Thermo-responsive and bioadhesive gels containing biodegradable polymeric nanoparticles for oral care cosmetics

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Introduction

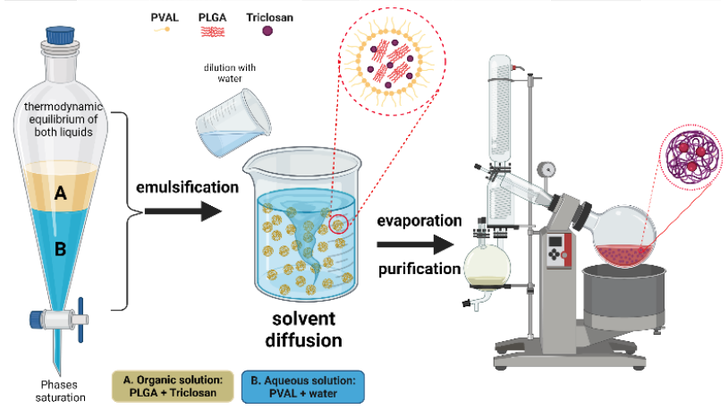
In the last decades, several cosmetic companies have invested in the development of nanotechnology-based products for hair, skin, teeth, lips, and nail care. In this study, the use of gels containing polymeric biodegradable nanoparticles loaded with a non-ionic antimicrobial agent as an oral hygiene product was proposed [1-2]. Triclosan (2,4,4'-trichloro-2'-hydroxydiphenyl ether) is a broad-spectrum antibacterial and antifungal agent, extensively used in many personal hygiene products including toothpaste, antibacterial soaps (bar and liquid), and deodorants (bar and liquid) [3-4]. Two different kinds of gels were evaluated, bioadhesive gels from Carbomer homopolymer Type B USP NF and thermo-responsive gels from Poloxamer 407. The effect of the polymer concentration on the physical and mechanical properties of the obtained gels was evaluated.

Materials & Methods:

Preparation of nanoparticles

Emulsification-diffusion method

Batch number	Polymer	Solvent	Triclosan [mg]	PLGA [mg]	Initial Triclosan Content [%]	Volume of saturated solvent [mL]	Volume of 0.5% PVAL solution [mL]	Distilled water [mL]
1	PLGA	Ethyl acetate	120	400	23.07	20	40	160
2	PLGA	Ethyl acetate	200	400	33.33	20	40	160

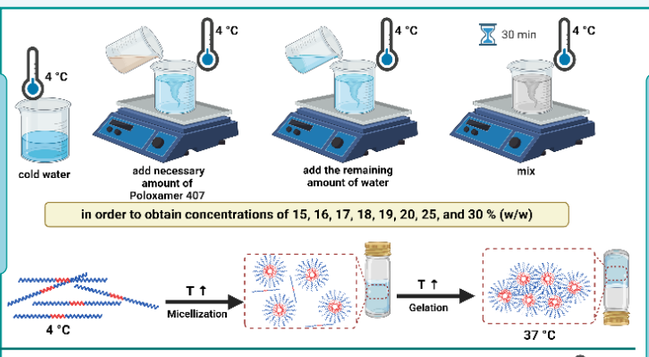


Characterization

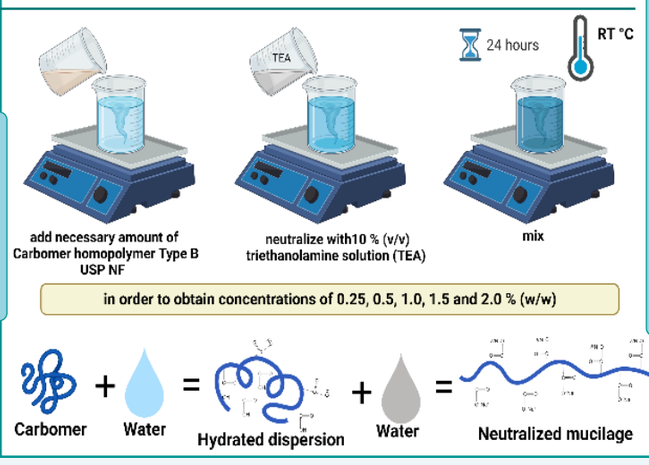
- Solid state properties
- Mean size
- Polydispersity index
- Zeta potential
- Residual stabilizer
- Entrapment efficiency (EE)
- Drug Loading (DL)
- Triclosan release profile (dialysis bag procedure).

