

NEW BIOACTIVE TEXTILE DRESSING MATERIALS FROM DIBUTYRYLCHITIN STIMULATING WOUND HEALING

Abstract: Tests of these DBC dressing materials under clinical conditions were done and proved the excellent results of DBC-based dressing materials for the ordered healing of tissues and wounds. From the clinical tests, it was clearly observed that the DBC dressing materials were absorbed into the fresh tissue formed during the healing process of the wounds. The obtained results proved the importance of the O-substitution of the hydroxyl groups present in chitin, not only for the solubility of the derivatives and the mechanical properties of the produced fibres, but still more important for the biological properties of these ester derivatives of chitin containing butyric acid. The mechanical properties of DBC were further optimized by blending it with poly(ϵ -caprolactone). Good transparent and flexible products, such as films, with a high elongation to break were obtained by blending 10 to 20wt% of poly(ϵ -caprolactone) with DBC. This creates new possible bioactive applications for DBC or poly(ϵ -caprolactone).

Keywords: Chitin, biomedical properties, mechanical properties, blends

1. INTRODUCTION

Chitin, the natural most abundant polysaccharide containing nitrogen, undergoes degradation by enzymes, induces human cells to promote the restoration of wounds, enhance and enhances the healing process of wounds and has high permeability for substances of medium molar masses in serum [1-2]. The first investigations of biological properties of DBC materials, carried out in vitro and in vivo in accordance with the European standards EN ISO 10993 ("Biological evaluation of medical devices"), showed good biocompatibility of DBC and his ability to accelerate wound healing [3]. Chitin might be an ideal raw material for bioactive dressing materials, but due to its low solubility can be only hardly converted into useful forms like films, fibre or non-woven matrices. The first clinical investigations into medical properties of DBC have been carried out at the Polish Mother's Health Institute in Łódź, Poland. Results of their clinical investigations were presented on the 6th International Conference of the European Chitin Society and published.

2. MATERIAL AND METHOD

2.1. Preparation of Dibutrylchitin (DBC) and DBC Characteristics

DBC as a raw material used for manufacturing of non-woven dressing materials was prepared from shrimp chitin. Shrimp shell chitin powder with particle size of 200 mesh and viscosity average molar mass $M_v = 454,6 \times 10^3$ g/mol was delivered by FRANCE CHITIN, Marseille, France.

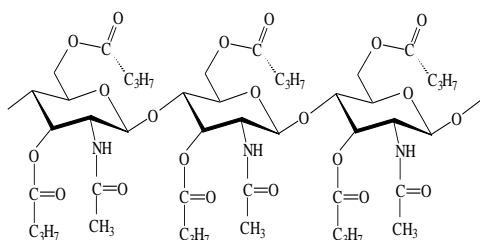


Figure 1. Dibutrylchitin (DBC): chemical structure after complete o-butyrylation (degree of substitution = 2)

2.2 Mechanical Properties

The mechanical properties were measured on films cast from an acetone solution. The elasticity modulus, elongation and maximum stress were obtained from the tensile stress-strain data on the films using an Instron 3369 tensile tester. The product TUL-DBC was the DBC with an average molecular weight M_w of $153 \cdot 10^3$ g/mol and UGT-DBC the DBC with an average molecular weight M_w of $456 \cdot 10^3$ g/mol.

2.3. Preparation Of Dibutrylchitin Fibres

Wet spinning of DBC fibres was made at the Institute of Chemical Fibres, Łódź, Poland, on an apparatus commonly used for preparation of rayon fibres. Dopes containing 15 % of DBC from krill chitin in dimethylformamide or 12 % of DBC from shrimp chitin in dimethylsulphoxide were added to

the reservoir of the spinning system and extruded through a spinneret (300 holes, 80 µm diameter of the hole) to a coagulation bath. The filaments were coagulated in water, drawn in hot water, collected on rollers with a rate of 40 m/min and dried. Properties of DBC fibres are given in Table 1.

Table 1. Properties of DBC fibres

DIBUTYRYLCHITIN FIBRE						
Fibre's symbol	dtex	Solvent	Tenacity (cN/tex)	Loop (cN/tex)	Elongation at break (%)	Max. Elongation (loop; %)
8 E/1	3.3	Ethanol	6.5	2.9	4.8	2.1
22/3	2.1	DMF	15.7	3.1	6.2	2.3
35/1	2.8	N-MP	13.0	2.2	9.4	3.4
68	2.9	DMSO	11.2	3.5	12.6	2.6

3. RESULTS AND DISCUSSION

The surgical staff of the Department of Pediatric Surgery was provided with a number of DBC petals for medical application. The first group of patients, composed of 10 persons, suffered from burns. The total area of thermal burns of patients changed within the range of 5-20%. The depth of burns was classified in each case as 2a. All the burns healed up within 1 – 2 weeks after DBC petal application. The healing processes are documented. The result of the healing process was very good.

4. CONCLUSION

As far as thermal burn patients are concerned, in all cases DBC dressings have been applied to the clean wound and not removed till the end of the healing process, while DBC has been disintegrated in the area of the wound. No other medical products have been applied for the wound healing. The presented observations are preliminary and further evaluation is necessary. Summarising, it is possible to conclude from the preliminary results of DBC application that DBC seems to promote wounds' healing. Further randomised trials with referential groups should be completed to obtain evidence-based proofs of beneficial effects of DBC wound dressings.

Blending DBC with PCL gave very good flexible products, with a good value of elasticity modulus, a high elongation to break and a good transparency for films containing between 10 and 20wt% PCL.

REFERENCES

1. Oshimoma Y, Nishino K, Yonekura Y., Kishimoto S., Wakabayashi S.: Clinical application of chitin non-woven fabric as wound dressings. 1987. *Eur J Plast Surg* v. 10, 66-69.
2. Muzzarelli R.A.A.: In vivo biochemical significance of chitin-based medical items in *Polymeric Biomaterials*, 1993. S. Dimitriu (ed.), Marcel Dekker, Inc., N.Y., 179-197.
3. Szosland L., Cisło R., Krucińska I., Paluch D., Staniszevska-Kuś J., Pielka S., Solski L., Żywicka B. : Dressings made from dibutrylchitin and chitin accelerating wound healing. 2002. *Proceedings of International Conference MEDTEX'2002*, Łódź, Poland.