# Biodegradable wet-spun fibers loaded with antimicrobial peptides as a tool against *Staphylococcus aureus* induced infections

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## Introduction

**Resistant microorganisms (RM)** → *May cause the death of 2.4 million people in Europe, North America and Australia in the next 30 years*

***S. aureus*** →
- *Common opportunistic pathogen resistant to multiple antibiotics;*
- *Among the most prevalent RM-induced infections;*
- *Health public issue reported by the WHO.*

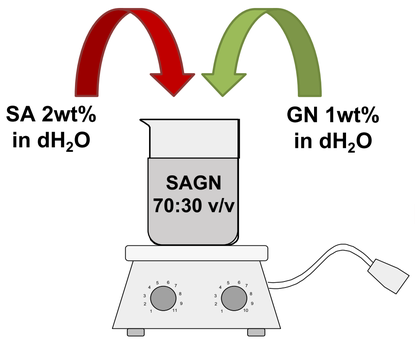
**Antimicrobial peptide (AMP) Nisin Z** →
- **Antimicrobial peptide with outstanding antibacterial activity against gram-positive bacteria**
- **Classified as "Generally Recognized as Safe" by the Food and Drug Administration (FDA)**
- **Positively charged at neutral pH and water soluble**

**Sodium alginate (SA)** + **Gelatin (GN)** → *Biodegradable, biocompatible, non-toxic and water-soluble biopolymers which can serve as delivery platforms*

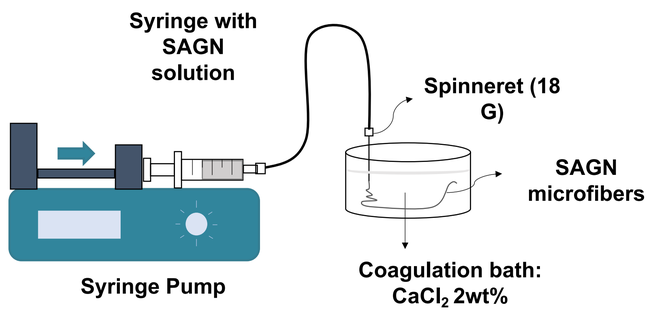
**The aim of this study was to produce SA/GN microfibers via wet-spinning technique, and subsequently functionalize these fibers with Nisin Z, in order to map Nisin Z's controlled release kinetics and antimicrobial action against *S. aureus***

## SAGN fiber's production and functionalization

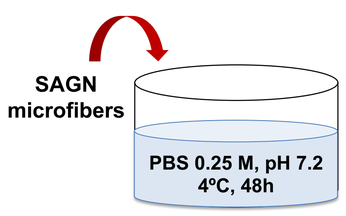
### Preparation of SAGN solution



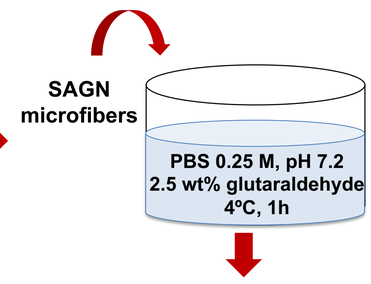

### Fiber's production via wet-spinning




### Obtention of SA-free fibers




### Chemical crosslinking




### Fiber's functionalization with Nisin Z

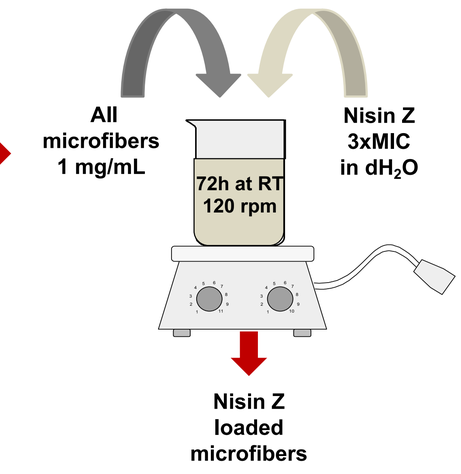
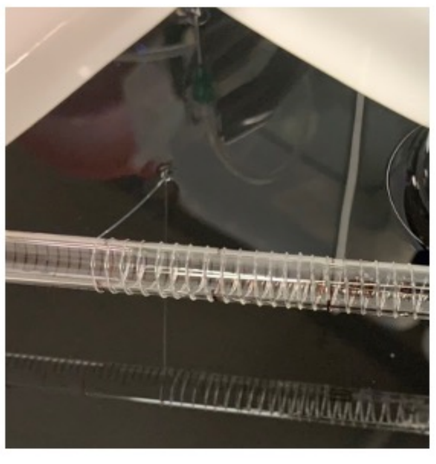



