Collagen and elastin hydrolysates hydrogels cross-linked by dialdehyde starch and pectin

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Plan of presentation

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- Collagen,
- Elastin,
- Cross-linking agents,
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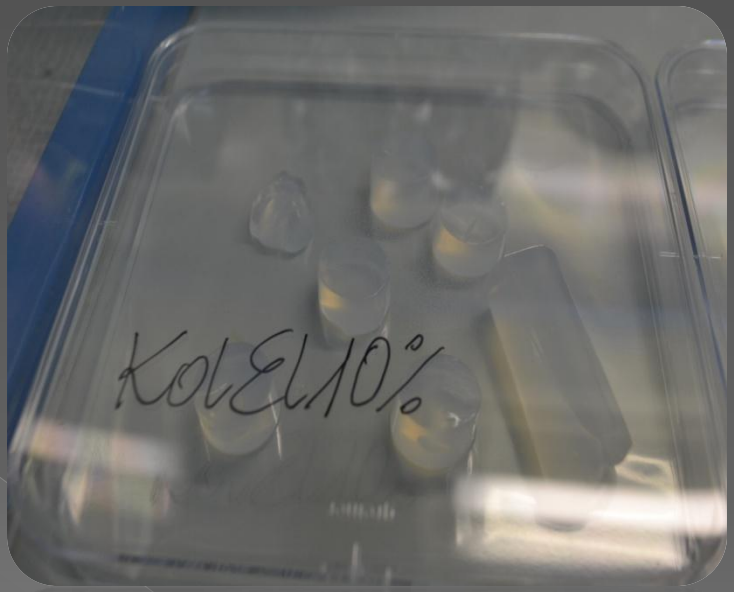
- Mechanical properties,
- Scanning Electron Microscopy,
- Summary.



Introduction

For several years three-dimensional porous scaffolds have been extensively investigated as a matrices for tissue engineering. Their task is to replace the extracellular matrix, provide mechanical support and a biological environment for cells and newly formed tissue. Collagen and elastin, as the proteins of extracellular matrix, are the most valuable materials for tissue engineering.

Pictures source:
http://laboratoria.net/img/istock/badania.jpg?1369809391370?1369809391370

Collagen

Collagen is the main structural protein of the various connective tissues in mammals. Collagen, in the form of elongated fibrils, is mostly found in fibrous tissues such as tendons, ligaments and skin. The amino acid composition of collagen is unusual for proteins, mostly because of its high hydroxyproline content.

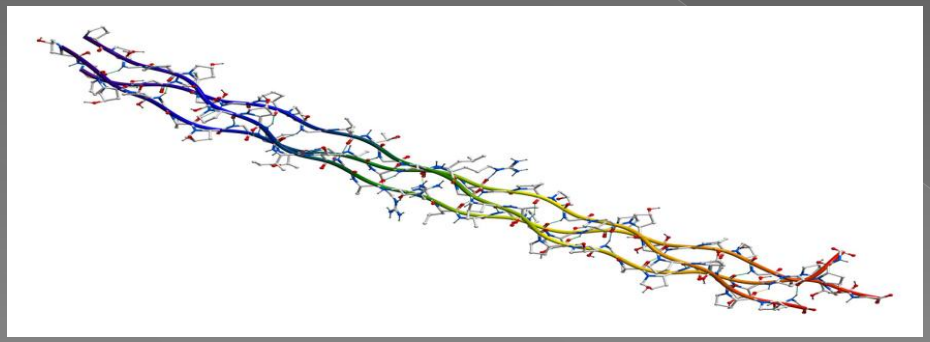


Fig. 1 Structure of collagen

Pictures source:
http://www.collagenplus.pl/wpcontent/uploads/2014/02/kolagen-b.jpg

Elastin

Elastin is a protein which can be mostly found in connective tissues. It is elastic and allows many tissues in the body to resume their shape after stretching or contracting. The chemical composition of elastin is also unusual for proteins, because of desmosine and isodesmosine content.

