**Problem**

The number of companies making food products from insects has increased. These products are relatively expensive because they have no supply of wholesale insect ingredients. A sustainable alternative to increasingly expensive fishmeal is also sought.

**Goal:** Develop a process to extract lipids from insects, producing a crude oil and high-protein flour/meal

- Design and size equipment for storage, cleaning, extraction and milling operations
- Study drying, mechanical separation, pasteurization and baking properties of insects
- Determine economic feasibility of large scale insect processing

**Background and Societal Impact**

- Around the globe, 2 billion people already regularly eat insects.
- Insects are a complete protein high in unsaturated fats, omega 3, thiamin, riboflavin, vitamin A and β-carotene.
- Several insect processing enterprises are beginning in Europe, Africa and Asia. Only one has begun so far in the U.S.

**Process Design**

- Mechanical oil extraction was successful.
- Only 1.5 log reduction from 1 min blanching.
- Breads with cricket flour bake to smaller volume.
- More optimization is needed in all areas.

**Alternative Solutions**

- Grow insects “in-house” on organic waste streams.
  - **Pros:** cheaper, more sustainable
  - **Cons:** regulation, nutritional quality
- Process other insect species (Black soldier fly, termite).
- Use hexane extraction instead of extrusion.
  - **Pros:** efficiency, effectiveness, quality
  - **Cons:** capital costs, perception
- Extract chitin & refine oil.
- Move operation to SE Asia or Africa.
  - Lower capital, labor costs
  - More consumer acceptance
  - Better insect growing conditions

**Economic Analysis**

- Flour for humans is more profitable than meal for fish.
- Innovation is needed in insect farming technology to bring down price of insects.

**Insects require less feed and land than traditional livestock.**

<table>
<thead>
<tr>
<th>Mealmworm</th>
<th>Cricket</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber, Ash, 1.0%</td>
<td>Fat, 13.1%</td>
</tr>
<tr>
<td>5.6%</td>
<td>17.0%</td>
</tr>
<tr>
<td>Moisture, 63.4%</td>
<td>Moisture, 64.3%</td>
</tr>
<tr>
<td>Protein, 21.2%</td>
<td>Protein, 7.8%</td>
</tr>
<tr>
<td>2.1%</td>
<td>3.94%</td>
</tr>
</tbody>
</table>

**Experiments**

- **Mealworms**
  - Moisture (%): 5.0 - 25.0%
  - View graph for moisture over time.

- **Crickets**
  - Moisture (%): 5.0 - 25.0%
  - View graph for moisture over time.

**References:**