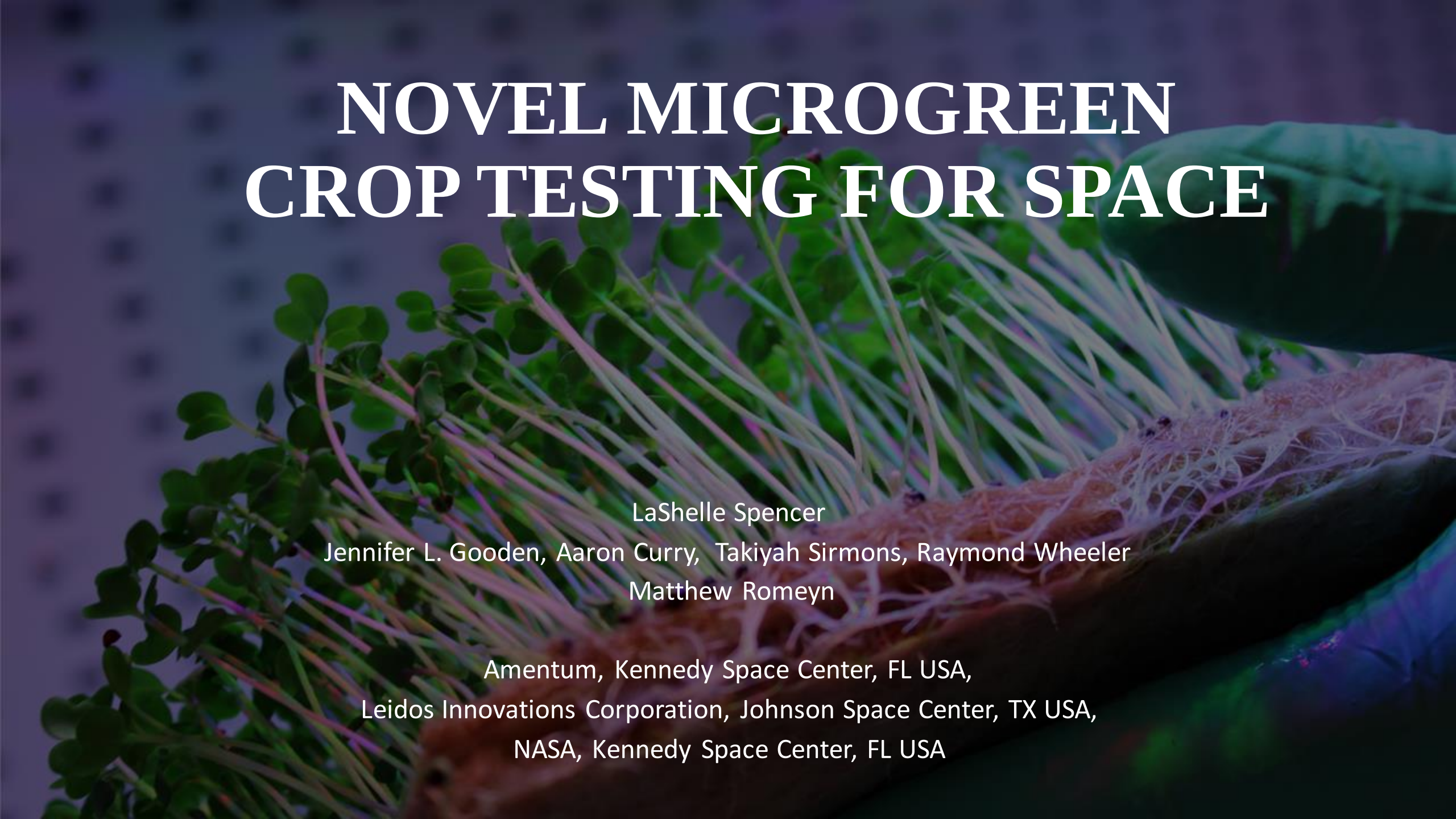
# NOVEL MICROGREEN CROP TESTING FOR SPACE

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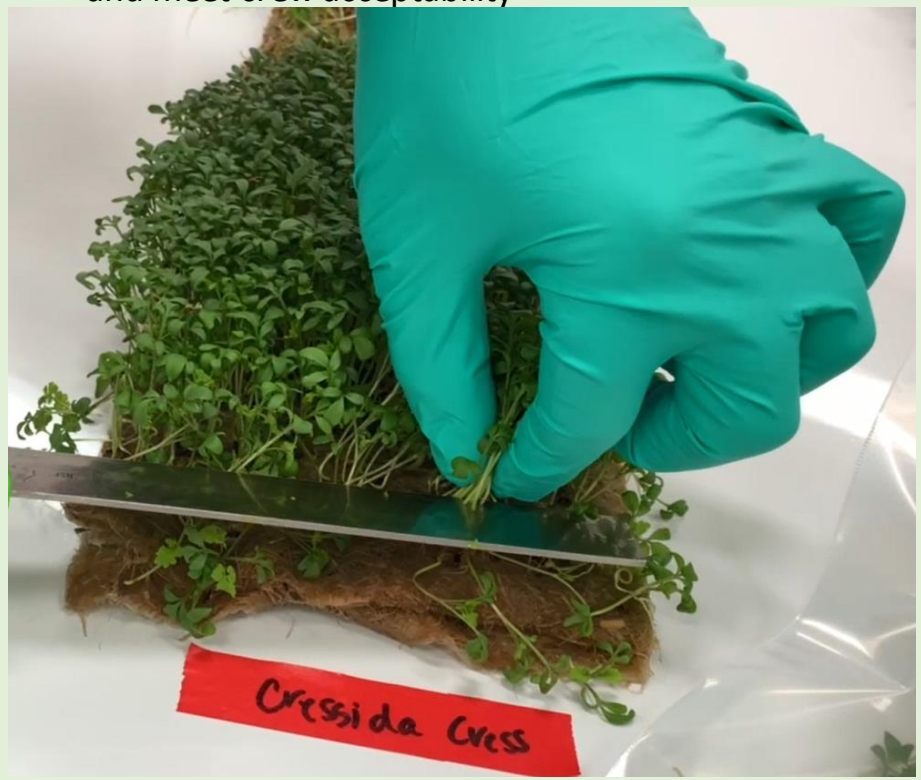
# Background

- Microgreens are vegetable greens, grown in a lawn, harvested just after the cotyledons have emerged
- Can have up to 9x as much nutrients as the mature version
- Increase the number of crops that can be reliably grown in space under narrow band LEDs and elevated $CO_2$ (~3000 ppm)
- Select crops that address nutritional deficits and meet crew acceptability




# Materials and Methods

- Microgreen cultivars selected
- Cultivated in NFT system
- 3000 ppm $CO_2$, 50% Relative Humidity, 23°C, and PPF ~300µmol $m^{-2}$ $s^{-1}$
- Samples were harvested
- Nutritional analysis was conducted by outside lab
- Samples were washed, packaged and shipped to Johnson Space Center Food Laboratory for sensory analysis

# Microgreen Cultivars

| Crop Type | Cultivar |
|---|---|
| Bean | Mung Beans |
| Beet | Detroit Mix |
| Beet | Bulls Blood |
| Brussels Sprouts | Long Island Im proved |
| Chia | Black OG |
| Collards | Vates |
| Cress | Cressida |
| Cress | Upland |
| Grain | quinoa |
| Grain | Buckwheat Groats |
| Kohlrabi | Early White Vienna |
| Kohlrabi | Purple Vienna |
| Lentils | Green |
| Melon | Cantaloupe |
| Mustard | Tatsoi |
| Nasturtium | Empress of India |
| Nasturtium | Alaska |
| Orach | Purple |
| Pea | Dun |
| Pea | Snow Pea, Dwarf Sugar Grey |
| Pea | Snow Pea, Mammoth Melting Sugar Pod |
| Pea | Dwarf Grey Sugar Pea |
| Pea | Mammoth Melting Sugar Pea |
| Root | Carrot |
| Shiso | (Perilla) Green |
| Sunflower | Black Oil |
| Swiss Chard | Yellow |
| Tree | Chinese Mahogany |

