Project Title - Developing Earth-Based Testbeds to Improve Food Acceptance for Long Duration Space Missions

Host University - Massey University

Industrial Partner – Eight360

Fonterra Research and Development Centre

Fix and Fogg

Academic Supervisor(s)

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Project Description

Images of astronauts eating from toothpaste-like tubes have long captured public imagination. Whilst such products have largely disappeared, food remains pivotal to crew performance and morale during missions. Beyond protecting against physical challenges of spaceflight, food plays a vital role in psychological wellbeing, often one of few opportunities for enjoyment in restrictive environments. Yet ensuring astronauts consume sufficient nutrition remains a persistent challenge, especially for missions planned to Mars. Low interest and acceptance of food remain critical barriers to adequate intake, highlighting the importance of positive sensory experiences. Aotearoa New Zealand's expanding aerospace capability, together with its strong agrifood economy position it to contribute to future space food systems that sustain mission performance. Food consumption is inherently multisensory, with perception, liking, and emotional responses strongly influenced by ambient aromas and sounds. Descriptions of spacecraft interiors consistently reference unpleasant odours, often characterised as metallic, antiseptic, or reminiscent of waste and body odour, alongside a constant mechanical hum of 60–85 dB, comparable to eating beside a vacuum cleaner. These factors likely suppress appetite and enjoyment, particularly with repeated exposure, yet they remain underexplored. Whilst direct evaluation of food responses in space is ecologically valid (realistic), it is time consuming, limited to small sample sizes, and prohibitively constrained by payload limitations. Scalable alternatives are urgently needed. Unlike analogue facilities designed for mission training, this project provides a controllable food-specific testbed where spacecraft-relevant visual, auditory and olfactory cues can be linked to sensory perception, liking and intake. To address this gap, controlled Earth-based multisensory analogue approaches are needed to systematically manipulate environmental conditions whilst maintaining experimental control. Emerging digital analogue approaches, including virtual and mixed reality technologies, offer scalable alternatives for simulating space-relevant sensory conditions. This project will leverage the Food Experience and Sensory Testing (Feast) Lab, equipped with immersive technologies capable of projecting 360° spacecraft imagery alongside synchronised sound and olfactory cues for sensory and intake research. Whilst true microgravity can only be created for seconds on Earth, related stressors can be simulated using advanced motion technologies, such as the VRlinked motion simulators developed by Wellington based partner Eight360. These systems extend immersion beyond visual and auditory cues, enabling investigation of food experiences under physiologically and psychologically stressful conditions. This PhD brings together a strong transdisciplinary team across sensory science, aroma research, food manufacturing and motion simulation, anchored in expertise from NASA and German

Aerospace Center (DLR), to develop technologies and evidence-based strategies for improving space food systems.

Key outcomes:

- Development and validation of scalable, multisensory Earth-based testbeds for evaluating food experiences in space-relevant environments.
- Quantification of how spacecraft ambient stimuli impact on sensory perception, liking, and emotional response to foods in space conditions
- Identification of sensory interventions (auditory, olfactory) that enhance food acceptance in space relevant environments
- Exploration of motion based stressors to increase the ecological-validity of sensory testing environments for aerospace.

Together, these outcomes aim to establish an evidence-base for testing and improving space food experiences on Earth, supporting adequate nutrient intake, crew wellbeing and mission readiness during future missions.

Student Time Split

University base for student (university, campus, department):

Massey University, Palmerston North, School of Food Technology and Natural Sciences

Industry base for student (company, site, address):

Eight360, Wellington, 33 Pito-one Road, Korokoro, Lower Hutt, 5012

Expected Time Split Between University and Industry Partner (in months):

6 months in industry, 30 months in university

Rationale for Time Split:

Massey University provides strong, well-integrated support networks and is exceptionally well-positioned to deliver this project, offering extensive facilities, disciplinary expertise, and robust doctoral supervision frameworks. This is further strengthened through academic supervision from early career researcher Dr Low, bringing experience in aroma perception research within proxy space travel environments and development of space-like stressors. Industry and external expertise further enhance the project. DSM-Firmenich (Switzerland) will provide aroma expertise and materials, whilst A-NZ based Fonterra and Fix & Fogg (peanut butter) will contribute food manufacturing insights and product. Advisory input (Fritsche/Blomqvist) from NASA and the German Space Agency together with Wellington based Eight360 immersive simulation specialists, establishes a strong, international and cross disciplinary team supporting the PhD. Most time will be spent at university, due to the immersive laboratory's location where most experimental work will occur. However, six months will be spent with A-NZ industry partners and space agency advisors. This includes 4

months in Wellington with Eight360 to apply NOVA technology as a stressor and conduct exploratory experiments, visiting Fix & Fogg to learn about peanut butter production for space applications, and placements at the Fonterra Research and Development Centre to engage with industrial sensory science practice and graduate training programmes.

Application

To apply for this project please first read the guidance document and then complete the application form on the Applied Doctorates Scheme website.