



UNIVERSITÀ DEGLI STUDI
DI MILANO



Physicochemical characterization of F127 hydrogels

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Thermogelling Hydrogels

Composed by:

- Three-dimensional polymeric networks of hydrophilic nature.



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“Smart” hydrogels respond to external stimuli as:

- Temperature
- pH
- Ionic Force
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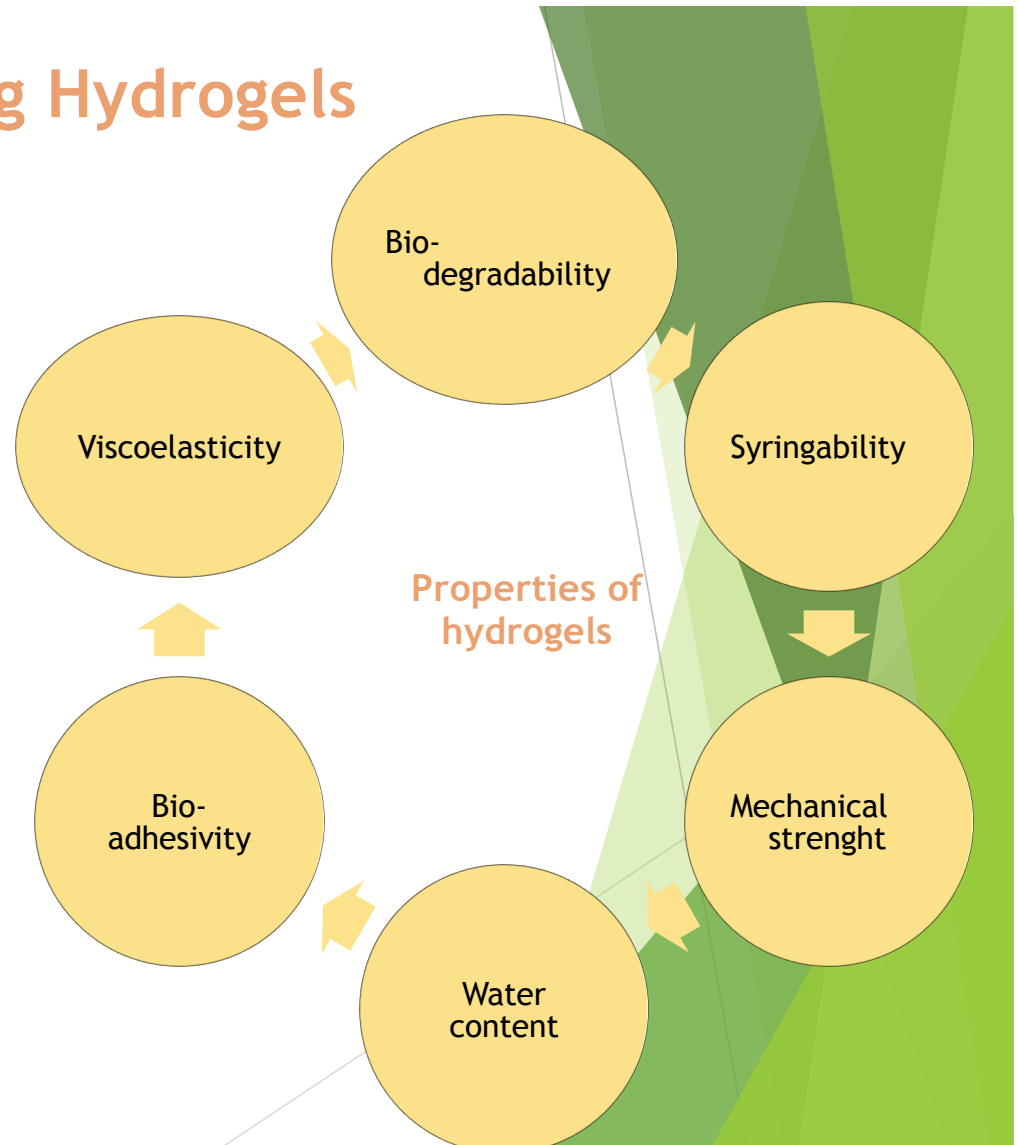
- Three-dimensional polymeric networks of hydrophilic nature.

“Smart” hydrogels respond to external stimuli as:

- Temperature
- pH
- Ionic Force
- Solvent

Application fields:

- Biomedicine
- Cosmetic



Application fields

Drug delivery
systems;

Tissue
engineering;

Cell
encapsulation;


Theranostic
devices;

Cancer device;

Bioinks for 3D
printing.

