CENTRO DE CIÊNCIA E TECNOLOGIA TÊXTIL

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Biodegradable wet-spun fibers as a delivery platform for Nisin Z controlled release: antibacterial features against *Staphylococcus aureus*

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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)

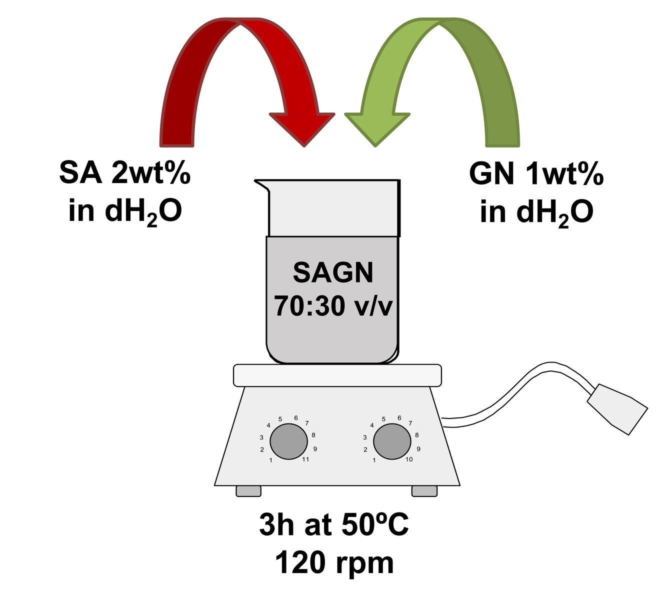
Positively charged at neutral pH and water soluble

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

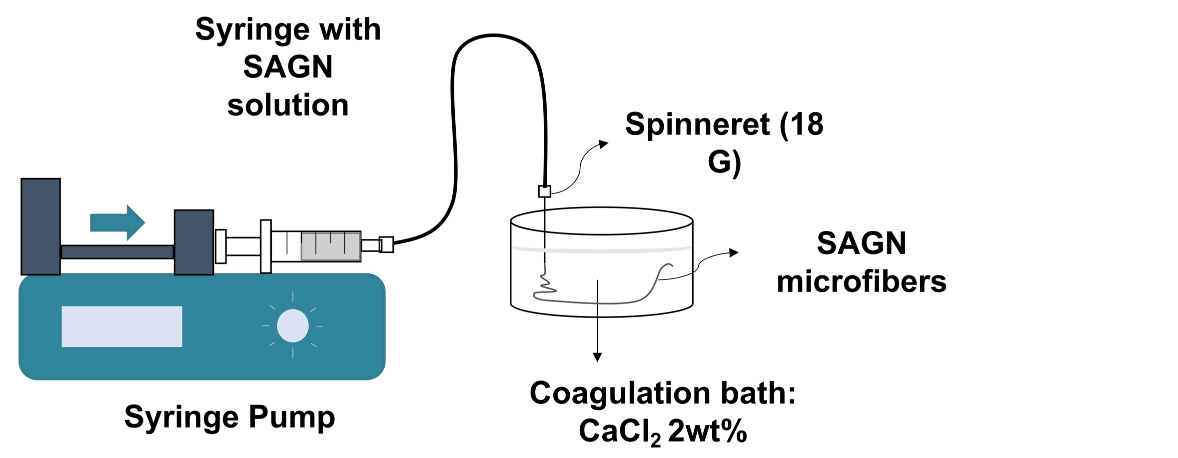
The aim of this study was to produce SA/GN microfibers via wet-spinning technique, and subsequently functionalize these fibers with Nisin Z, in order to map Nisin Z's controlled release kinetics and antimicrobial action against *S. aureus*