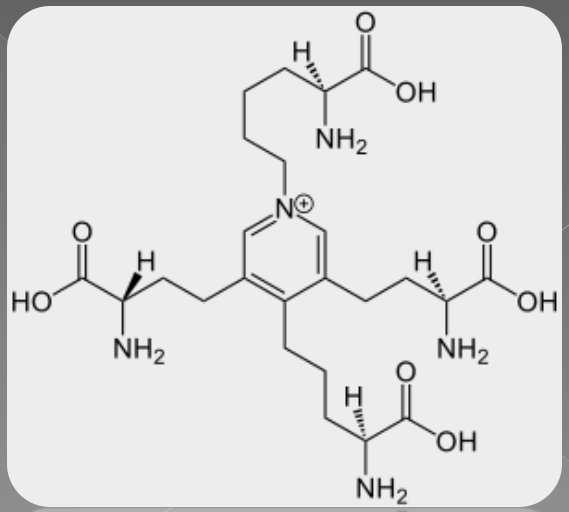


Fig. 2 Structure of desmosine

Cross-linking process

Cross-linking process of the materials was designed to improve its properties, like mechanical strength, porosity and susceptibility to degradation. The aim of our study was to investigate the influence of dialdehyde starch and pectin on the properties of collagen/elastin hydrogels.

Dialdehyde starch and pectin

Dialdehyde starch is a polysaccharide obtained by chemical modification of natural starch. It is prepared by periodate oxidation of starch.

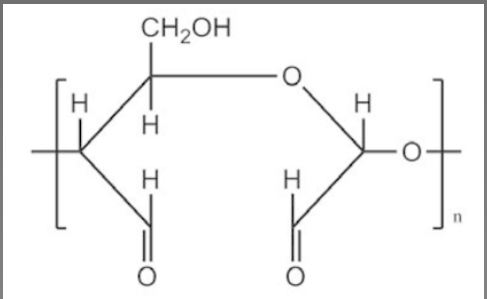


Fig. 3 Fragment of structure dialdehyde starch

Pectin is a complex polysaccharide consisting mainly of

D-galacturonic acid residues esterified with methyl groups.

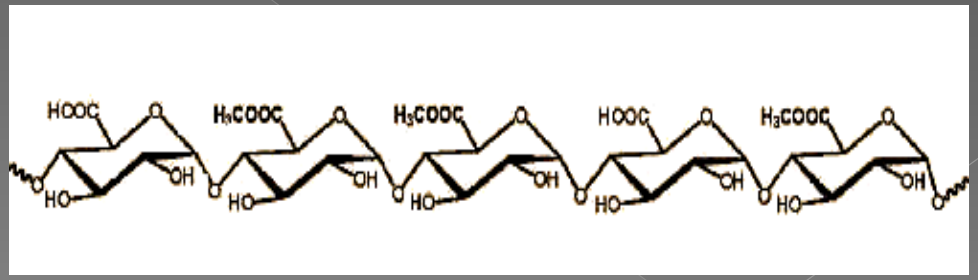


Fig. 4 Fragment of structure pectin

Methods

Collagen was obtained from rat tail tendons. Elastin hydrolysates were isolated from porcine aorta. 1% solution of collagen in 0.1 M acetic acid and 1% solution of elastin hydrolysates in water were prepared. Mixtures of the proteins were prepared in different volume ratios (Coll 100%; Coll 95%-El 5%; Coll 90%-El10%) and were cross-linked with dialdehyde starch and pectin. After that, a dialysis against deionised water was performed.

Mechanical properties

The obtained materials were mechanically tested using Zwick&Roell Z 0.5 machine. The pieces of hydrogels (D=16mm, h=10mm) were placed on the bottom disk and pushed by a steel rod with speed 10mm/min.

Compression modulus of collagen and elastin hydrolysates gels with cross-linked agent: dialdehyde starch and pectin

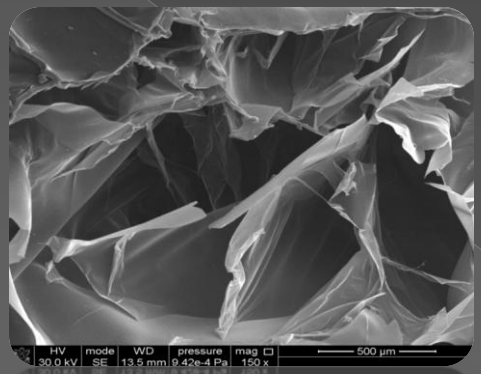
Sample	E [kPa]
Coll	0,48±0,06
CollDS5%	0,45±0,04
CollDS10%	0,34±0,04
CollP5%	0,32±0,02
CollP10%	-

Sample	E [kPa]
CollEl5%	0,46±0,06
CollEl5%DS5%	0,44±0,09
CollEl5%DS10%	0,57±0,05
CollEl5%P5%	0,46±0,06
CollEl5%P10%	0,23±0,03