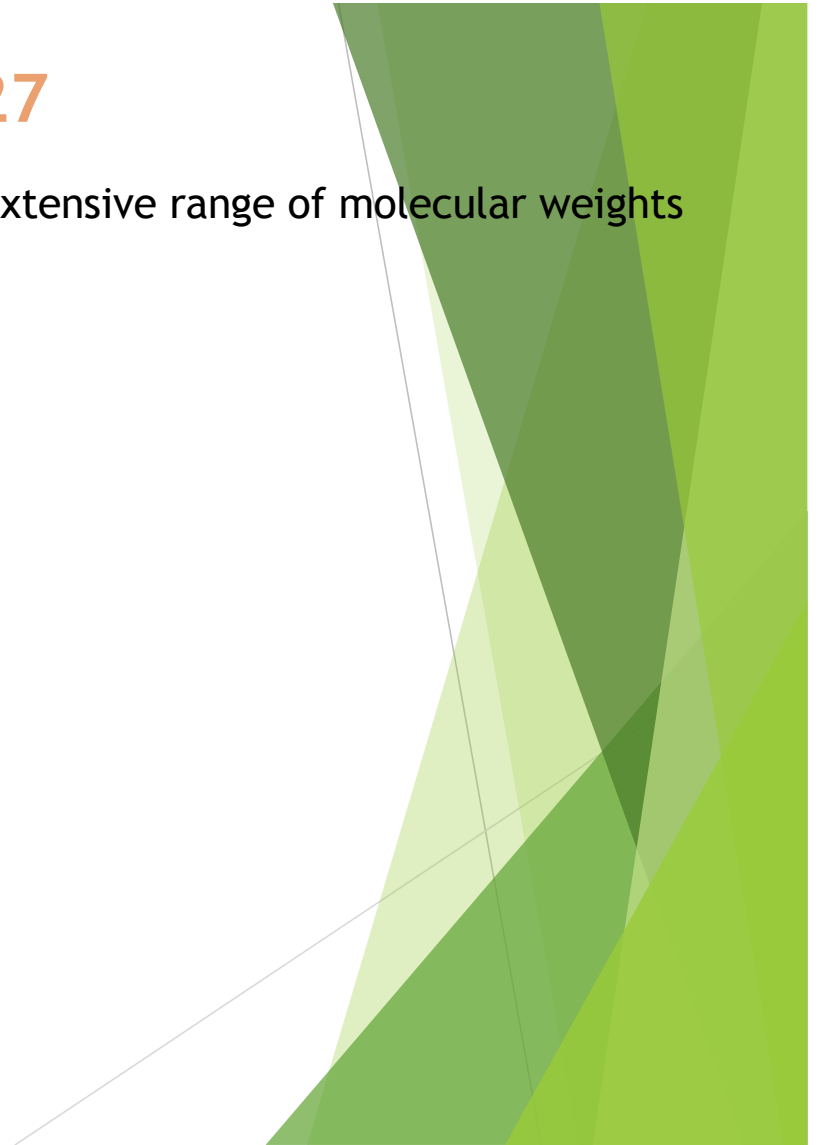


Target

- ▶ Evaluate the changes imparted by different additives to F127 formulations to obtain the most suitable mixture to contain APIs for periodontitis therapy.
- 

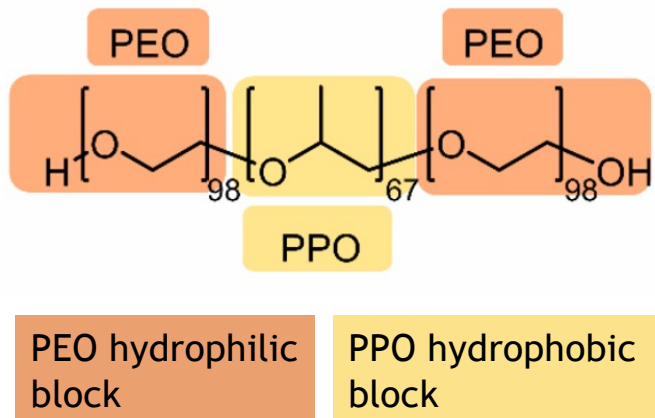
Poloxamer F127

The PEO-PPO-PEO block-copolymers are available in an extensive range of molecular weights and PPO/PEO ratios



Poloxamer F127

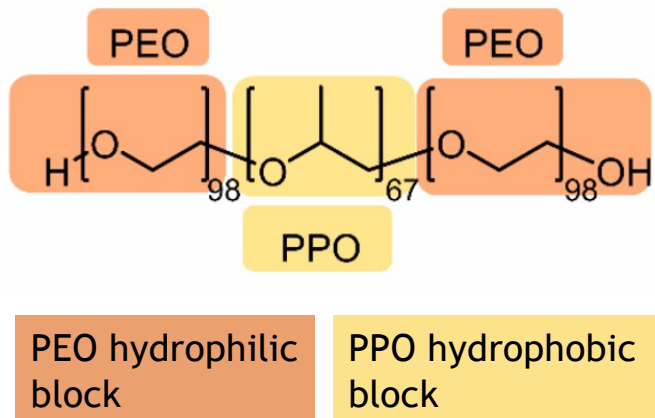
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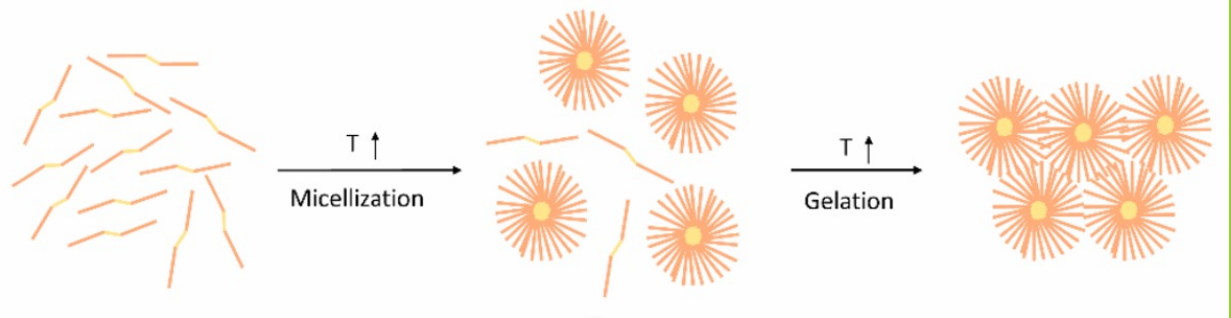
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- By changing the length of PPO/PEO, the total molecular weights and the final properties as the $T_{\text{sol-gel}}$ change.