SAGN fiber's production and functionalization

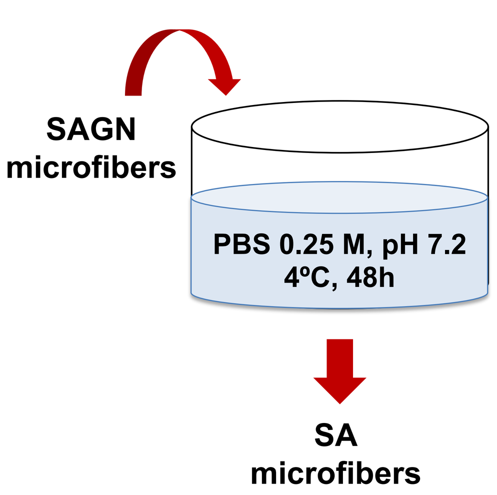
Preparation of SAGN solution



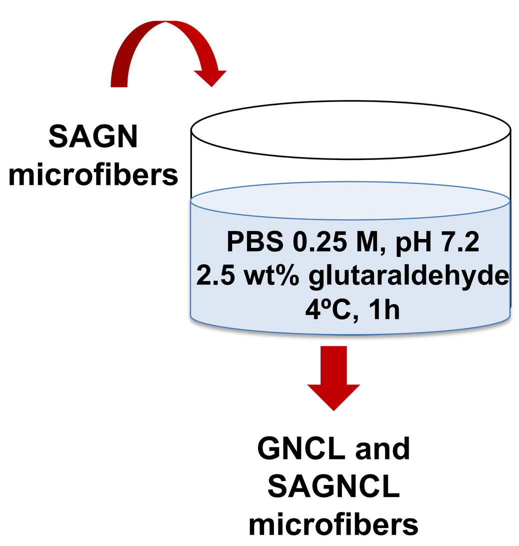
Fiber's production via wet-spinning



Obtention of SA-free fibers



Chemical crosslinking



Fiber's functionalization with Nisin Z

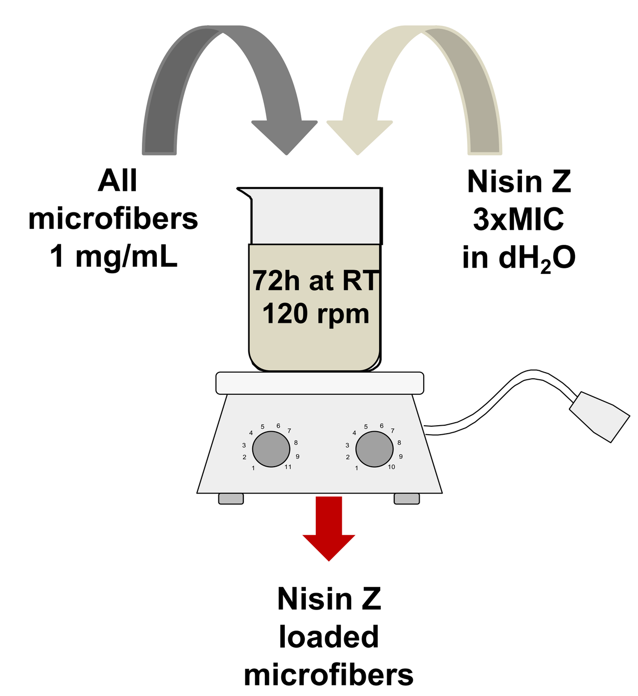
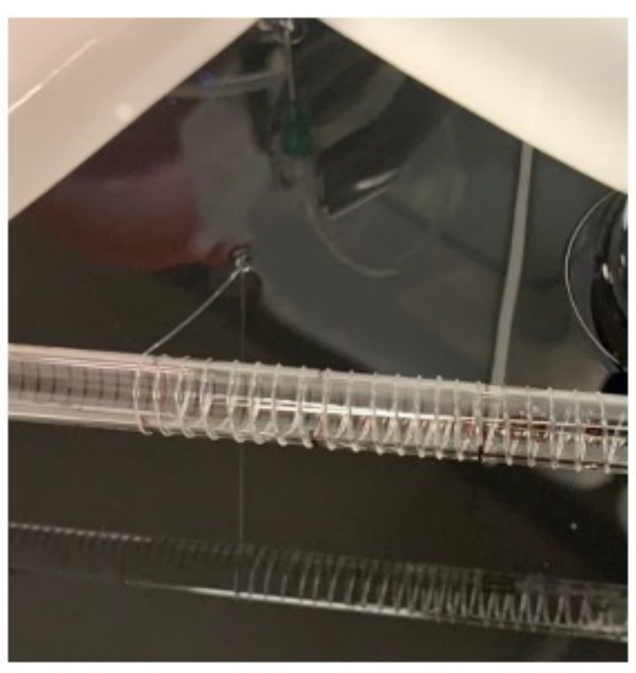


Figure 1. Aspect of the SAGN fibers during (left) and after (right) wet-spinning processing.



