PREPARATION AND INVESTIGATION OF FILMS FROM PDMS AND SORBITOL MODIFIED POLYESTERS

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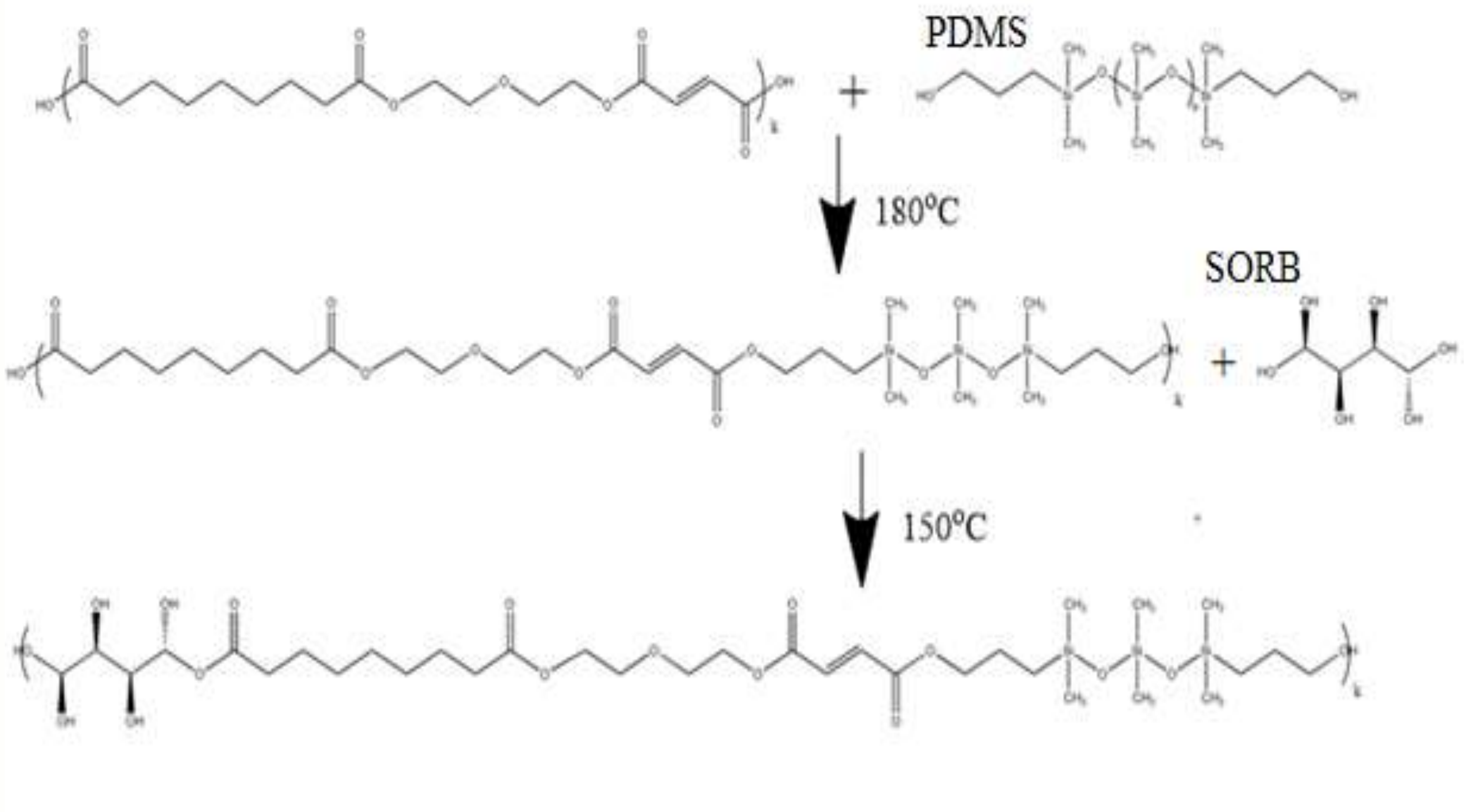
Introduction

