PICK-AND-EAT SALAD-CROP PRODUCTIVITY, NUTRITIONAL VALUE, AND ACCEPTABILITY TO SUPPLEMENT THE ISS FOOD SYSTEM

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**Project Aim:** To examine light quality and fertilizer formulation on crop morphology, edible biomass yield, microbial food safety, organoleptic acceptability, nutritional value, and behavioral health benefits.

The Veggie light cap contains Red, Blue and Green LEDs. Our goal is to determine the optimum ratio for production of salad crops on ISS.

**Project Team:**
- **KSC:** Food Crop Production, Microbiology
- **JSC:** Advanced Food Technology, Behavioral Health
- **Purdue:** Food Crop Production
- **ORBITEC:** Food Crop Production, Lighting, Software, Food Safety
- **Florikan:** Fertilizer Consultants

**Preliminary Research**

**Leafy Greens Candidates**
- ‘Tyee’ spinach
- ‘Flamingo’ spinach
- ‘Outredgeous’ red romaine lettuce
- ‘Waldmann’s green’ leaf lettuce
- ‘Bull’s Blood’ beet
- ‘Rhubarb’ Swiss chard
- ‘Tokyo Bekana’ Chinese cabbage
- Mizuna

**Dwarf Tomato Candidates**
- ‘Red Robin’ tomato
- ‘Sweet ‘n’ Neat’ tomato
- ‘Mohamed’ tomato
- ‘Patio Princess’ tomato
- ‘Tiny Tim’ tomato
- ‘Tumbler’ tomato

**Crop Selection Factors**

**Horticultural factors**
- Amount of growth (food), Size, Percent moisture, Germination*, Ease of growth*, Days to fruit†, Trueness to type† (consistency of dwarf character), Mass per fruit†

**Dietary factors**
- Elemental Factors - Composition of key elements (K, Fe, Ca, Mg)
- Nutrient Factors - Beneficial phytonutrients (Vitamin K, Lutein, Zeaxanthin, Antioxidants, Phenolics†, Anthocyanins†, Lycopene†)

**Organoleptic factors**
- 9-p Hedonic Scale: Overall taste, Appearance, Color, Flavor, Bitterness*, Texture*, Aroma†
- 5-point Just About Right Scale: Crispness*, Tenderness*, Sweetness†, Juiciness†, Tartness†

* indicates leafy green-specific criteria and † indicates dwarf tomato-specific criteria

**Top Scoring Candidates**
- ‘Tokyo Bekana’ Chinese cabbage
- ‘Red Robin’ tomato

**Planned Ground Research and ISS Flight Testing**

**Plant Testing**
- Red and Blue LED light & fertilizer testing with top leafy green and tomato candidates
  - Testing at NASA KSC, Purdue, ORBITEC
  - Four light regimes will be assessed: (R=Red, B=Blue)
    - 90% R: 10% B, 70% R: 30% B, 50% R: 50% B, split treatment over time with % growth duration 90% R: 10% B + X 50% R: 50% B
  - Three fertilizer release treatments will be assessed:
    - 100% 180-day release, 66% 180 d: 34% 100 d, 50% 180 d: 50% 100 d
    - 18-6-8 (N-P-K) formulation for leafy crop, 14-4-14 for tomato
  - Plants assessed for growth, nutrition, and sent to JSC for taste tests
  - Ground testing will identify top fertilizer treatment and top 2 light treatments
  - Second Veggie unit will be flown and then each crop will be tested under top 2 light treatments on ISS
  - VEG-04 (Chinese cabbage) tests scheduled for 4/2017, VEG-05 (Tomato) scheduled for 4/2018

**Space Food Safety Testing**
- Hazard Analysis and Critical Control Point (HACCP) Plan
  - Assess risks
  - Evaluate operating parameters
  - Set controls to mitigate risk
- Task will involve
  - Assessment of crop microbiology
  - Work to develop standards for space-grown produce
  - Work with stakeholders to implement regular crew consumption

**Behavioral Health Aspects**
- A highest priority stressor anticipated for a long duration mission is lack of sensory stimulation due to isolation and confinement
- Plants have potential countermeasure benefits:
  - Dramatic visual relief
  - Growth and development provide cues to time passing
  - Fresh vegetables add flavor, texture and dietary variety
  - Scents, colors and textures augment environment
- Flight approach: Questionnaires with Visual Analog Scales to minimize time required. Also open-ended options.

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