PRODUCTION OF ARTIFICIAL SPIDER SILK THROUGH YEAST FERMENTATION

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Need for Change in the Textile Industry

The global textile industry is a major contributor of environmental waste and pollution.

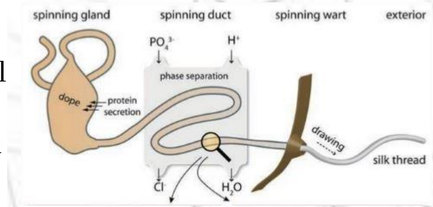
- The textile industry in the US is ranked as the 6th largest steam consumer in the country
- Agricultural damage caused by use of pesticides and soil degradation affects communities across the world
- Chemicals used to clean fibers, which include dyes and finishes, account for an estimated 20% of industrial freshwater pollution

The yeast fermentation method of spider silk production removes these environmental risks from the textile manufacturing process

The Technology of Spider Silk

Spider silk possesses a combination of strength and elasticity that make it ideal for the textile industry.

- High tenacity and elasticity when compared to other textiles
- Large stretch ratio



The yeast fermentation method mimics the natural spinning process

- Proteins are secreted into a water bath
- Hydrophobic ends line up to create single long protein chain
- Protein is compressed through spinning wart and drawn out of the body

Spider silk is superior to common textiles

- Cotton underperforms on measures of strength and elasticity
- Yeast fermentation can replace the dirtiest part of the traditional textile production chain by removing energy consumption and pollution

The Yeast Fermentation Method: A Step Forward

Gene Modification Process

- DNA samples that mimic natural spider silk proteins are placed in the yeast
- Yeast, fed with sugar and water, is allowed to ferment.

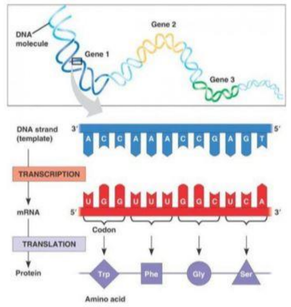
Transcription and Translation

- Ethanol produced from fermentation begins the transcription process of DNA
- The silk proteins are formed from the amino acids produced during the translation process.

Spinning Process

- Pure synthetic spider silk protein is pushed through a apparatus designed to mimic a spider's wart
- The resulting silk strands are spun into spools of thread

The yeast fermentation method begins with inserting modified spider silk genes in yeast batches.



- Yeast metabolizes ethanol when fermented to stimulate the production of proteins
  - An ethanol promoter is produced through the fermentation process drives the transcription process
  - Then the protein is built from the amino acids formed in the translation process
  - The spider protein formed can be extracted from the yeast
- The protein is collected from fermentation tanks and purified
  - The most common method of purification is chromatography
- Purified proteins are compressed through device that mimics a spider's spinning wart
- The resulting long strands of silk are passed through a spinline device to create spools of silk, which can be woven into fabric

Case Study: Bolt Threads

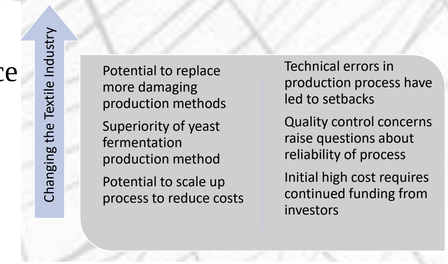
Bolt Threads has pioneered the yeast fermentation method.

- Biotech company specializing in sustainable materials in the fashion industry.
- Raised $213 million in funding.
- Aim to produce artificial silk fibers that mimic the strength and elasticity of natural spider silk while minimizing harm to the environment.
- Committed to sustainability, Bolt Threads will complete a life cycle analysis of its process to determine the environmental impacts of the material when compared to other natural and synthetic materials.

Feasibility of Bolt Threads Production

Bolt Threads has hurdles to overcome before it can produce at a mass scale.

- Streamline fermentation process to reduce errors.
- Increase the number of fermentation tanks.



- Fix quality control concerns.
  - Proteins have a tendency to clump, making spinning difficult.
  - Often, process produces a weaker silk than natural spider silk.

Bolt Threads has also had major successes.

- It is the first company to bring spider silk garments to market.
- Continues to garner financial support as it expands its production.
- Has made concrete steps towards addressing the challenges it faces by focusing on improving its process.