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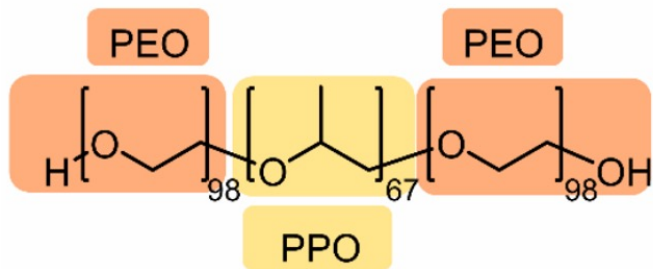
- $25^\circ\text{C} < T_{\text{sol-gel}} < 37^\circ\text{C}$



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PEO hydrophilic
block

PPO hydrophobic
block

Poloxamer F127

- $25^\circ\text{C} < T_{\text{sol-gel}} < 37^\circ\text{C}$

	MW:	% PEO	% PPO	HBL
PEO ₁₀₀ PPO ₆₅ PEO ₁₀₀	12600 Da	75	25	22



Methods used for the characterization of the gels

- pH-evaluation
- Measurement of solution-gel transition temperature ($T_{\text{sol-gel}}$)
- Erosion tests
- Determination of the viscosity
- AFM imaging
- In vitro release studies

F127 and additives

Bulking agents were dissolved in H₂O MilliQ at room temperature than with the "cold method" F127 was solubilize. Using the "inverted tube test," T_{sol-gel} is measured

ID formulation	F127%	Additive %	T _{sol/gel} (°C)	pH
F1	20	-	21.9	7.19
F2	18	-	25.5	7.09
F3	15	-	38.5	7.05
F4	13	-	-*	6.95

* The gelation did not occur in the range 4-50 °C

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F5	18	XG 0.2	22.0	6.45
F6	18	E407 0.2	25.0	6.61
F7	18	HPMC 1	22.5	5.89
F8	18	PVP 4	-*	5.82
F9	18	PVP 4 - HPMC 1	22.0	5.74

- PVP



* The gelation did not occur in the range 4-50 °C



- Carrageenan



F127 and additives

Bulking agents were dissolved in PBS 1x at room temperature than with the "cold method" F127 was solubilize. Using the "inverted tube test," $T_{\text{sol-gel}}$ is measured



ID
formulation

F127%

Additive %

$T_{\text{sol/gel}}$ (°C)

