DESIGN OF ANTIOXIDANT AND ANTIMICROBIAL BIOACTIVE HYDROGELS BASED ON DEXTRAN

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INTRODUCTION

- Polysaccharide-based porous hydrogels, in particular, can address challenges related to bioavailability, solubility, stability, and targeted delivery of natural antioxidant compounds. Their porous structure facilitates these compounds' encapsulation and controlled release, enhancing their therapeutic effectiveness [1,2].
- In the present study, the cryogelation technique was adopted to prepare novel dextran (Dx)-based porous hydrogels embedding a polyphenol-rich natural extract from *Picea abies* spruce bark (SBE) [3].
- We systematically investigated the innovative approach of stabilizing polyphenolic extracts from spruce bark, a byproduct of the wood processing industry, by incorporating them into Dx-based cryogels. The integration of SBE into Dx-based cryogels forms a synergistic system with an extended functional lifespan, reduced environmental impact, and potential applications in pharmaceuticals, food preservation, and environmental protection [3].

RESULTS

PREPARATION OF DX-BASED CRYOGELS

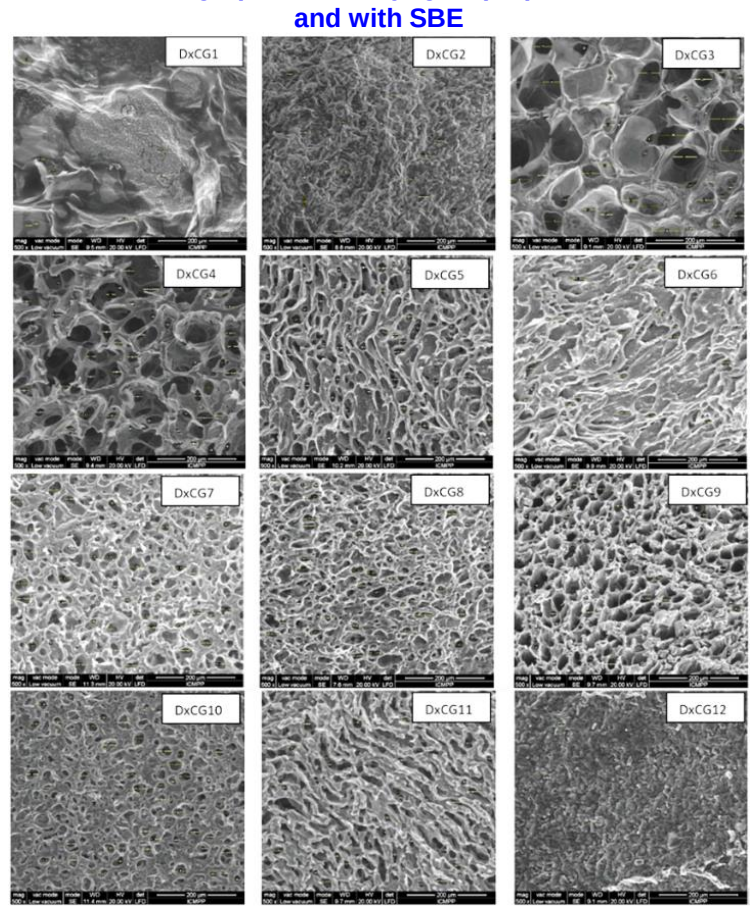
The sample codes and the compositions of Dx-based cryogels (DxCG)

Sample Code	Dx, wt.%	SBE, g	H_2O, mL	[a]EGDGE, g/mL
DxCG1	5	0	2	0.28
DxCG2	5	1.4	-	0.28
DxCG3	10	0	2	0.28
DxCG4	10	1.4	-	0.28
DxCG5	20	0	1	0.42
DxCG6	20	0	2	0.42
DxCG7	20	0.7	-	0.42
DxCG8	20	1.4	-	0.42
DxCG9	20	0	2	0.28
DxCG10	20	1.4	-	0.28
DxCG11	20	0	2	0.56
DxCG12	20	1.4	-	0.56