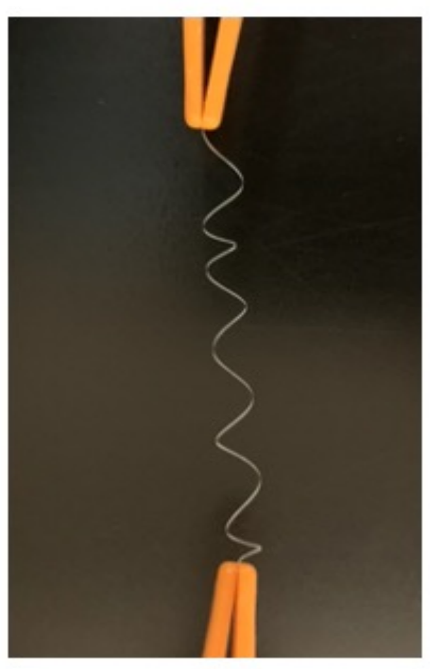
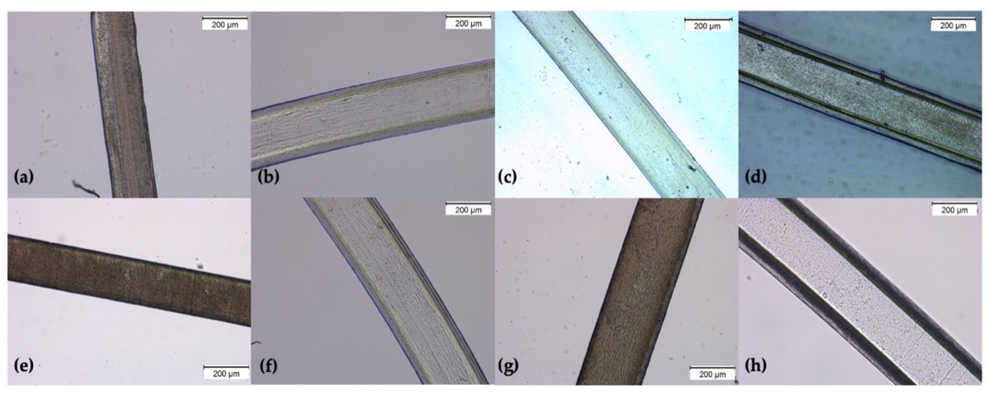


Table 1. Produced fibers and respective treatments employed.