pH

F10

18

-

24.0

7.10

F11

18

XG 0.2

21.5

7.08

F12

18

E407 0.2

23.0

7.01

F13

18

HPMC 0.5

22.0

7.11

F14

18

PVP 4 - HPMC 1

19.5

7.01

- PVP



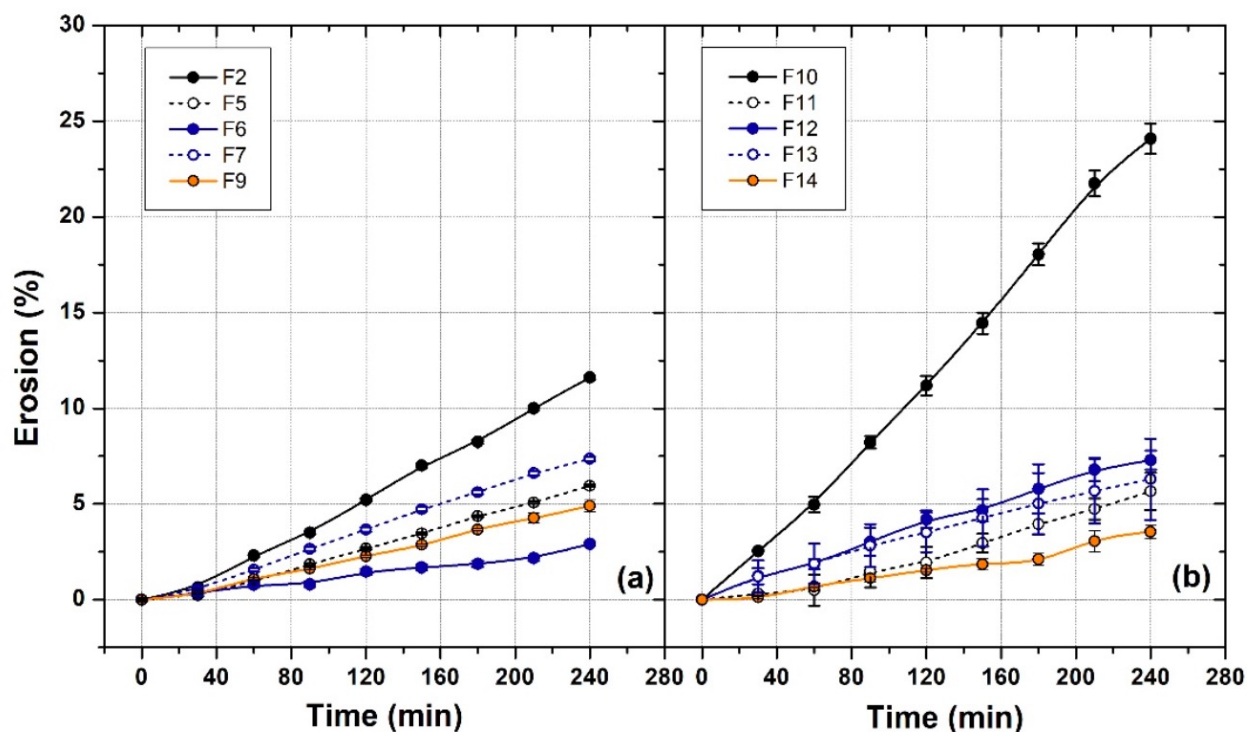
- Carrageenan



Erosion test

Formulations in H₂O MilliQ and PBS 1x were stirred under 37°C and thermostated. Over was distributed 1mL of a saliva-like solution of KH₂PO₄ 0.05 mM; pH 6.75. Every 30 minutes, the weight change is

$$\text{measured. Erosion \%} = \frac{W_i - W_t}{W_i} \times 100$$

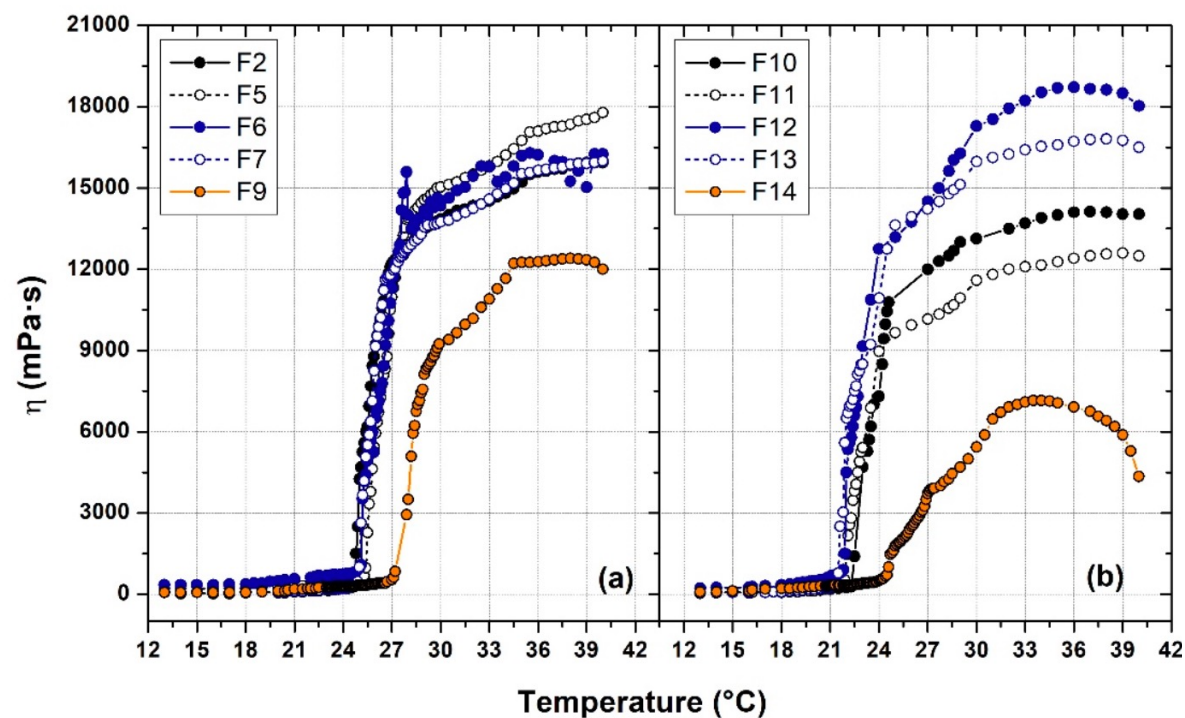


Formulation prepared in water (a) and in PBS 1x (b).

