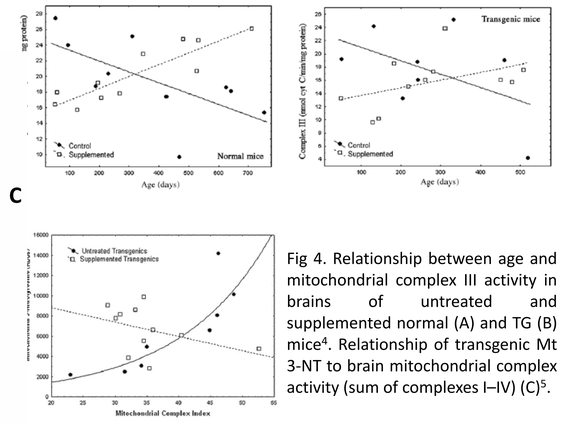


Fig 4. Relationship between age and mitochondrial complex III activity in brains of untreated and supplemented normal (A) and TG (B) mice[4]. Relationship of transgenic Mt 3-NT to brain mitochondrial complex activity (sum of complexes I–IV) (C)[5].

2 Gy EXPOSURE

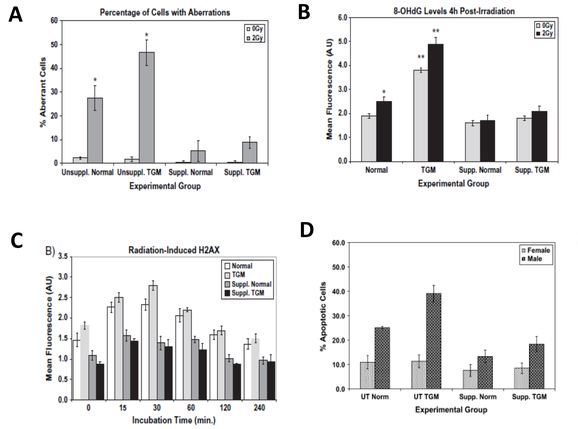
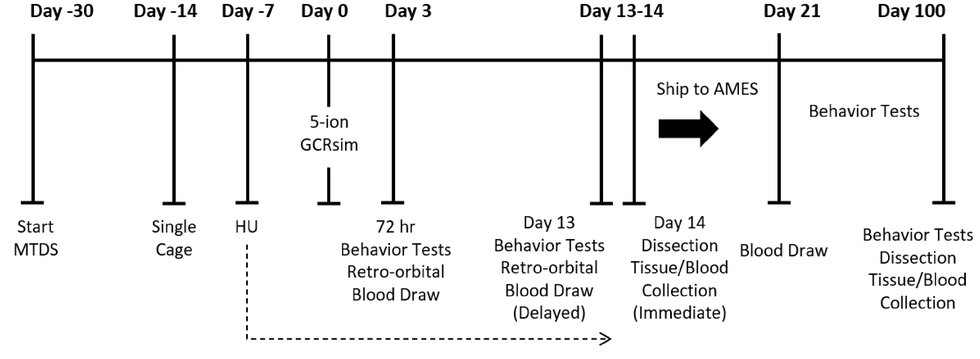


Fig 5. Average number of constitutive and radiation-induced chromosome aberrations (A) radiation induced 8-OHdG (base damage) (B) and radiation induced γH2AX (DSB) (C) in bone marrow of normal diet and MTDS mice#. Radiation-induced lymphocyte apoptosis in age-matched control mice on a normal diet compared to MTDS (D)[6].

MTDS COMPONENTS[9]

Vitamin B1	Curcumin
Vitamin B3 (Niacin)	Folic Acid
Vitamin B6	Garlic (allicin)
Vitamin B12	Ginger
Vitamin C	Gingko Biloba
Vitamin D	Ginseng
Acetyl L-Carnitine	L-Glutathione
Alpha Lipoic Acid	Magnesium
Acetylsalicylic Acid	Melatonin
Beta Carotene	N-Acetyl Cysteine
Bioflavonoids	Selenium
Chromium	Vitamin E
Coenzyme Q10	Omega 3

STUDY PLAN



10 Gy CRANIAL EXPOSURE

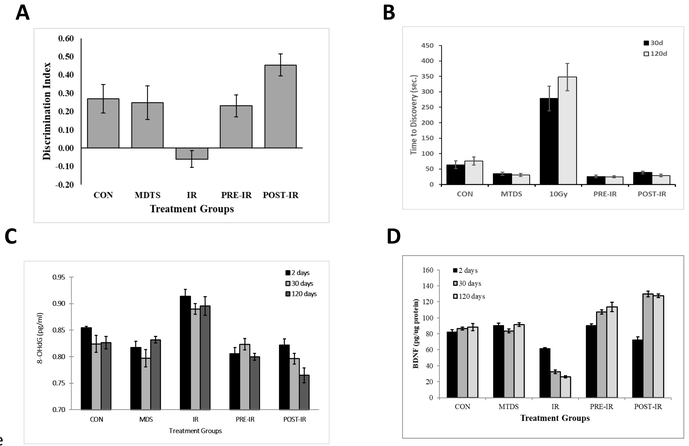


Fig 6. Novel object recognition in mice 30 days following irradiation (A). Latency to uncover food in buried food test 30 and 120 days following irradiation (B). Plasma 8-OHdG levels in mice at 2, 30 or 120 days following irradiation (C). Hippocampal BDNF protein levels in mice at 2, 30 or 120 days following irradiation (D)[7].

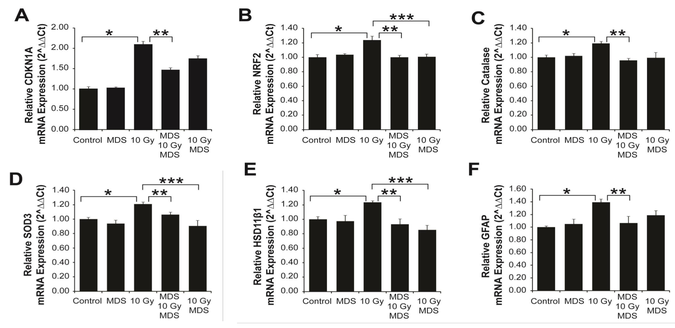


Fig 7. RT-qPCR mRNA expression analysis of markers of cellular stress in 30 days post-irradiated brain tissue of cyclin-dependent kinase inhibitor-1 (CDKN1A;A), nuclear factor like-2 (NRF2;B), catalase (C), superoxide dismutase 3 (SOD3;D), 11β-hydroxysteroid dehydrogenase-1 (HSD11β1;E), and glial fibrillary acidic protein (GFAP;F)[8].

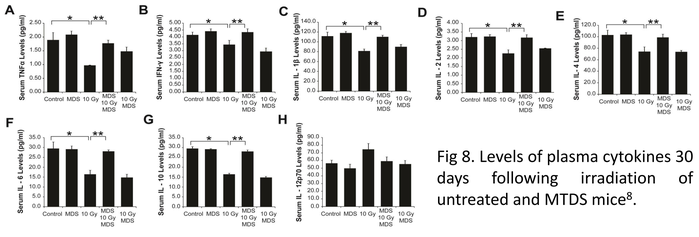


Fig 8. Levels of plasma cytokines 30 days following irradiation of untreated and MTDS mice[8].

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