Preparation of gels

Poloxamer

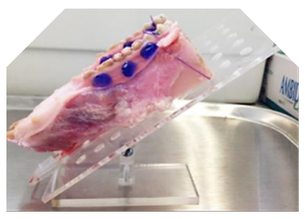


Carbomer



Characterization

- ✓ Sensory evaluation (color, transparency, appearance, odor, texture, and consistency)
- ✓ Spreadability (measuring the spreading diameter)
- ✓ Sol-gel transition temperature
- ✓ Viscosity (25 and 37 °C; viscosimeter Brookfield® LVDV-E)
- ✓ Bioadhesive properties (using gingival tissue sections; Texture Analyzer CT3 (Brookfield®)
- ✓ Residence time (using pig mandible: directly on the gingiva; Nakamura method)



Results & Discussion:

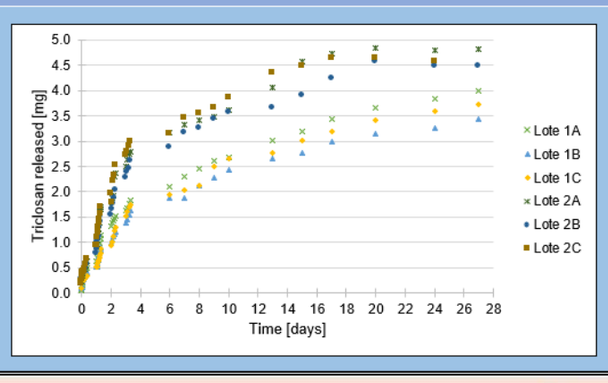
Table 1. Properties of triclosan-loaded nanoparticles.

The emulsification–diffusion technique allowed the preparation of polymeric submicron particles.

Physicochemical Properties	Batch number	Sample	Mean diameter size [nm]	Polidispersity Index	Zeta Potential (mV)	Residual PVAL (%)	DL (%)	EE (%)
	1	1a	488.667	0.388	-0.331	0.433	12.597	54.676
		1b	576.533	0.429	-31.933	0.532	12.893	55.959
		1c	595.233	0.474	-0.066	0.554	12.611	54.736
		1d	-	-	-	-	11.809	51.255
		1e	-	-	-	-	11.395	49.458
		1f	-	-	-	-	12.683	55.050
		Average	**553.478**			**0.506**	**12.331**	**55.123**
		Standard Deviation	**±66.347**			**±0.064**	**±0.589**	**±2.559**
	2	1a	489.000	0.182	-15.367	0.659	28.560	84.597
		1b	508.433	0.180	-12.267	0.582	26.711	79.121
		1c	520.700	0.250	-25.067	0.612	29.244	86.622
		1d	-	-	-	-	25.032	74.148
		1e	-	-	-	-	26.006	77.033
		1f	-	-	-	-	22.353	66.212
		Average	**506.044**			**0.618**	**26.318**	**77.956**
		Standard Deviation	**±15.440**			**±0.039**	**±2.498**	**±7.401**

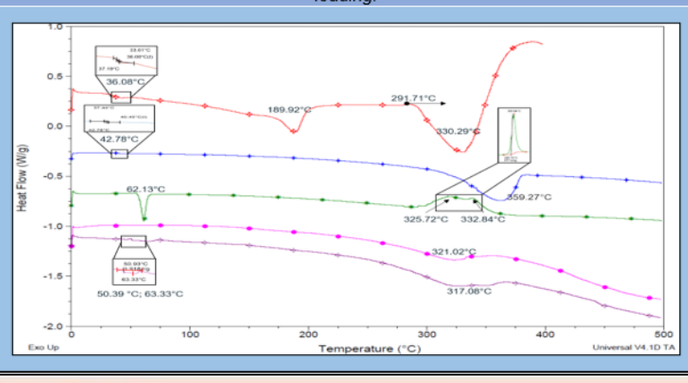
Release profiles

Release profiles of triclosan from several batches of triclosan-loaded nanoparticles