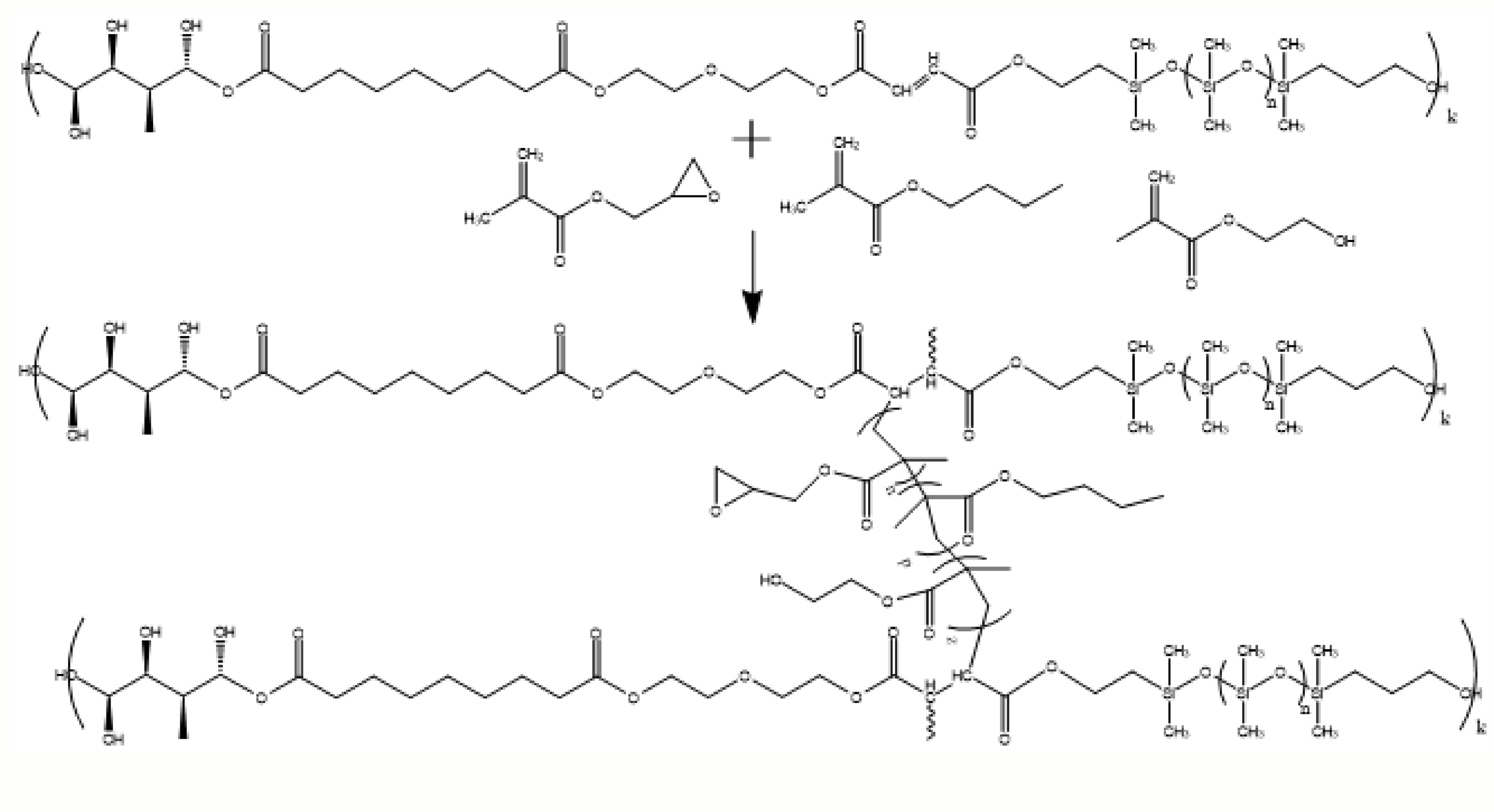
Tissue engineering as stated by Langer and Vacanti is an interdisciplinary field that applies the principles of engineering and the life sciences to the development of biological substitutes that restore, maintain or improve the function of biological tissue or the whole organ. One of the most important goals is to create a scafold in which cells can live and multiply. Polyesters modified with various materials are used to make the scafolds. Polydimethyloxane (PDMS) is an inorganic polymer that, due to its good properties, is widely used in all fields of engineering. It is characterized by chemical stability, thermal resistance, optical transparency, gas permeability, oxidation resistance, low toxicity, and biocompatibility [1]. However, PDMS has a hydrophobicity that limits its use and therefore it can be modified. Sorbitol is a monomer derived from renewable sources and is readily available today. Sorbitol has suitable properties for tissue engineering [2]. The aim of this work was to use sorbitol and PDMS to modify unsaturated polyesters and to evaluate their effect on the resulting films.

