PURDUE UNIVERSITY

CAPSTONE EXPERIENCE 2015

Insects for Food and Feed

Agricultural & Biological ENGINEERING

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Problem

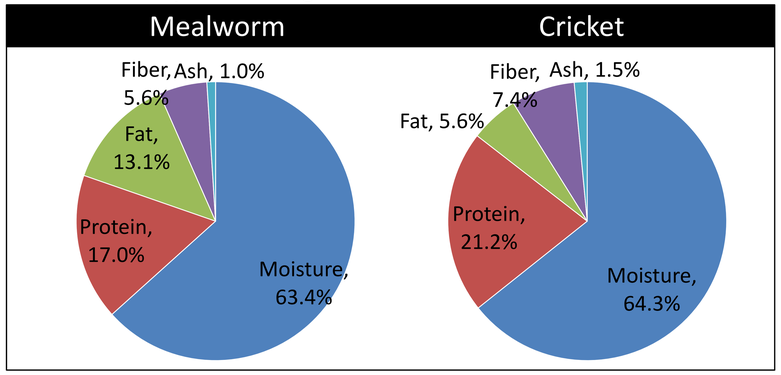
The number of companies making food products from insects has increased. These products are relatively expensive because they have no supply of wholesale insect ingredients. A sustainable alternative to increasingly expensive fishmeal is also sought.

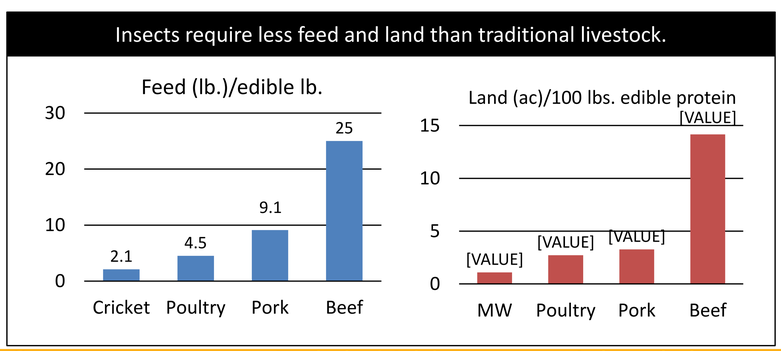
Goal: Develop a process to extract lipids from insects, producing a crude oil and high-protein flour/meal