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

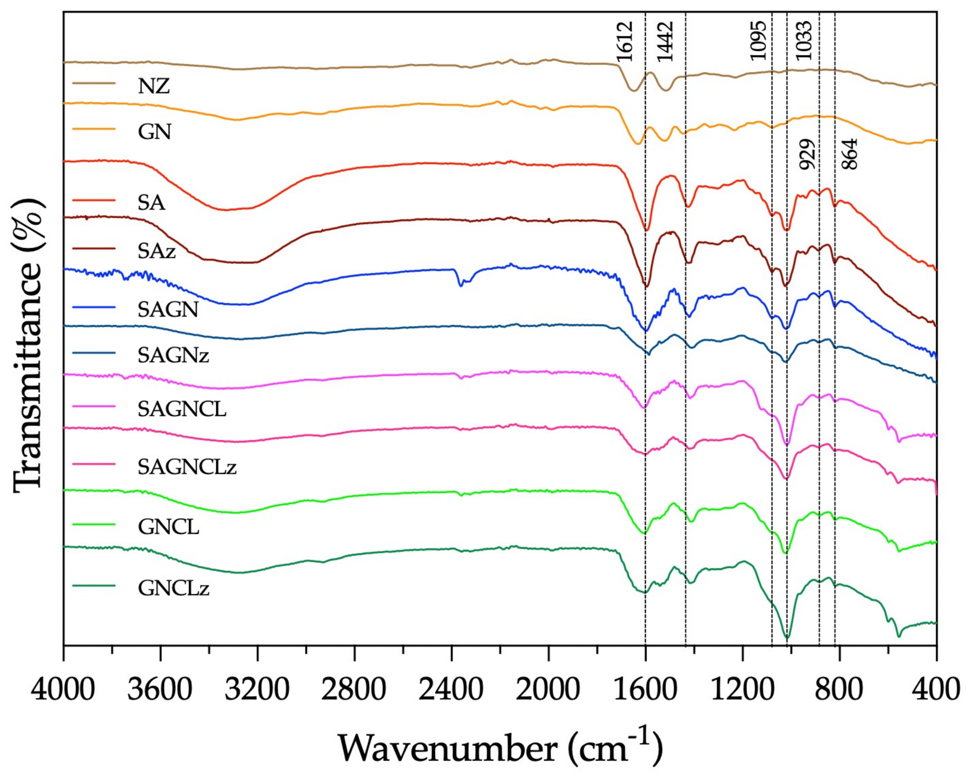
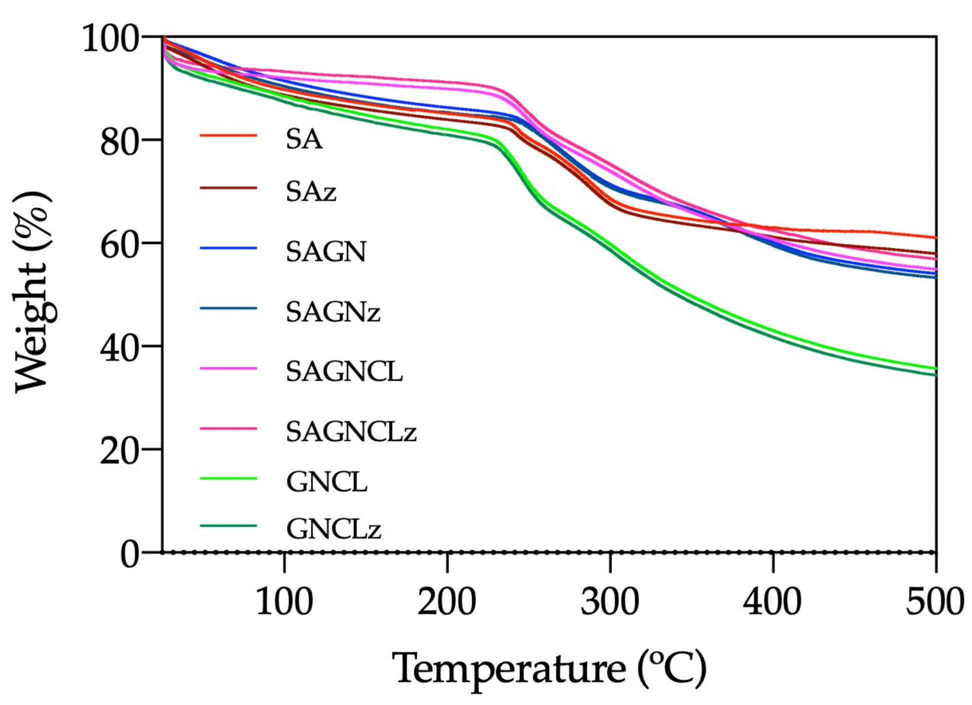


Table 3. ATR-FTIR peaks detected.