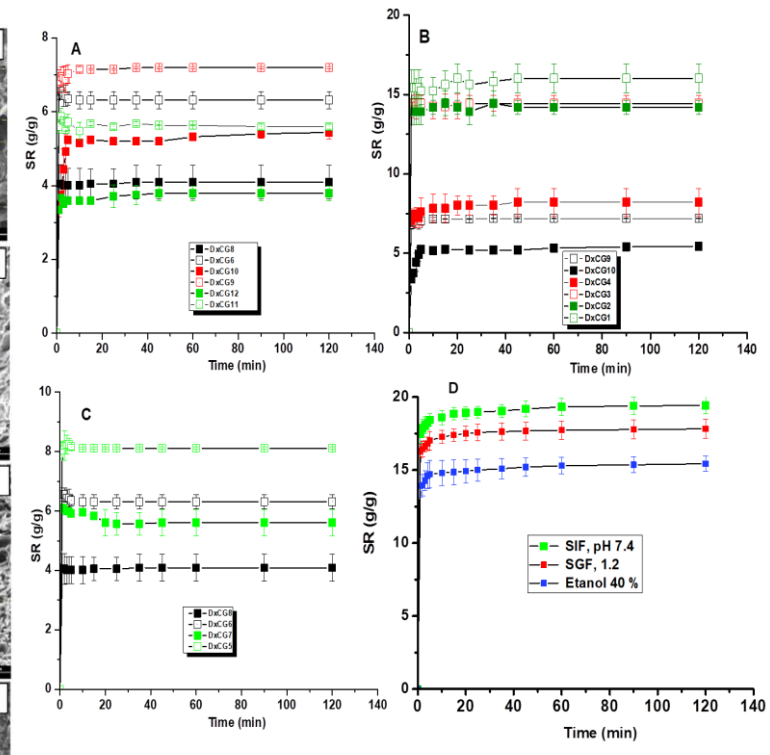
[a] Ethylene glycol diglycidyl ether (EGDGE) with a concentration of 50 wt.%