Materials and methods

In this work, unsaturated polyesters were synthesized from azelaic acid (AA), maleic acid anhydride (MA), diethylene glycol (DEG), PDMS and sorbitol (SORB) (Scheme 1). The structure of polyesters was confirmed by FT-IR and ^{1}H NMR. Glycidyl methacrylate (GMA), butyl methacrylate (BMA) and 2-hydroxyethyl methacrylate (HEMA) were attached to obtained polyesters to form UV curable films (Scheme 2).



Scheme 1. Polyester synthesis and modification



Scheme 2. Polyester curing with GMA, BMA and HEMA

Results

Mechanical properties

Table 1. Results of mechanical testing of films

Films	[GMA]:[BMA]	X_R, %	σ_R, MPa	E, MPa
[MA]:[AA]:[DEG]:[SORB]:[PDMS]= 0.5:0.5:0.8:0.2:0.1	1:1	44	0,43	112
[MA]:[AA]:[DEG]:[SORB]:[PDMS]= 0.5:0.5:0.8:0.2:0.1	2:1	57	1,10	160
[MA]:[AA]:[DEG]:[SORB]:[PDMS]= 0.5:0.5:0.7:0.3:0.1	1:1	116	0,03	20
[MA]:[AA]:[DEG]:[SORB]:[PDMS]= 0.5:0.5:0.7:0.3:0.1	2:1	149	0,15	10
[MA]:[AA]:[DEG]:[SORB]:[PDMS]= 0.5:0.5:0.6:0.4:0.1	1:1	106	0,25	52
[MA]:[AA]:[DEG]:[SORB]:[PDMS]= 0.5:0.5:0.6:0.4:0.1	2:1	170	0,13	20

The higher relative elongation at break, but the lower Young's modulus of films were obtained when higher amount of sorbitol was used for synthesis of polyesters (Table 1).

Si analysis

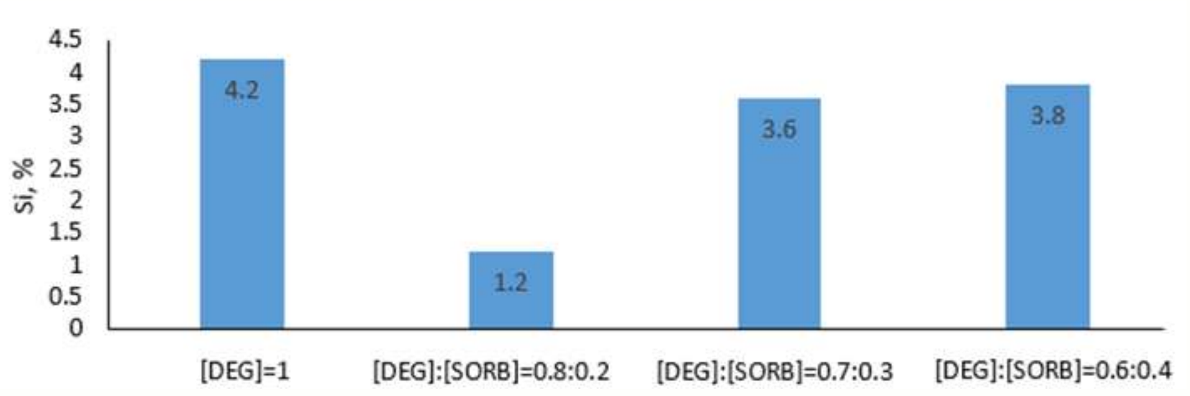


Fig 4. Dependence of Si content in films on film composition ([GMA]: [BMA] = 1: 1)

