**Introduction**

Spider Silk

Spider silks have caught the attention of researchers for many years due to their incredible strength, elasticity, and other mechanical properties. Other properties such as biocompatibility and biodegradability also make spider silks ideal biomaterials. Spiders produce six different types of silk as well as a glue (Figure 1). Each silk type possesses various properties that make them more ideal for specific applications.

Spider silk is the strongest fiber found in nature and one of the strongest materials known to man. Spider silk is tougher than Kevlar, more elastic than nylon, and stronger than steel by weight. These properties arise from specific structures in the protein that act like molecular building blocks or springs. Due to an inability to farm spiders, substantial work has been done to produce recombinant spider silk proteins (rSSps) in transgenic hosts for large-scale production. Current hosts include bacteria, goats, alfalfa, and silkworms. All of these systems have pros and cons with regards to protein recovery and the final products.

![Diagram of healthy gums vs. diseased gums](image)

**Periodontal Disease**

Periodontal disease (Figure 2) is an inflammatory disease that affects both soft and hard structures that support the teeth. In the more severe form of periodontal disease called periodontitis, the gums pull away from the tooth and supporting gum tissues are destroyed. Bone can be lost, and the teeth may loosen or eventually fall out. According to recent findings from the Centers for Disease Control and Prevention (CDC), half of Americans aged 30 or older have periodontitis. Reducing pocket depth and eliminating existing bacteria is important to prevent the progression of periodontal disease. Deeper pockets are more difficult for patients and dental care professionals to clean. In periodontal treatment antimicrobial chips, spheres, or gels are placed into the periodontal pocket in order to eliminate bacteria allowing the supporting gum tissue to reattach to the tooth.

**Introduction Continued**

**Spider Silk Use in Periodontal Disease**

Spider silks are an ideal material for periodontal chips/gels because they are biocompatible, biodegradable, lightweight, strong, and create no immune response. Furthermore, the various silks types and forms allow for tunable materials and properties. Spider silk materials may have an advantage over other products because of the ability to release medication more consistently over a longer period of time and be adjusted as needed. Unlike products currently on the market, our chip/gels are biocompatible, which aids in reducing the bodies immune response to periodontal treatment. The ability to incorporate multiple bioactive compounds into the spider silk materials allows them to become multifunctional treatment devices against inflammatory response, infection, and other related complications that come from periodontitis.

![Comparison of periodontal chips from the left to right:](image)

The purpose of this research project is to develop and test spider silk chips/gels and compare them with products currently on the market to determine the feasibility and potential of spider silk materials. To characterize these silk and conventional materials the release, activity, robustness, geometry, and longevity will be analyzed.

**Materials and Methods**

Spider silk proteins were obtained through the purification of milk from transgenic goats expressing the spider silk proteins MaSp1 (M4) and MaSp2 (M5). Tested in this experiment were preparations of 25% (w/v), 12.5% (w/v), and 6.25% (w/v) concentrations of spider silk with ratios of 80:20 M4:M5 and 100% M4. The rSSps are first solubilized in deionized water with mild heat (<130 °C) and pressure. These conditions mildly denature the proteins and force them into the aqueous solution. Once the rSSps are in solution chlorhexidine gluconate (CHG) was added to the solubilized dope in a 1:1 mixture. This addition brought the final concentrations of silk to 12.5% (w/v), 6.25% (w/v), and 3.125% (w/v). This solution is then used to form the chips by pipetting 100 μm of the solution onto a polydimethylsiloxane (PDMS) mold and allowed to form and cure overnight.

These periodontal chips were then placed into 5 ml of phosphate buffered saline (PBS) and allowed to release the medication. In order to track the amount of CHG released, samples were taken every day, and a new PBS was added. This process was repeated for fourteen days. In order to test the amount of CHG released we used the process of reverse phase ultra pressure liquid chromatography (RP-UPLC). Using known standards, the amount of CHG released could be calculated based upon the corresponding absorbance amount and retention time. All of the samples, both spider silk and PerioChips were analyzed with this method.

Antimicrobial activity was tested and observed during this project. The chips were placed on a plate of *E. coli* after spreading the cells and placed in a 37 °C incubator and observed over fourteen days.