- 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

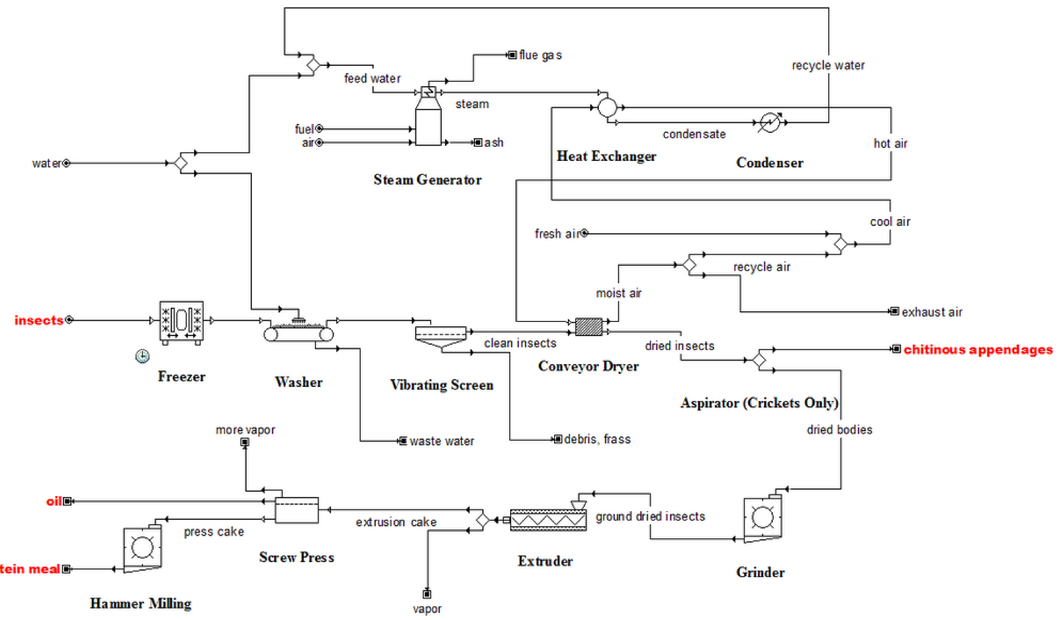
Background and Societal Impact

- 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



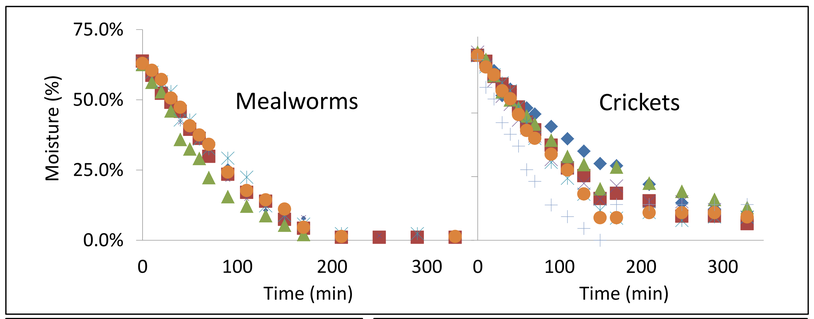
Stream (lbs./day)	Mealworm	Cricket
Insects	2722	3765
Chitinous appendages	-	17
Oil	350	155
High protein flour/meal	591	786

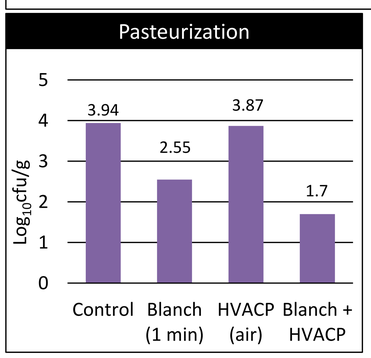
Alternative Solutions

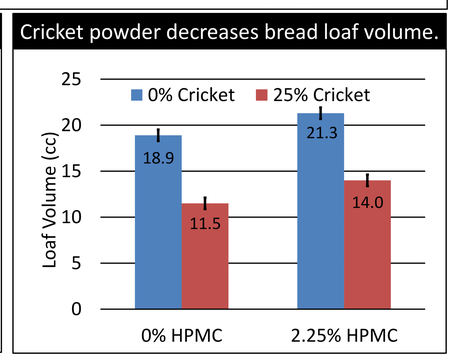
- Grow insects "in-house" on organic waste streams.
  - **Pros:** cheaper, more sustainable
  - **Cons:** regulation, nutritional quality
- Process other insect species (Black soldier fly, termite).
- Use hexane extraction instead of extrusion-expelling.
  - **Pros:** efficiency, effectiveness, quality
  - **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

Experiments

- 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.







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.

	Mealworm	Cricket
Flour/meal production (tons/year)	89.3	117.7
Oil production (tons/year)	52.9	23.1
Raw materials	$4,395,600.00	$12,144,000.00
Total product cost	$6,028,725.99	$13,777,125.99
Gross profit (depreciation included)	$178,164.57	$2,742.07
Income tax rate	35%	35%
Net profit	$115,806.97	$1,782.35
Annual cash flow	$158,916.41	$44,891.78
ROI	9.20%	0.14%
Payback period	6.7 years	23.8 years

Total equipment cost	$269,568.00
Fixed capital investment	$1,070,184.96
Working capital	$189,106.91
Total capital investment	$1,259,291.87

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