The data obtained showed that the increase in sorbitol content in the films slightly decreased the Si content. It was about 4.2 % in the sorbitol-free film. In other films, its content ranged from 1.2 % to 3.8 % (Fig. 4).

Solubility and swelling degree

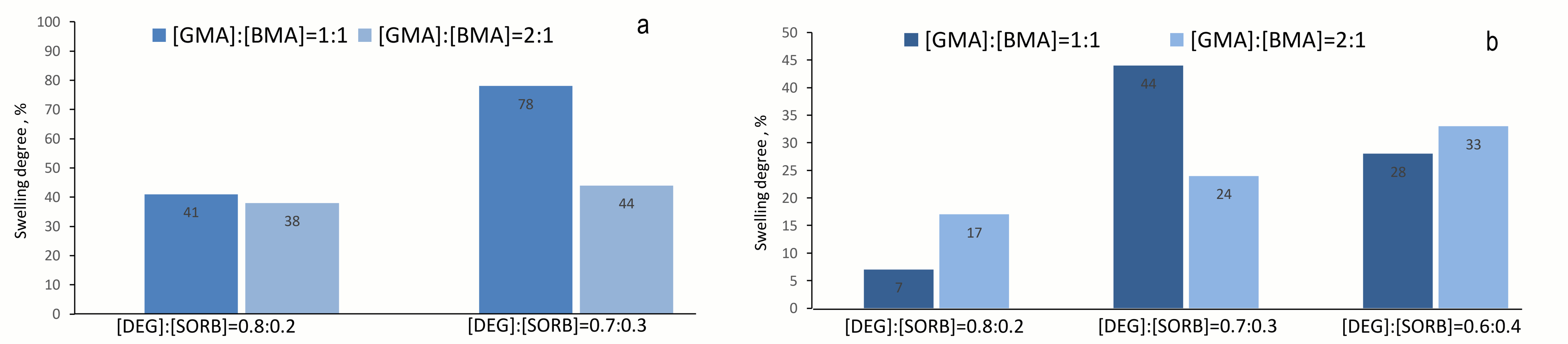
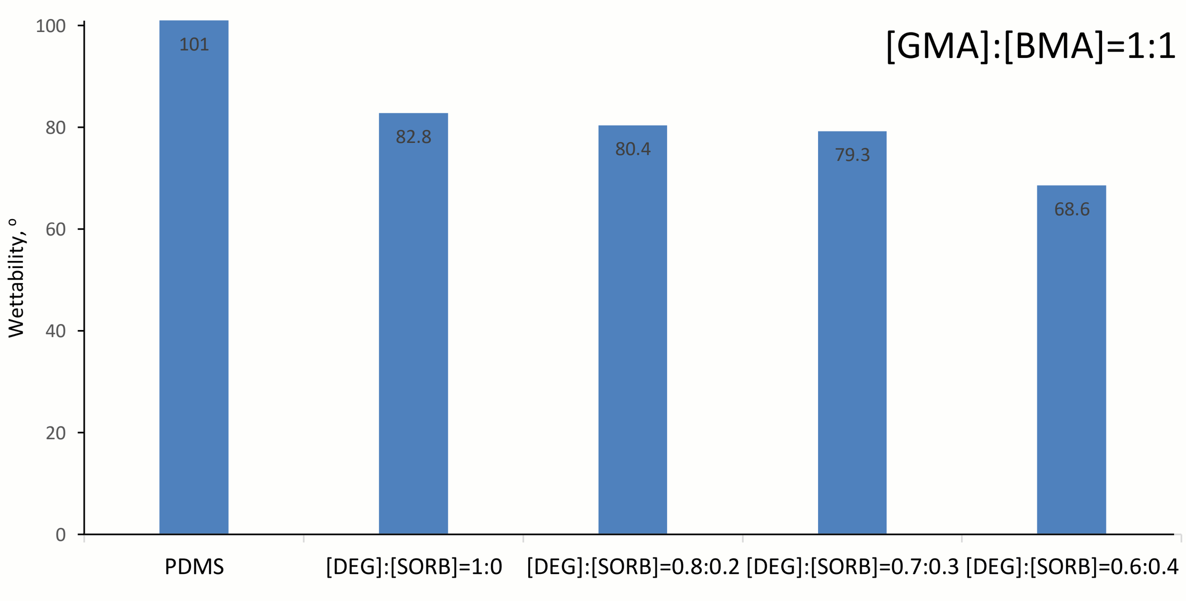


