

CBS'E Science Project Report

Title: Artificial Silk from Natural Plant-Based Polymers

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Session: 2025-26

Introduction/Problem Statement

The textile industry is rapidly evolving, and the demand for sustainable, eco-friendly, and cost-effective alternatives to traditional silk has never been greater. Traditional silk production involves ethical concerns and environmental costs, including the killing of silkworms and heavy water consumption. In this project, we propose an innovative and eco-conscious method of producing artificial silk using the natural cellulose structure of plants like cactus or aloe vera, combined with chemical agents such as hydrochloric acid

(HCl) and copper sulfate (CuSO_4). This process aims to produce a silk-like thread or fabric prototype that is both biodegradable and cruelty-free.

Objective:

- 1) To explore a new method of synthesizing artificial silk using naturally available plant materials.
- 2) To utilize the cellulose content in cactus or aloe vera as a primary raw material.
- 3) To attempt creation of a silk-like fiber by combining plant pulp with chemicals like HCl and CuSO_4 .
- 4) To build a working prototype of artificial silk and explore the feasibility of scaling up.

Hypothesis:

If plant-based cellulose from cactus or aloe vera can be chemically treated and restructured using specific agents, it may be possible to mimic the properties of natural silk, leading to the production of a sustainable artificial silk fiber.

Materials Required:

- 1) Fresh cactus or aloe vera pulp
- 2) Hydrochloric Acid (HCl) (Diluted)
- 3) Copper Sulphate (CuSO_4)
- 4) Cotton fibers (optional, for structural support)

- 5) Filter paper and funnel
- 6) Distilled water
- 7) Glass beakers and stirring rods
- 8) Protective gloves, apron, and safety glasses
- 9) Heating source (if needed)
- 10) Mould or drying trays

Theoretical Background:

Cellulose is a key structural component in plant cell walls and plays a crucial role in bio-fiber creation. Cactus and aloe vera both contain high levels of cellulose and mucilage (a gel-like substance), which can be chemically altered to form a polymer structure resembling silk fibers. The use of HCl aids in breaking down the cell wall, while CuSO_4 helps in forming complexes with cellulose chains, potentially forming a regenerated silk-like material.

Procedure:

1. Preparation of Plant Pulp:

Extract fresh cactus or aloe vera pulp and crush it into a fine paste.

Filter out the juice using muslin cloth or filter paper, retaining the fibrous pulp.

2. Chemical Treatment:

In a beaker, slowly mix the plant pulp with diluted HCl. Stir well and let it rest for 1–2 hours. This helps break down the lignin and other impurities, exposing the cellulose structure.

Add copper sulfate solution to this mixture. Stir continuously. The copper ions may bind with the cellulose and begin forming complex polymer-like chains.

Optional: Add cotton fibers at this stage to enhance tensile strength.

3. Filtration and Forming Fiber:

Filter the solution to remove excess liquid. Retain the thick paste.

Use a syringe or small nozzle to extrude this paste into a neutralizing solution to solidify the thread-like structures.

Alternatively, spread the paste thinly on a tray to dry and observe the texture.

4. Drying and Observation:

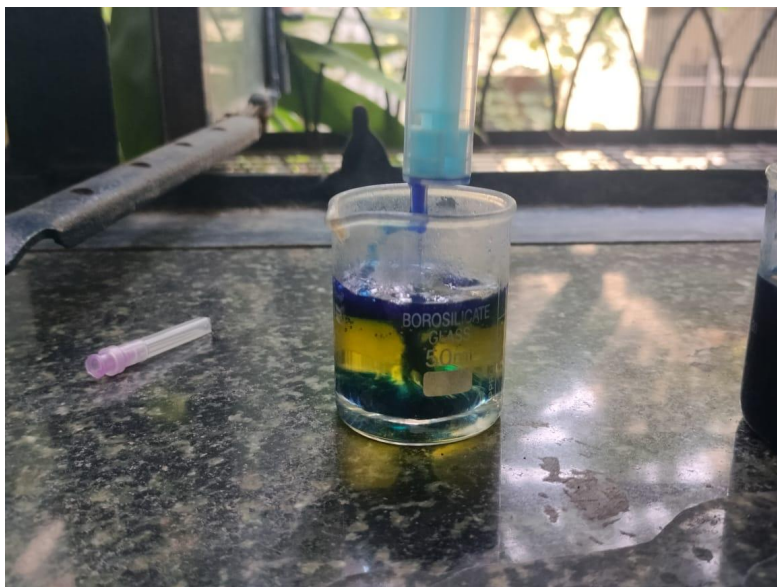
Allow the fibers or sheet to dry naturally or under low heat.

Once dried, examine the texture, flexibility, and appearance of the material.

5. Prototype Formation:

The dried product can be twisted into threads or layered to form a thin sheet resembling silk.

Test its durability, elasticity, and softness.



Observations:

The plant-based paste reacts with chemicals to form a thickened, gluey substance.

Threads formed show a silk-like sheen, depending on drying and processing technique.

Adding cotton improved structure and thread strength.



Result:

The prototype formed showed visual and tactile resemblance to silk. Though not identical in all properties, the material has potential for refinement and further development. It validates our hypothesis that cellulose from cactus or aloe vera, when treated with appropriate chemicals, can form silk-like fibers.

Applications:

Could serve as an alternative to silk in the fashion and textile industry.

Provides a cruelty-free, plant-based silk-like fabric.

Potential uses in medical dressings, eco-fashion, art and crafts, and biodegradable textiles.

Advantages:

Environmentally friendly and sustainable

No animal exploitation involved

Low-cost raw materials (easily available)

Potential to be produced on a small scale with minimal equipment

Limitations:

The prototype may lack the same tensile strength or smoothness as real silk.

Large-scale production requires more refinement in processing and chemical ratios.

Handling of chemicals requires safety precautions.

Future Scope:

This project holds significant promise for the future. If our small-scale prototype succeeds in meeting quality benchmarks, we aim to develop larger prototypes and possibly explore other plant materials or natural additives to improve the properties of artificial silk. Collaborations with textile engineers and biochemists can help in optimizing this formula for mass production, making this a green innovation in the textile world.

Group Members:



