This Fisheries Diversification Project (FDP) set out to demonstrate the technology used to turned fish waste into silage and, hopefully, be the catalyst for the commercial development of a local silage enterprise.

**Background**

The Government of Newfoundland and Labrador Department of Fisheries and Aquaculture has been promoting 100% utilization of all fish products for years.

Meetings with Atlantic Canada Opportunities Agency (ACOA), Fisheries and Oceans Canada (DFO), and Environment Canada have been part of a strategy to develop a cooperative approach to the problem.

Various presentations and initiative by the Department of Fisheries and Aquaculture, such as “The Utilization of Marine By-Products” conference/workshop (FDP # 128) at Gander, have helped create an industry focus towards this environmental potential and this commercial opportunity.

At this time silage is only commercially produced in Europe at this time where it has been the solution to the dumping of soft fish waste for over 20 years. The silage produced there has applications that range from agricultural feed for animals such as pigs, chickens, mink etc., to aquaculture applications where it is used as an ingredient in the production of farmed salmon feed.

**Methodology**

Ensiling or the making of fish silage involves chopping or grinding the fresh fish offal, to increase the surface area.

An acid is added to adjust the ph level to a point where the material is stable. Natural enzymes present in the material help to convert the ‘material’ into a liquid protein and oil.

Once liquified, the silage can then be concentrated in order to remove most of the water, which comprises over 50% of the fish silages initial weight. This aids in reducing shipping and handling costs.
Results

- Approximately 2 tonnes of concentrate have been produced and are being held in storage, pending completion of lab analysis and further production/accumulation of concentrate.

- The stability of the silage is quite good with an expected shelf life of two years.

- Some lab work that has been done and indicates a protein level @ 12%. This is low, most likely due to the high content of oil still present in the samples.

- The oil content of the turbot silage is 22% in unconcentrated form. At current market prices between $525 - $540 USD value per tonne of input could be worth $185 per tonne, based on oil content only. ($525 x .22 x 1.60$Can/$USD)

- Two industry requests for the loan/demonstration of the system have been received. These are from Allen's Fisheries, Benoit's Cove and from the plant at Gaultois.

- The system has been shipped to Benoit's Cove for a year's production and it is hoped to ship another system to Gaultois in the before March. (Some spare tanks have already been shipped)

Recommendations

- Although some technical challenges remain, such as improving the performance of the concentrator, there is a significant interest from industry to carry on with this work. Therefore, it is recommended that the project be continued.

- There is also interest from industry for the project to provide quantities of silage from shellfish, herring and salmon. This should also be attempted within the time frame that remains.
The use of phosphoric acid instead of formic can be used to make silage products suitable for compost or fertilizer. This should be done within the scope of the project, should time allow.

In addition to Allen’s Fisheries, Benoit’s Cove, there has been a request from Gaultois to locate a primary ensiling unit at Gaultois to process salmon waste from the Bay D’Espoir area. This can be accommodated within the scope of this project and due to the peculiarities and geographics of this area it is recommended that a second system be supplied for this purpose. This would provide salmon silage which should have a very high market value while addressing disposal problems in the area.

Modifications to the concentrator should be completed so that silage concentrate can be shipped to end users.

Although there have been business plans developed in the past, these are either outdated or proprietary. Although it cannot be accomplished within the scope and time frame of this project, it is recommended that support be given in the future towards developing a business model for ensiling in Newfoundland and Labrador outlining capital requirements, cost/benefit analysis and logistical considerations.

### Analysis

Analysis was performed on samples of unconcentrated red fish and turbot silage, concentrated turbot silage and dried turbot silage. The dried turbot silage was produced using a technology called’ refractance Window’. Results of the lab analysis are indicated in the above table.

The potential value of fish silage, which is related to the amount of digestible protein and oil in the product, can be estimated by comparing the values to market prices of other nutritional sources of material such as fish meal, soy meal and fish oil.

<table>
<thead>
<tr>
<th>Sample</th>
<th>% Protein</th>
<th>% Fat</th>
<th>% Moisture</th>
<th>% Ash</th>
<th>% Salt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Redfish</td>
<td>13.34</td>
<td>16.79</td>
<td>74.58</td>
<td>7.85</td>
<td>3.5</td>
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<tr>
<td>Turbot</td>
<td>10.69</td>
<td>14.60</td>
<td>79.99</td>
<td>5.95</td>
<td>3.1</td>
</tr>
<tr>
<td>Turbot (Concentrated)</td>
<td>7.42</td>
<td>57.93</td>
<td>28.79</td>
<td>2.14</td>
<td>1.9</td>
</tr>
<tr>
<td>Turbot (Dried)</td>
<td>41.77</td>
<td>28.29</td>
<td>8.25</td>
<td>12.58</td>
<td>N/A</td>
</tr>
</tbody>
</table>

- Analysis

Silage separation tank
Conclusion
This FDP project showed the production of various types of fish silage. The purpose of the project has been reached, that being to produce sufficient quantities of silage in order for potential users to assess the value based on protein content, quality and other characteristics. The project was located at Beothic Fisheries, Valleyfield, and at Woodman’s Sea Products in New Harbour, where cod, redfish and turbot silage were produced for shipment to potential end users like Suregain, Moore/Clarke and Connors Brothers.

It is hoped that positive feedback from these markets will encourage commercial development in complete by product development and the goal will be a step closer thanks to this technology.

Top layer is solids, Center layer is oil and Bottom layer is a protein water mix.