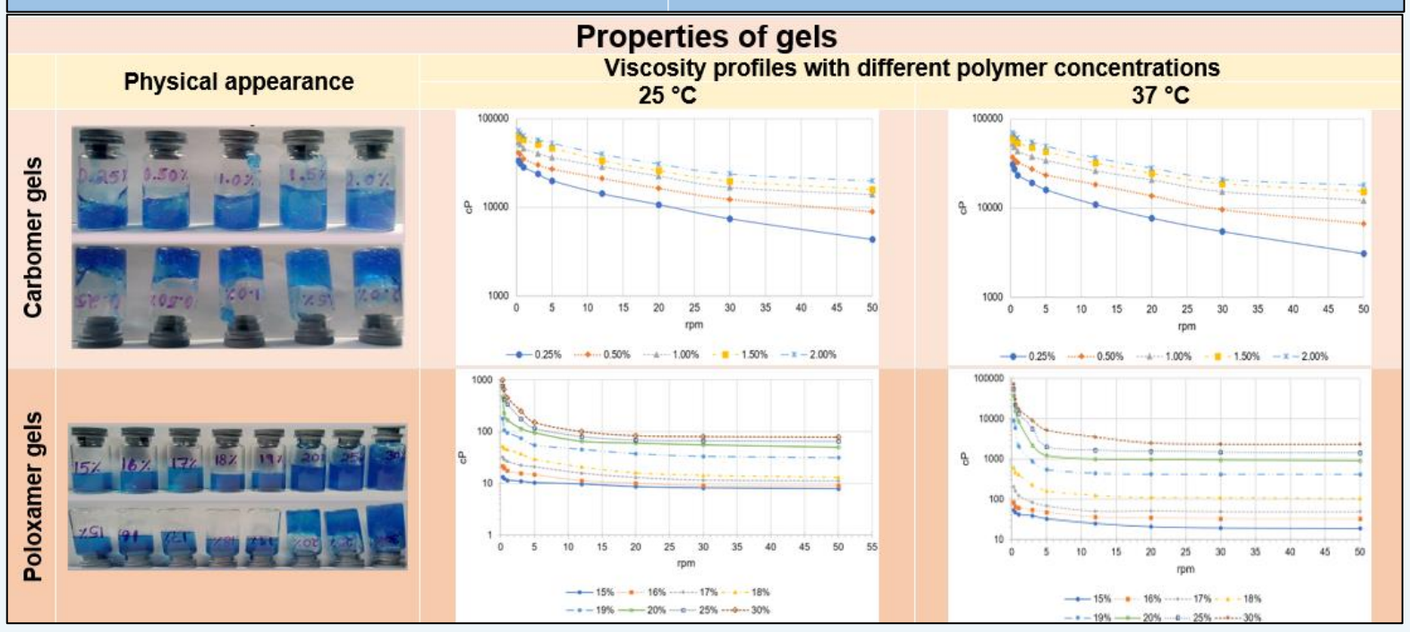


Thermal Analysis

DSC thermograms for the individual components of the triclosan-loaded nanoparticles as well as thermograms for two samples from batches 1 and 2 which have different triclosan loading.



Properties of gels



Conclusions:

Bioadhesive and thermo-responsive gels are useful to carry triclosan-loaded nanoparticles, prolonging their residence time in the oral cavity, thus improving oral hygiene.

The Poloxamer 407 and Carbomer homopolymer Type B USP NF gels evaluated showed interesting characteristics to be used as carriers for biodegradable nanoparticles loaded with triclosan in a formulation for personal care, although the release profiles of the triclosan-loaded PLGA nanoparticles showed a very slow release for triclosan.

Nevertheless, the exhaustive characterization of the gels used offers the possibility that these systems can be used as carriers for triclosan or other active ingredients to help improve personal appearance. Specifically, the performance of carbomer gels at concentrations of 1.0 and 2.0 % and poloxamer at 25% and 30% is extremely interesting.

Aknowledgments:

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