Entry	F127%	Additive %
F2	18	-
F5	18	XG 0.2
F6	18	E407 0.2
F7	18	HPMC 1
F9	18	PVP 4 - HPMC 1
F10	18	-
F11	18	XG 0.2
F12	18	E407 0.2
F13	18	HPMC 0.5
F14	18	PVP 4 - HPMC 1

Determination of viscosity

Test performed with an IKA medium rotational viscometer using a constant stir speed and a temperature ramp ranging from 12-40° C

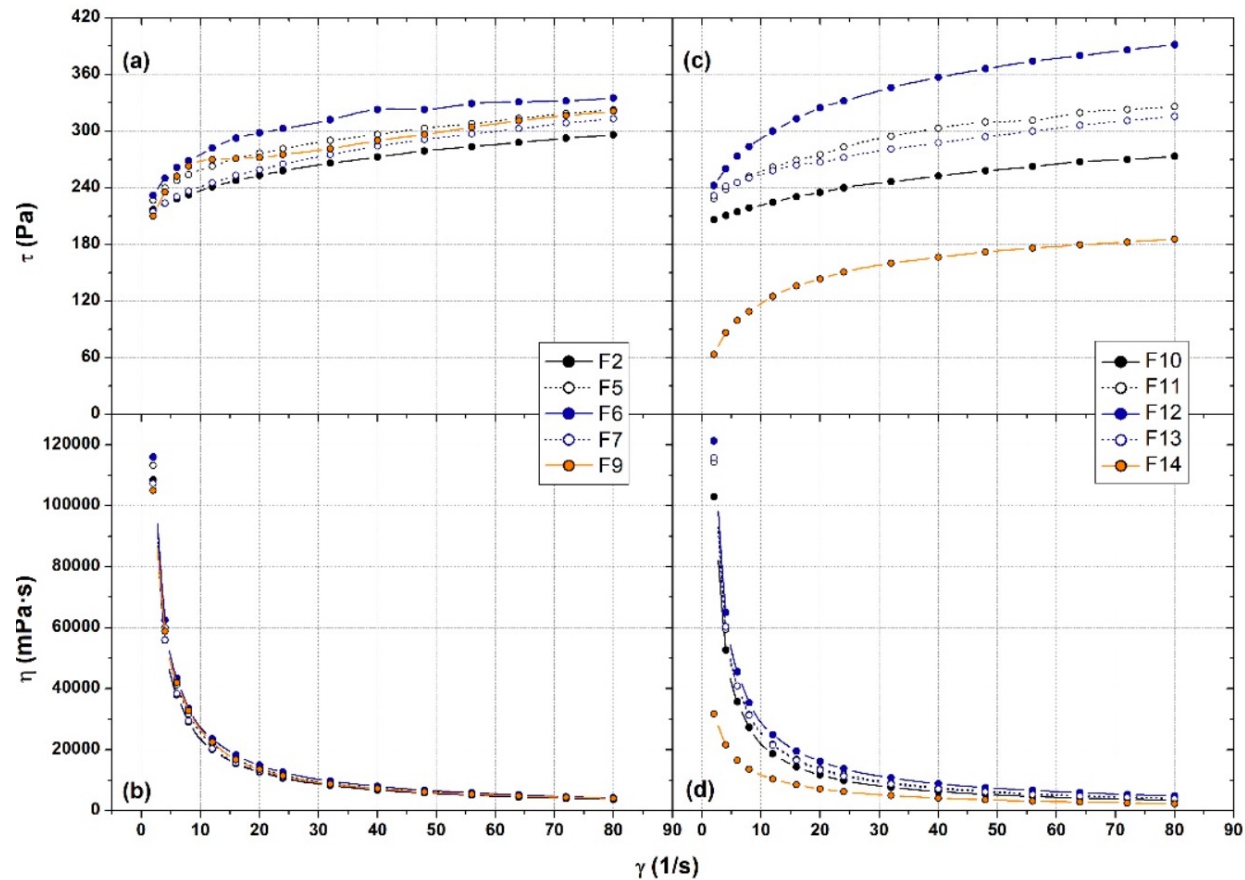


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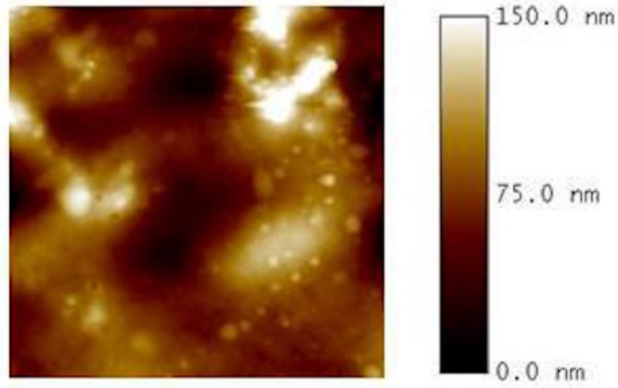
Test performed with an IKA medium rotational viscometer using a constant temperature of 35° C at different share rate



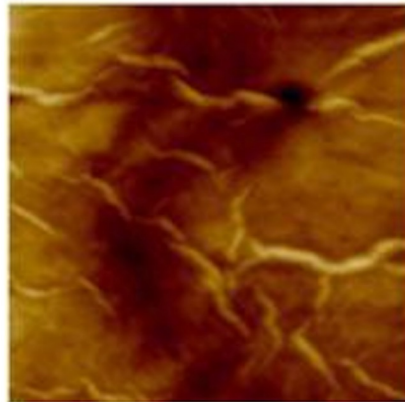
Formulation prepared in water (a)-(b) and in PBS 1x (b)-(c).