**Figure 1.** Aspect of the SAGN fibers during (left) and after (right) wet-spinning processing.



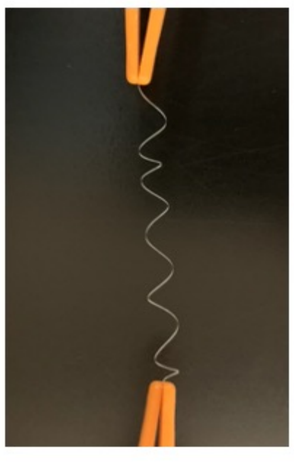
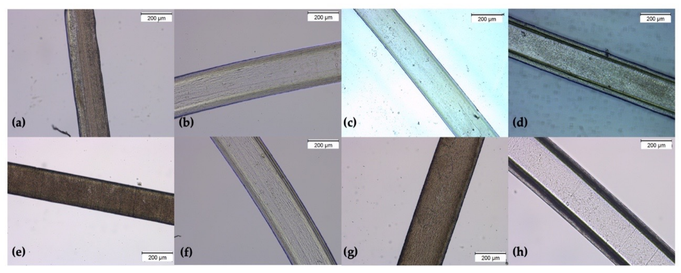


**Table 1.** Produced fibers and respective treatments employed.

| Fiber | SA Removal | Crosslinking | Nisin Z adsorption |
|---|---|---|---|
| **SA** | No | No | No |
| **SAz** | No | No | Yes |
| **SAGN** | No | No | No |
| **SAGNz** | No | No | Yes |
| **SAGNCL** | No | Yes | No |
| **SAGNCLz** | No | Yes | Yes |
| **GNCL** | Yes | Yes | No |
| **GNCLz** | Yes | Yes | Yes |

## Fibers' morphology

### Brightfield microscopy




All microfibers were determined cylindrical, homogeneous and uniform

**Table 2.** Average fiber diameter (μm) ± SD.

| | | |
|---|---|---|
| (a) | SA | 228.2±5.1 |
| (b) | SAGN | 278.5±3.2 |
| (c) | SAGNCL | 221.0±6.3 |
| (d) | GNCL | 259.2±4.8 |
| (e) | SAz | 223.5±4.0 |
| (f) | SAGNz | 281.2±3.9 |
| (g) | SAGNCLz | 219.3±7.4 |
| (h) | GNCLz | 263.4±3.6 |

## Chemical characterization

### ATR-FTIR

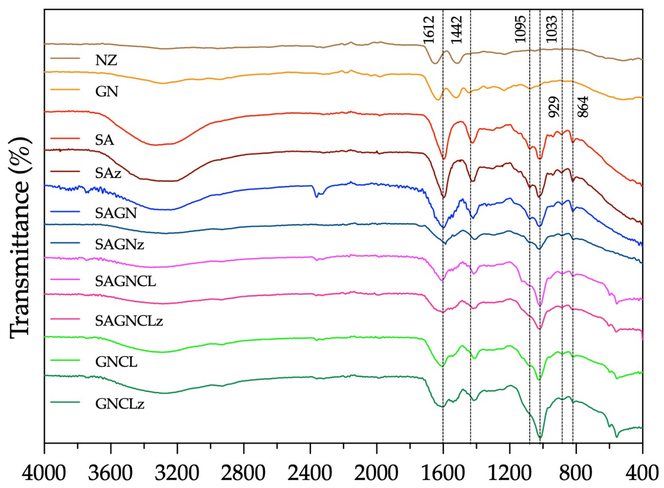
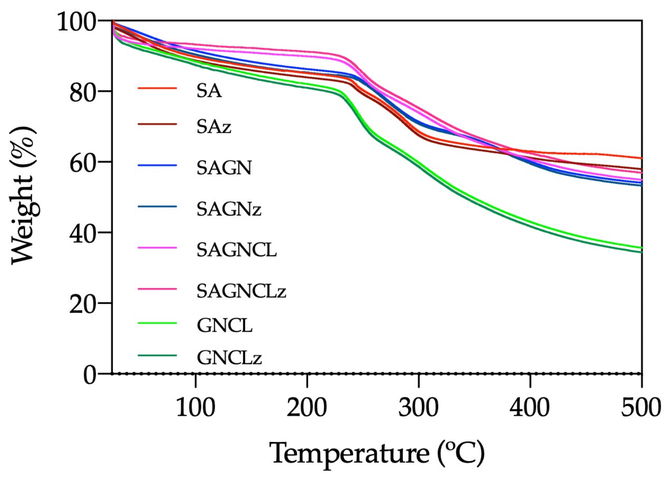



