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Comparison of the Stress Analysis To Obtain The Tensile Properties of Three Type-1 and Type-3 Collagen Membranes

Introduction

The treatment of sequelae caused by destruction of the periodontal structure resulting from periodontal disease, especially the treatment of alveolar bone defects, known as guided bone regeneration (GBR), is generally aimed at restoring the periodontal insertion apparatus, with the possibility of structural support of membranes and/or barrier, and has been widely studied, according to Raz et al., 2019. Depending on the reaction to their biological environment, membranes can be grouped into two types: resorbable membranes, which, due to biological degradation, induce a tissue response that can negatively affect wound healing and complicate regeneration; and non- resorbable membranes, which have proven to be effective in preventing the invasion of connective and epithelial tissue in the healing area, according to the analysis by Bouguezzi et al., 2020. Resorbable membranes have great potential for application in periodontal and peri-implant regeneration. Studies proposed by Chu et al., 2016. indicate collagen as the principal extracellular component involved in processes, including cell migration and differentiation. Collagen membranes have many specific characteristics.

Materials and Methods

The sample was sent to and analyzed at the AFINKO laboratory in São Carlos- SP, Brazil, filed under record number AFK223047, as shown in Table 1 and Figure 1:

AFK235443	Lumina Dermal - Critéria Biomateriais
AFK235440	Bioguide - Geistlich Pharma
AFK235437	Jason - Straumann

Table 1: Identification and record of collagen membrane samples

Purpose

Evaluate the mechanical tensile strength for control and specification of three collagen membranes, cross-linked and non-cross-linked, as well as their stress– strain curve.



Figure 1: Sample of the Bioguide - Geistlich Pharma membrane, for the laboratory analysis
Figure 2: Sample of the Lumina Dermal - Criteria Biomateriais membrane, for laboratory analysis.
Figure 3: Sample of the Jason - Straumann membrane, for laboratory analysis.

Tensile Test

This test is used to acquire tensile property data for material control and specification, as well as for qualitative characterization and for the purposes of research and development. Tensile properties are rather susceptible to sample preparation and testing conditions, such as speed, temperature and humidity in some cases; the results are shown in Table 2.

Membrane	Quantity	Width	Thickness	Load	Speed
Lumina Dermal	3	19.03 ± 0.44mm	0.22 ± 0.04mm	500 N	5mm/min
Bioguide	3	25.23 ± 0.42mm	0.52 ± 0.12mm	500 N	5mm/min
Jason	3	20.27 ±0.29mm	0.15 ± 0.02mm	500 N	5mm/min

Table 2: Tensile test conditions at 23.8 °C with 46% humidity and 12 mm distance from the grips.

Results

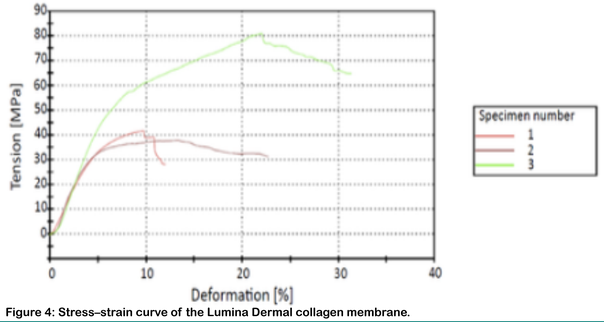


Figure 4: Stress–strain curve of the Lumina Dermal collagen membrane.

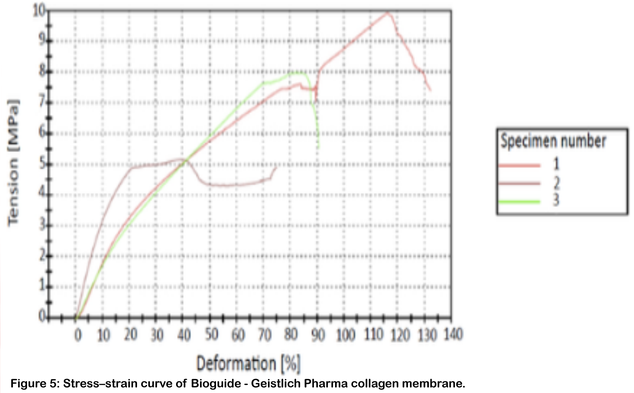


Figure 5: Stress–strain curve of Bioguide - Geistlich Pharma collagen membrane.

Membrane	Sample	Elastic modulus (GPa)	Breaking stress (MPa)	Breaking strain	Maximum load (N)
	1	0.39	41.76	9.78	234.92
Lumina Dermal	2	0.21	37.78	13.54	132.03
	3	0.30	80.96	21.95	285.81
	1	0.02	9.83	117.49	106.27
Bioguide	2	0.04	4.90	74.77	61.82
	3	0.02	7.96	84.72	136.50
	1	0.19	13.54	22.07	35.09
Jason	2	0.22	33.64	32.46	116.05
	3	0.16	21.27	29.52	67.18

Table 3: Results of the collagen membrane tensile test (mean and standard deviation).

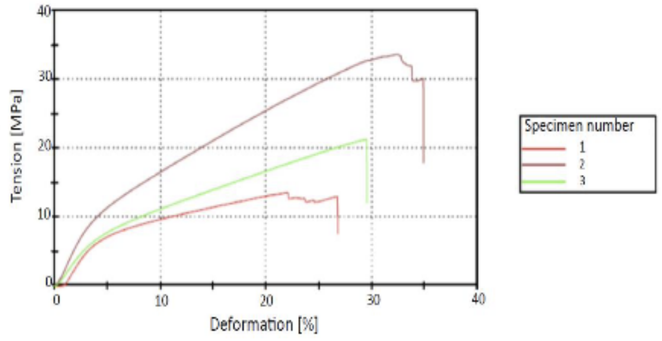


Figure 6: Stress–strain curve of the Jason - Straumann collagen membrane.

Membrane	Quantity	Elastic modulus (GPa)	Breaking stress (MPa)	Breaking strain (%)	Maximum load (N)
Lumina Dermal	3	0.30 ± 0.09	53.50 ± 23.87	15.09 ± 6.23	217.58 ± 63.34
Bioguide	3	0.02 ± 0.01	7.57 ± 2.49	92.33 ± 22.35	101.53 ± 37.57
Jason	3	0.19 ± 0.03	22.82 ± 10.14	28.01 ± 5.35	73.04 ± 40.40

Table 4: Summary of the results obtained after the collagen membrane tensile test.

Conclusion

When assessing the physical stress and tensile properties of the three membranes, one can see high levels of mechanical strength, mainly in the Lumina Dermal membrane manufactured by Criteria Biomateriais, which presents higher rates based on the methodologies and tests applied, mainly when compared to other samples.

References

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