MORPHOLOGY OF DX/SBE CROSS-LINKED CRYOGELS

SEM micrographs of Dx cryogels prepared without and with SBE

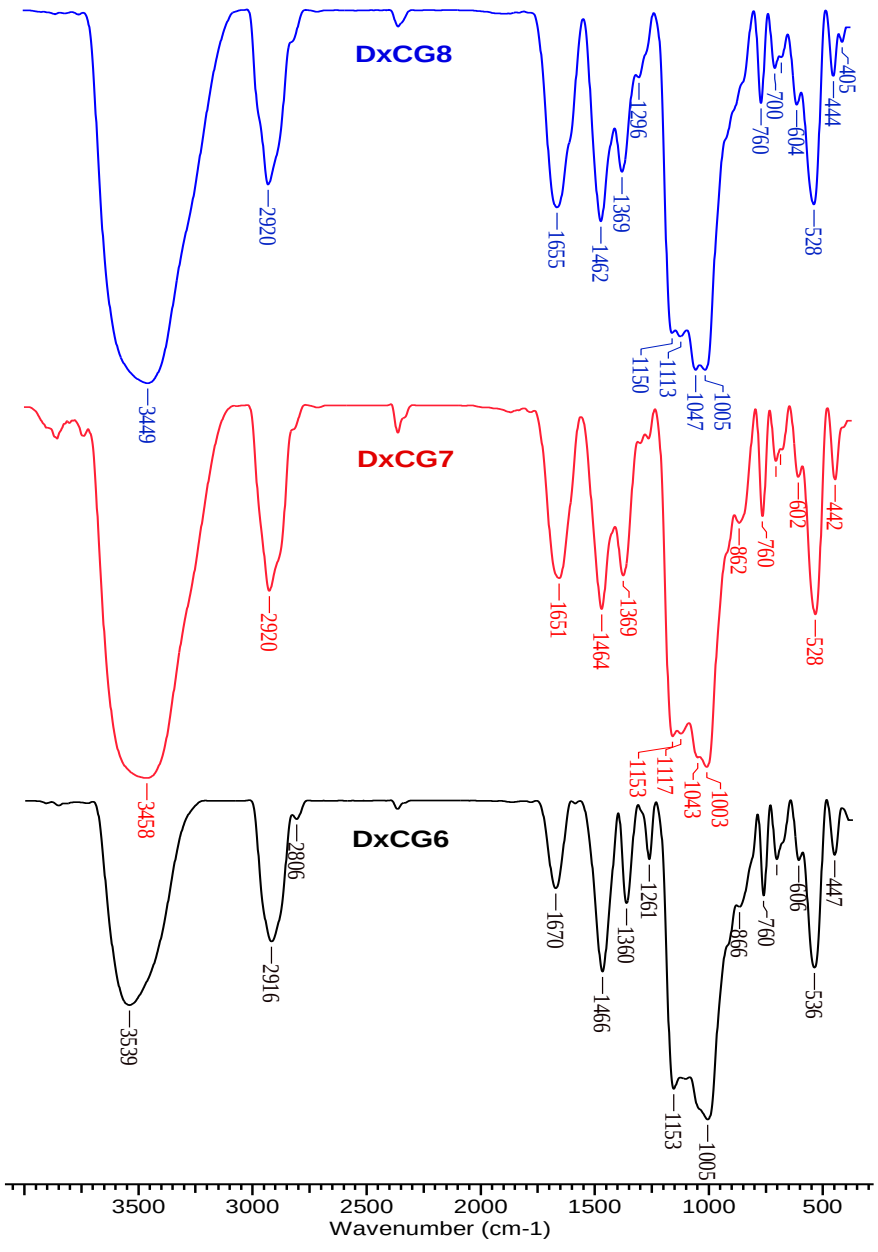


SWELLING BEHAVIOR OF DX/SBE CROSS-LINKED CRYOGELS



The swelling kinetics of Dx-based cryogels differ by EDGDE content (A), initial Dx concentration (B), and SBE amount (C). (D) The Swelling kinetics of DxCG12 under conditions simulated body fluids (SIF at pH 7.4 and SGF at pH 1.2) or food media (ethanol 40%).

FTIR ANALYSIS



ANTIMICROBIAL ACTIVITY

Microorganisms		Inhibition of Bacterial Growth (%)			
		DxCG6	DxCG7	DxCG8	SBE
Gram(+)	*Listeria monocytogenes ATCC 7644*	51	100	100	100
Gram(−)	*Escherichia coli ATCC 25922*	27	100	100	100
Gram(−)	*Salmonella typhymurium ATCC 14028*	67	100	100	100

ANTIOXIDANT ACTIVITY

Samples	DPPH Radical Inhibition (%)	IC_{50} (mg/mL)
DxCG6	0	-
DxCG7	30.37 ± 0.11	-
DxCG8	42.19 ± 0.29	-
SBE 3.33 mg/mL	78.17 ± 0.19	1.76 ± 0.05
SBE 1.66 mg/mL	54.12 ± 0.12	
SBE 0.83 mg/mL	17.11 ± 0.11	

CONCLUSIONS

- Porous hydrogels composed of Dx and SBE, were successfully synthesized using a dual cross-linking method, which included chemical cross-linking with EGDGE and physical stabilization through freeze-thawing.
- FTIR analysis revealed the interactions between the functional groups of Dx and the phenolic compounds in SBE through hydrogen bonding. SEM images showed denser cryogels with smaller, uniformly distributed pores as Dx, EGDGE, and SBE concentrations increased, indicating enhanced cross-linking and structural stability.
- Swelling studies indicated controlled water absorption, which decreased as the Dx, EGDGE, and SBE concentrations increased, suggesting a denser network that limits water uptake.
- Cryogels containing SBE exhibited remarkable antimicrobial activity against both Gram-positive and Gram-negative bacteria, attributed to SBE's phenolic compounds. Additionally, these cryogels demonstrated good antioxidant activity, slightly lower than the SBE extract itself, possibly due to some antioxidant groups being involved in cross-linking.

REFERENCES

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