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-

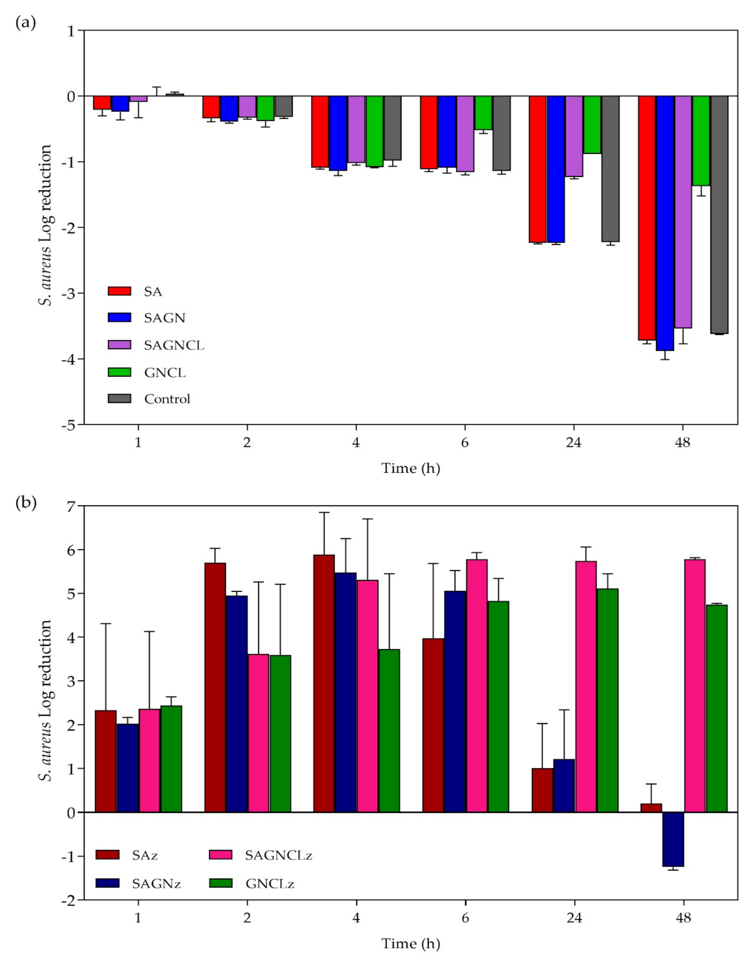
Thermal behaviour

TGA

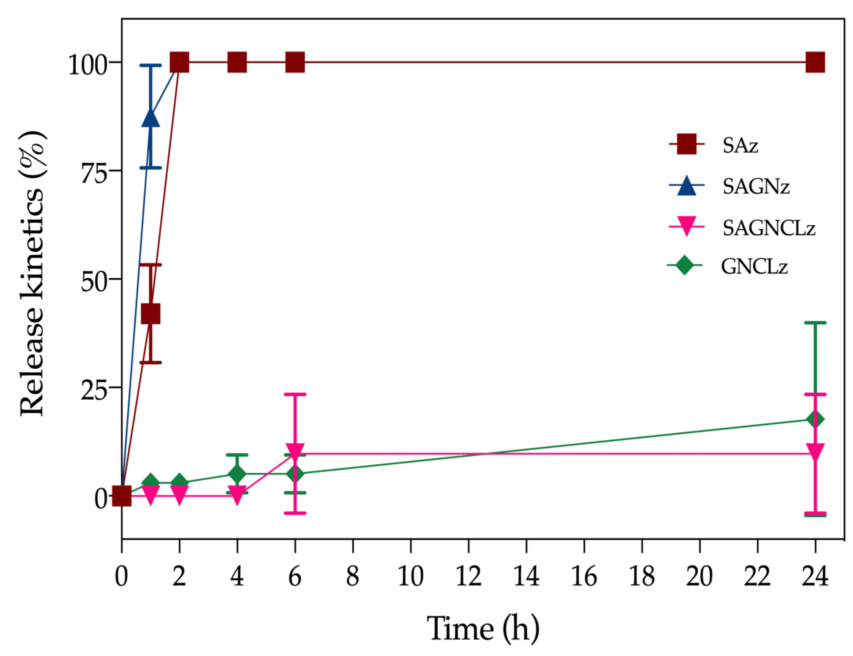


SAGNCL fibers proved to be more thermally resistant due to the crosslinking

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.

Acknowledgements

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