Atomic Force Microscope (TM-AFM) imaging

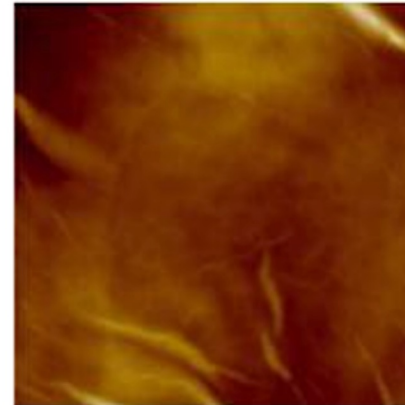
Mucin

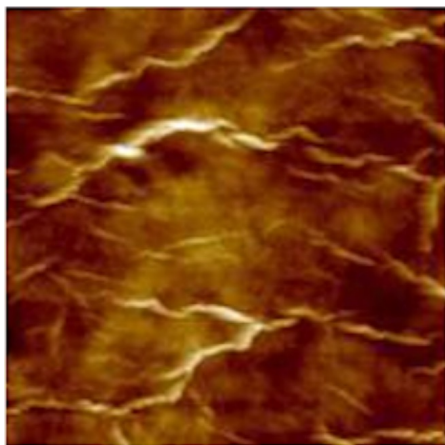


F127 18%

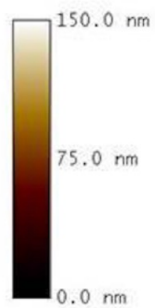


F127 18% + Mucin

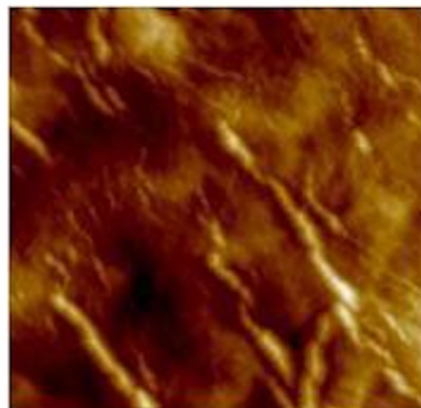




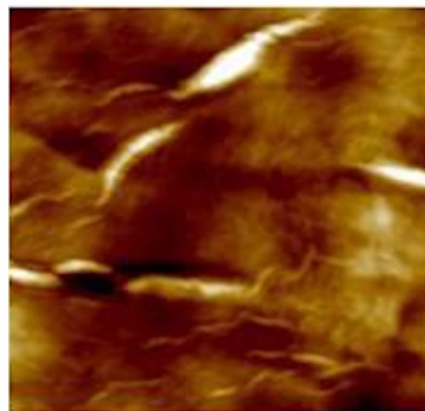
Sample w/o Mucin

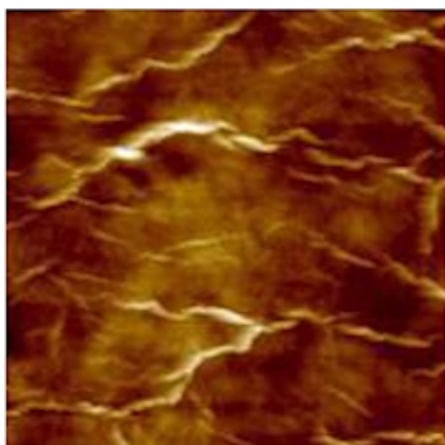


HPMC 1% + Mucin



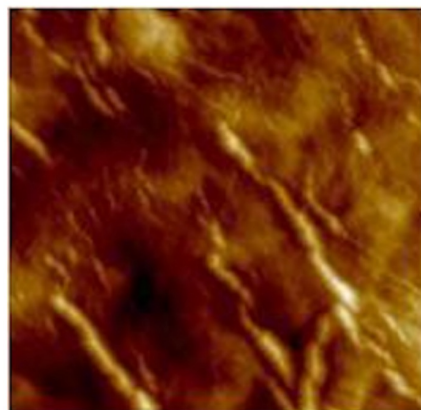
Carrageenan 0.2% + Mucin



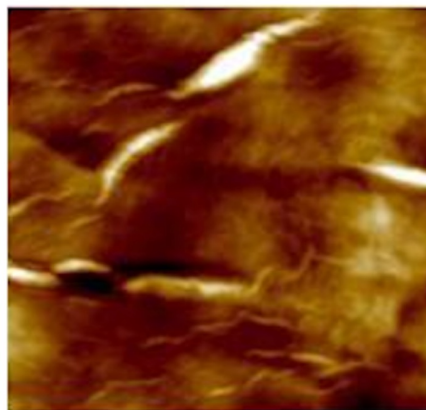


Sample w/o Mucin

