Novel Bio-Adhesives From Recombinant Hagfish Proteins $\alpha$ & $\gamma$

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Abstract

The aim of this project is to create a bio-logically-based adhesive that is "green", cost effective, and mechanically viable. Outcomes, in line with the aims, will be to produce spray-on and hydrogel adhesives that are environmentally friendly, less expensive than currently available bio-adhesives, and as equal or better strength than currently available bio-traditional adhesives in industrial applications. This project will be significant in that it is an entirely novel concept involving recombinant hagfish proteins and a novel application of them that can address current issues in industrial waste and cost of bio-adhesives. The result of this product will be environmentally clean, economically viable, scientifically innovative, and industrially effective.

Protein Purification

The primary test if this study was the LAP tensile test performed on a Tytron 250. The outputs for such tests include extension (change in length of the test materials, in this case in millimeters) force in newtons, and time is seconds. The calculated values also output include engineering stress (in pascal), engineering strain (% deformation). These values were collected for all adhesives samples on both polyester and steel substrates, and compared statistically, as will be discussed later. The yield stress, ultimate stress, and break energy of each test were also calculated, and the average of each was taken and is displayed in the following table (Table 1).

![Figure 5. Elastic moduli in megapascals comparison for all dopes.](image)

![Figure 6. Yield stress in kilopascals comparison for all dope. Note that the Gorilla Glue yield stress exceeded the material control.](image)

Table 1. Numerical values for all test results Note: while all values are representative of averages, no other statistical analysis is shown. Standard deviations are represented in respective figures.

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Alpha 15</th>
<th>Alpha 20</th>
<th>Alpha 25</th>
<th>Elmers Gamma 15</th>
<th>Elmers Gamma 20</th>
<th>Elmers Gamma 25</th>
<th>Gorilla Glue</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield Stress (kPa)</td>
<td>140</td>
<td>160</td>
<td>200</td>
<td>170</td>
<td>180</td>
<td>200</td>
<td>335</td>
<td>100</td>
</tr>
<tr>
<td>Ultimate Stress (kPa)</td>
<td>160</td>
<td>180</td>
<td>200</td>
<td>190</td>
<td>210</td>
<td>220</td>
<td>345</td>
<td>110</td>
</tr>
<tr>
<td>Break Energy (J)</td>
<td>2000</td>
<td>2400</td>
<td>3500</td>
<td>2100</td>
<td>2500</td>
<td>3200</td>
<td>4500</td>
<td>1200</td>
</tr>
</tbody>
</table>

Future Work

The project proved the feasibility of the technology. A number of the attempts and designs were completely unviable—steel-dope dopes did not survive to testing—and more work must be done to broaden both the application of the product, as well as to increase the reliability of the adhesives produced.

- Defining a solvent that is less toxic to be used in mass production and use of the adhesive. The new solvent would enable the adhesive to be applied in a less well-ventilated area, and lower the protein degradation rate.
- Searching for more potential application substrates for recombinant hagfish protein adhesives, as more substrates would increase the market.
- Additional applications of the hagfish protein will also be explored to find other potential products outside of the pure adhesives realm.
- Commercial production of hagfish protein-based adhesives for industrial use, work towards a product that could be sold through upscale and perfection of production, isolation and purification of the proteins from recombinant sources.

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