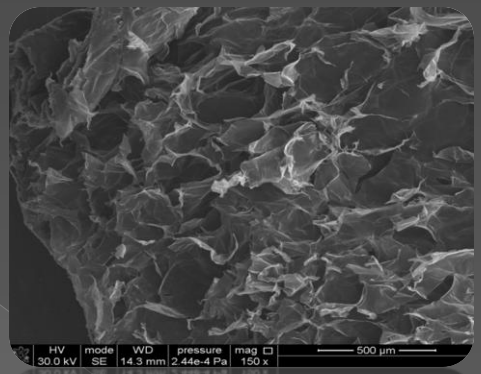
Sample	E [kPa]
CollEl10%	0,44±0,10
CollEl10%DS5%	0,59±0,10
CollEl10%DS10%	0,62±0,07
CollEl10%P5%	0,46±0,05
CollEl10%P10%	0,25±0,05

The sample CollP10% was not stiff enough to analyse. The higher content of elastin hydrolysates causes decrease of compression modulus of the gels. Cross-linking using dialdehyde starch lead to higher stiffness of the gels, while the samples containing pectin are less resistant to compression.

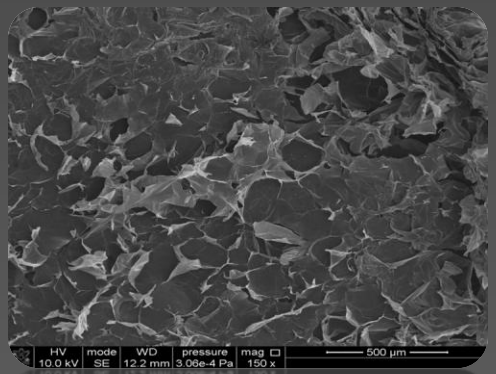
Scanning Electron Microscopy



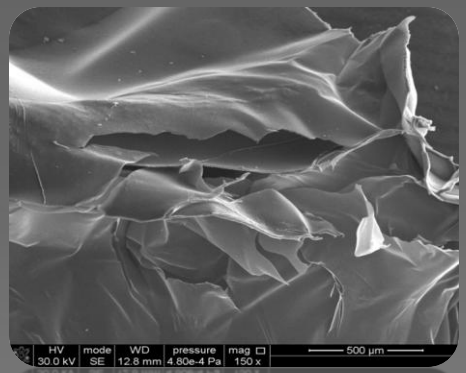
a) CollDS5%



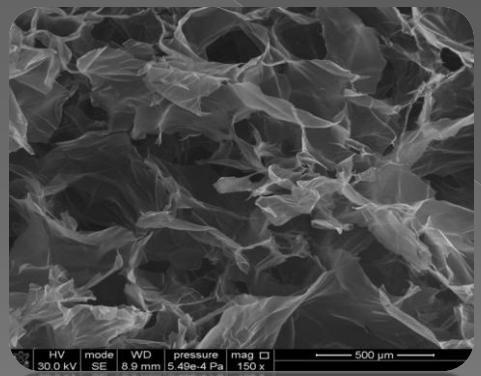
c) CollEl5%DS5%



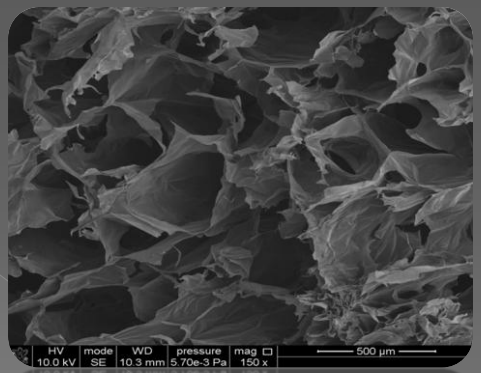
e) CollEl10%S5%



b) CollP5%



d) CollEl5%P5%



f) CollEl10%P5%

The lyophilized gels exhibit porous structure in SEM images. The various size of pores is observed. It is affected by the amount of elastin hydrolysates and also the type of cross-linked agent.

Summary

The addition of dialdehyde starch and pectin causes formation of cross-linking bonds in the collagen/elastin materials and the transparent, hydrogels are obtained. However, the gels containing dialdehyde starch are much stiffer than materials with pectin. Also the porous structure is modified by cross-linking process. The results show that dialdehyde starch is more suitable cross-linking agent for protein materials.

Acknowledgments

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Thank you for your attention