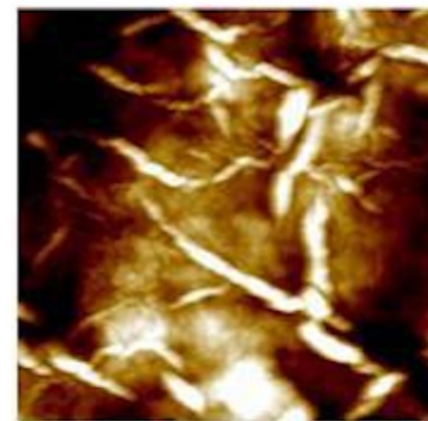
HPMC 1% + Mucin



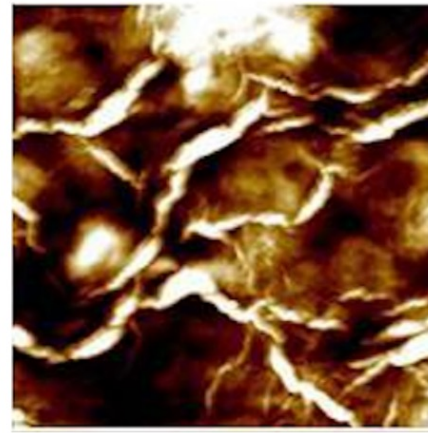
Carrageenan 0.2%
+ Mucin



XG 0.2% + Mucin

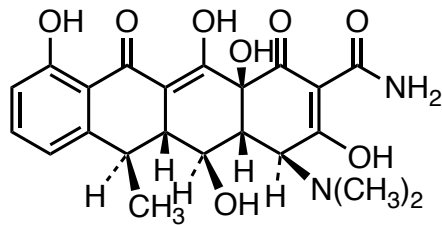


PVP 4% + HPMC 1%
+ Mucin

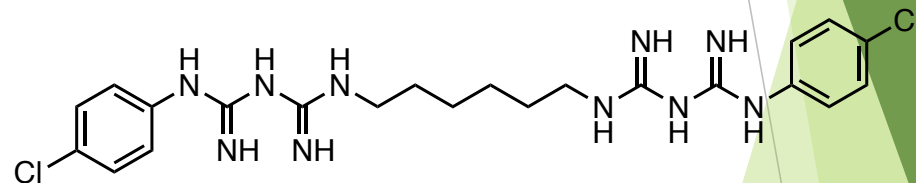


In Vitro Release Studies

- Formulation examined: F10-14
- The release was performed using a semipermeable membrane with a MWCO of 12kDa
- The temperature was set at 37°C
- Analysis by UV-vis absorbtion

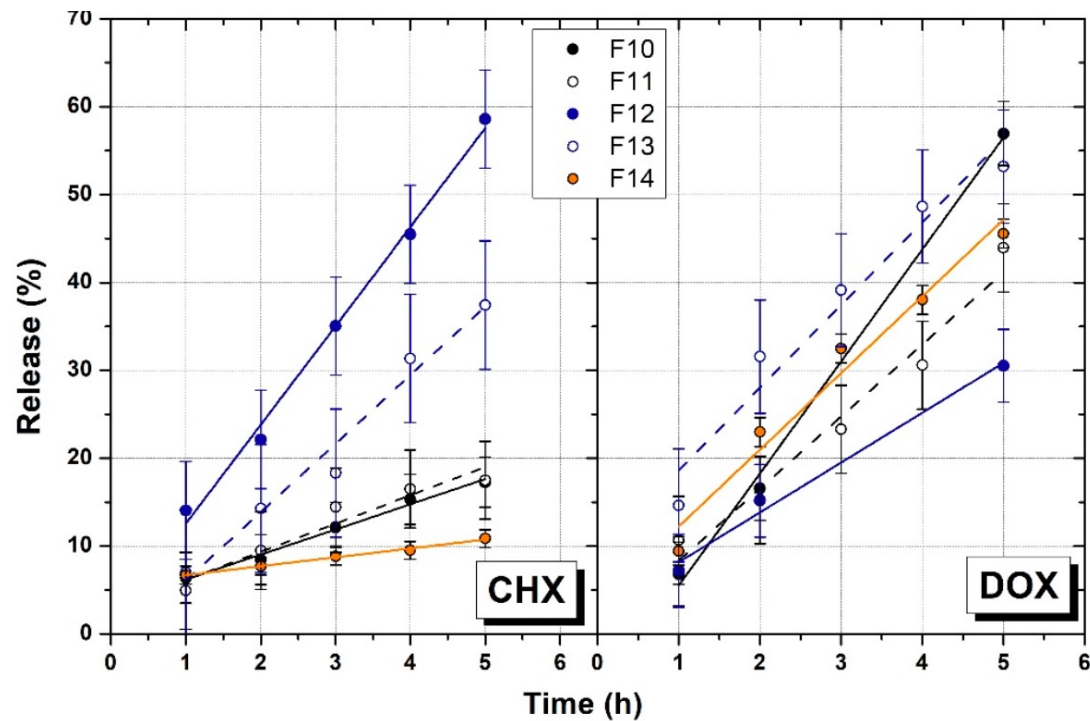


Doxycycline
(DOX)



