Industrial Design of a Catfish Skin Gelatin Production Facility

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Problem Statement
- The catfish industry in Alabama is currently in a state of decline and needs to be bolstered to allow the industry to remain competitive.
- As seen in Figures 1 and 2, domestic catfish have not been able to compete with international catfish supplies.
- Finding ways to use previously underutilized waste products, such as catfish skin, can bring additional value to the fish overall and can help achieve Best Aquaculture Practice endeavors.
- Developing a facility that can create a valuable product like gelatin from catfish skin can greatly increase the value of domestic catfish.
- Skins are sold for about $0.05/lb and gelatin is sold for about $5.00/lb.

Objectives
1. Design a facility that produces one ton of dry, powder gelatin product per day from 6.7 tons of catfish skin acquired from catfish processors.
2. Perform a cost analysis for the facility including the capital costs involved in the initial construction, the operational costs, and the projected profitability in order to determine a payback period.

What is Gelatin?
- Versatile product that serves as an important part of the food, pharmaceutical, and photographic industries.
- Chemically, gelatin is a pure protein from skin or bone.
- Gelatin has several extremely valuable physical qualities:
  - Can form a clear, transparent solution
  - Melts when heated, thickens when chilled
  - Gluten-free, low allergenic potential
  - Typically pork or beef based
  - Fish gelatin can cater to restrictive religious dietary guidelines as it also serve as an alternative for those fearful of beef products from the “mad cow disease” scare.

Gelatin Production Process

- Process Breakdown Key:
  - Skin Preparation: Includes selection, washing, and dicing of the skins.
  - Pretreatment & Wash: Includes soaking skins in NaOH and Acetic Acid baths.
  - Extraction & Filtration: Involves extracting the gelatin (proteins) from the skins and thoroughly filtering the gelatin solution.
  - Drying & Packing: Includes drying the gelatin solution, milling the product into a powder, and packing the final product into 1000 kg bags.

Preliminary Cost Analysis

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<th>Capital Costs</th>
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<tr>
<td>Equipment</td>
<td>1,780,000</td>
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<tr>
<td>Building</td>
<td>775,000</td>
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<tr>
<td>Contingency (20%)</td>
<td>510,000</td>
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<tr>
<td>Engineering Design (12%)</td>
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<td>Total</td>
<td>3,370,000</td>
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<table>
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<th>Monthly Operational Costs</th>
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<tr>
<td>Chemicals</td>
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<td>Transportation</td>
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<td>Utilities</td>
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<td>Labor</td>
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<table>
<thead>
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<td>Gelatin</td>
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| Payback Period | 3.5 years |

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- Dr. Yifen Wang, the faculty sponsor for the project, for providing information on the gelatin production process.
- Dr. Jesse Chappell, the project client, for providing information on the catfish industry.
- Dr. Oladiran Fasina and Dr. Mark Dougherty, the Senior Design class instructors, for guidance throughout the duration of the semester.

References

Gelatin Handbook: Theory and Industrial Practice

Site Location Satellite Imagery:

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Extruded gelatin product being laid out for drying
Finished gelatin product. Varies in texture from powder to granules

- 3D models were developed to give a better idea of what the final, operating gelatin production facility could look like after construction.
- The building is currently planned to be 500 ft x 250 ft.
- In the center of the building, the process will run with two parallel lines that work from the center outward.
- The front of the building is designed to hold offices, a worker lounge and kitchen, bathrooms, and a foyer.
- Shipments will be brought in and out from the back of the building. The back will also have storage space, loading docks, an electrical room, and a freezer for raw material storage.

Location mapping of facility (from most general to most specific)