Fig 1. Swelling degree of films in ethanol (a) and water (b)

The films were smooth and transparent. The cured films were soaked in hexane, ethanol, and water. The swelling and solubility of films were evaluated prior to testing their properties (Fig. 1). The solubility in water and ethanol increased, when more SORB was used.

Wettability



As the sorbitol content increased, the films became more hydrophilic and the contact angle decreased (Fig. 2 and 3). Compared to commercial PDMS, all produced films showed a higher hydrophilicity.

Fig 2. Dependence of film wetting angles on the molar ratio of DEG and SORB used for polyester synthesis

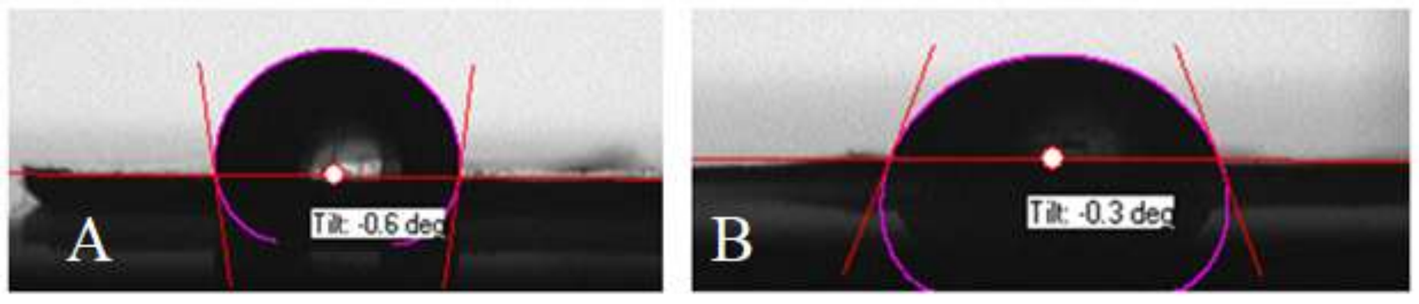


Fig 3. Wetting angles between the films and the sprayed water, when [MA]:[AA]:[DEG]:[SORB]:[PDMS] was 0.6:0.4:1:0:0.1 (A (94.5°)) or 0.5:0.5:0.6:0.4:0.1 (B (70.1°))

Conclusion

The wetting angles of films obtained from unsaturated polyesters modified with PDMS and sorbitol were lower than films obtained from PDMS or unmodified polyesters. The more sorbitol, the more hydrophilic films were obtained. The best properties of films were obtained when [MA]:[AA]:[DEG]:[SORB]:[PDMS] = 0.5:0.5:0.8:0.2:0.1 and [GMA]:[BMA] = 1:1 or 2:1. They were strong, smooth and transparent, sparingly soluble in solvents.

References

1. H. Zhang and M. Chiao. J. Med. Biol. Eng. 38, 2015, p. 143–155.
2. V. Kavimani and V. Jaisankar. J. Phys. Sci. Appl. India. 4, 2014, p. 507–515.