**Table 3.** ATR-FTIR peaks detected.

| Wavenumber ($cm^{-1}$) | Compound/ element | Functional group assigned |
|---|---|---|
| **≈ 3300** | All | -OH |
| **1658** | GN | amide-I, C-O, C-N |
| **1640** | NZ | Amide groups |
| **1585** | SAGN | $NH_3^+$ |
| **1573** | SAGN | $COO^-$ |
| **1530** | NZ | Primary amines |
| **1489** | GN | $-CH_2$ |
| **1095** | SA | C-O |
| **1033** | SA | C-C |
| **1030** | GN | Amine groups |
| **1020** | SA | O-C-O |
| **929** | SA | C-O |
| **864** | SA | C-O-C |
| **1431 - 1438** | SA | COO- |
| **1608 - 1635** | SA | COO- |

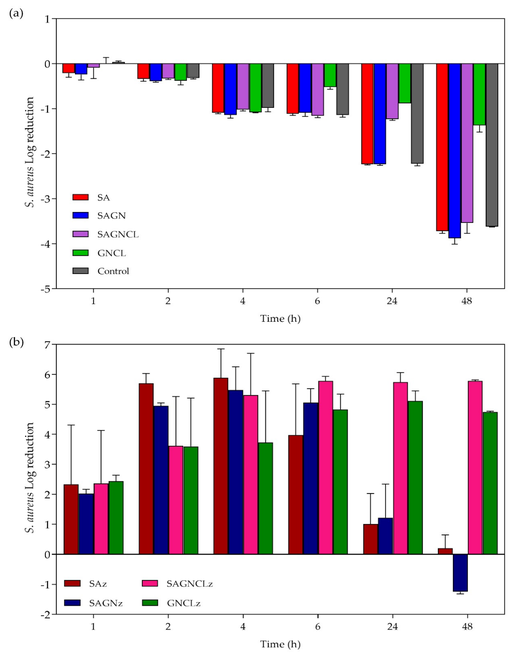
## Thermal behaviour

### TGA

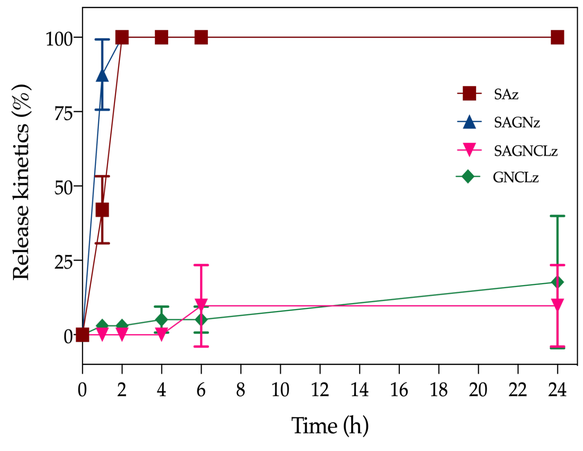



SAGNCL fibers proved to be more thermally resistant due to the crosslinking

## Antimicrobial action




## Nisin Z release kinetics




Nisin Z had its most impactful effect against the bacteria *S. aureus*, particularly when loaded onto the crosslinked samples. It was capable of progressively eliminating the viable cells, reaching an inhibition superior to 99% after 48 h of culture

The crosslinked fibers induced a more controlled and sustained release of Nisin Z over time

## Conclusions

**Overall, data revealed the potential of Nisin Z in fighting *S. aureus*-induced infections, while loaded onto biodegradable crosslinked polymeric scaffolds.**

### Acknowledgments

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