# Sensory Results

| Average | | | | | | |
|---|---|---|---|---|---|---|
| Sample | Overall | Appearance | Color | Aroma | Flavor | Texture |
| Dun Pea | 7.1 | 8.0 | 8.1 | 6.3 | 7.1 | 7.7 |
| Sunflower | 6.8 | 7.9 | 8.0 | 6.5 | 6.5 | 7.4 |
| Buckwheat | 6.7 | 7.3 | 7.3 | 6.6 | 6.6 | 6.6 |
| Collards | 6.7 | 7.8 | 7.8 | 6.3 | 6.6 | 7.4 |

| Average | | | | | | |
|---|---|---|---|---|---|---|
| Sample | Tenderness | Bitterness | Crispness | Nuttiness | Sweetness | Aromatic |
| Dun Pea | 3.0 | 3.5 | 3.1 | 2.9 | 2.6 | 2.6 |
| Sunflower | 3.0 | 3.7 | 2.8 | 2.7 | 2.7 | 2.6 |
| Buckwheat | 3.3 | 3.3 | 2.7 | 2.7 | 2.6 | 2.9 |
| Collards | 3.0 | 3.3 | 2.8 | 2.9 | 2.5 | 2.6 |

**Selected Taster Comments**

## Buckwheat

*Pros*

- Tasted slightly 'grassy', brought back childhood memories of rolling around on the lawn!
- Fresh taste with very little bitterness

*Cons*

- Wilted
- No aroma
- Too much stem

## Dun Pea

*Pros*

- Could definitely taste the raw pea-bean flavor.
- Crispy and extremely fresh
- Beautiful color

*Cons*

- Dislike too much stem
- Not much aroma
- Too bitter

## Sunflower

*Pros*

- Good leaf to stem ratio
- Beautiful green color and nice and crispy
- Buttery mouth feel

*Cons*

- Too tender
- No aroma
- Too bitter

## Collards

*Pros*

- Enjoyed slight spicy and nutty flavor
- Crispy and fresh
- Liked them and would be a good thing to have in flight to add flavor

*Cons*

- Grassy
- Not much aroma

# Nutritional Results

| Cultivar | Proximate Tests | | | | | | Vitamin | | |
|---|---|---|---|---|---|---|---|---|---|
| | Ash (%) | Calories (kcal/100 g) | Carbohydrates (Calculated-%) | Crude Fat (%) | Moisture (%) | Protein (%) | B1 (mg/100 g) | C (mg/100 g) | K (µg/g) |
| Mammoth Melting Sugar Pea | 0.92 | 35 | 3.34 | 0.55 | 91.0 | 4.19 | 0.161 | 3.50 | 0.91 |
| Cantaloupe | 1.07 | 31 | 4.58 | 0.34 | 91.7 | 2.31 | 0.041 | < 0.44 | 0.87 |
| Shiso | 0.73 | 31 | 4.18 | 0.43 | 92.1 | 2.56 | 0.068 | < 0.44 | 0.57 |
| Grey Striped Sunflower | 0.89 | 43 | 7.15 | 0.67 | 89.1 | 2.19 | 0.073 | < 0.44 | 0.72 |
| Buckwheat Groats | 0.68 | 46 | 7.10 | 0.62 | 88.6 | 3.00 | 0.138 | 3.75 | 0.20 |
| Rutabaga | 0.91 | 29 | 4.63 | 0.55 | 92.6 | 1.31 | 0.067 | 15.50 | 0.38 |
| White Kohlrabi | 1.45 | 34 | 5.49 | 0.60 | 90.9 | 1.56 | 0.050 | 11.80 | 0.18 |
| Dun Pea | 0.78 | 47 | 6.22 | 0.55 | 88.2 | 4.25 | 0.181 | 3.46 | 0.84 |
| Chia | 1.21 | 33 | 5.22 | 0.43 | 91.2 | 1.94 | 0.057 | < 0.44 | 0.14 |
| White Stem Pac Choi | 1.13 | 23 | 3.60 | 0.39 | 93.5 | 1.38 | 0.040 | 2.26 | 0.10 |
| Mung Beans | 1.14 | 38 | 4.76 | 0.54 | 90.0 | 3.56 | 0.114 | 0.50 | 0.21 |
| Cressida Cress | 1.48 | 42 | 6.00 | 0.83 | 89.0 | 2.69 | 0.073 | 10.70 | 0.23 |
| Dwarf Grey Sugar Pea | 0.90 | 57 | 6.67 | 0.75 | 85.8 | 5.88 | 0.300 | 1.98 | 0.60 |
| Persian Cress | 1.44 | 36 | 5.07 | 0.56 | 90.3 | 2.63 | 0.071 | 3.75 | 0.51 |
| Cilantro | 1.97 | 53 | 7.65 | 1.09 | 86.1 | 3.19 | <0.050 | < 0.44 | 2.49 |
| Daikon Radish | 0.70 | 35 | 3.88 | 0.84 | 91.7 | 2.88 | 0.150 | 1.03 | 2.65 |
| Collards | 0.74 | 35 | 4.98 | 0.69 | 91.4 | 2.19 | 0.100 | 0.66 | 1.83 |
| Wasabi Mustard | 1.10 | 34 | 4.99 | 0.53 | 91.0 | 2.38 | <0.050 | 0.83 | 2.39 |

# Nutritional Results

| Cultivar | Elemental Content | | | | | |
|---|---|---|---|---|---|---|
| | Ca (%) | Fe (%) | Mg (%) | P (%) | K (%) | S (%) |
| Mammoth Melting Sugar Pea | 0.069 | 0.0007 | 0.026 | 0.065 | 0.337 | 0.05 |
| Cantaloupe | 0.129 | 0.0009 | 0.067 | 0.086 | 0.296 | 0.04 |
| Shisio | 0.085 | 0.0038 | 0.035 | 0.061 | 0.194 | 0.03 |
| Grey Striped Sunflower | 0.095 | 0.0045 | 0.053 | 0.060 | 0.289 | 0.05 |
| Buckwheat Groats | 0.053 | 0.0019 | 0.061 | 0.088 | 0.179 | 0.05 |
| Rutabaga | 0.111 | 0.0004 | 0.041 | 0.062 | 0.256 | 0.08 |
| White Kohlrabi | 0.153 | 0.0004 | 0.047 | 0.077 | 0.448 | 0.14 |
| Dun Pea | 0.073 | 0.0012 | 0.026 | 0.064 | 0.278 | 0.05 |
| Chia | 0.148 | 0.0109 | 0.055 | 0.050 | 0.338 | 0.03 |
| White Stem Pac Choi | 0.103 | 0.0004 | 0.031 | 0.051 | 0.385 | 0.09 |
| Mung Beans | 0.123 | 0.0007 | 0.048 | 0.057 | 0.394 | 0.04 |
| Cressida Cress | 0.085 | 0.0008 | 0.038 | 0.081 | 0.584 | 0.12 |
| Dwarf Grey Sugar Pea | 0.064 | 0.0012 | 0.031 | 0.089 | 0.289 | 0.05 |
| Persian Cress | 0.078 | 0.0006 | 0.037 | 0.112 | 0.524 | 0.11 |
| Cilantro | 0.117 | 0.0023 | 0.061 | 0.089 | 0.707 | 0.03 |
| Daikon Radish | 0.092 | 0.0006 | 0.046 | 0.066 | 0.153 | 0.13 |
| Collards | 0.101 | 0.0006 | 0.040 | 0.072 | 0.161 | 0.10 |
| Wasabi Mustard | 0.107 | 0.0007 | 0.045 | 0.071 | 0.338 | 0.10 |

# Conclusions

- Microgreens grow well in mission relevant environmental conditions
  - Selected microgreens are palatable to tasters thus far
  - If chosen and cultivated correctly, they have the ability to supply substantial amounts of protein, vitamin C, B1, and K