Chlorhexidine
(CHX)

In vitro release study



ID formulation

Additive %

F10

-

F11

XG 0.2

F12

E407 0.2

F13

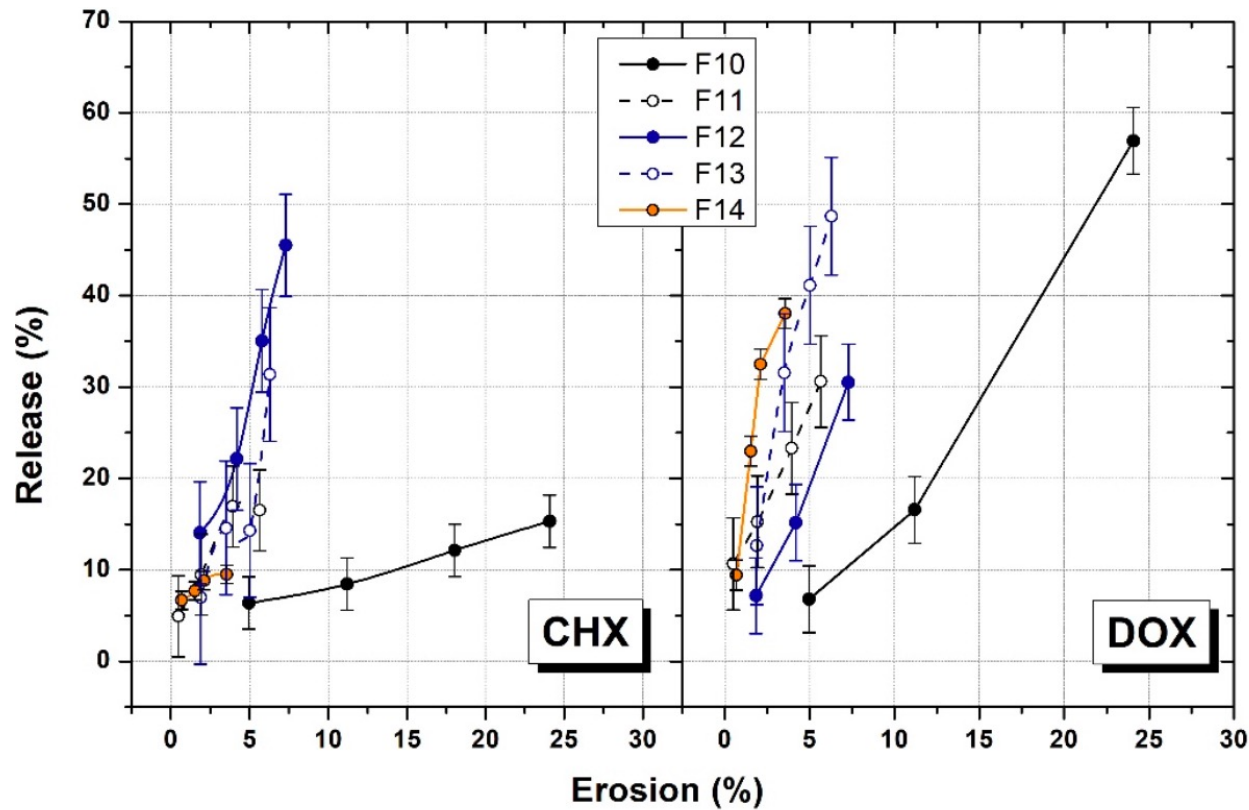
HPMC 0.5

F14

PVP 4 - HPMC 1



In vitro release study



Correlation of cumulative percent gel eroded and cumulative percent released of CHX and DOX.



Conclusions

- Physical-chemical characterization of F127-based hydrogel in water and PBS:

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 - Hydrophilic polymers reduce the erosion rate;
 - TM-AFM:
 - XG and PVP impart mucoadhesive properties;
 - Release study:
 - DOX: excipients decrease the release profile
 - CHX: release profile influenced by interactions between polymer and API .

Future applications

Periodontal Therapy

Cosmetic face masks

Development of supports for in
vitro 3-D cell growth



polymers

an Open Access Journal by MDPI



Ploxamer-Based Hydrogel as Drug Delivery System: How Polymeric Excipients Influence the Chemical-Physical Properties

Elisa Brambilla; Silvia Locarno; Salvatore Gallo; Francesco Orsini; Carolina Pini; Marco Farronato; Douglas Vieira Thomaz; Cristina Lenardi; Marco Piazzoni; Gianluca Tartaglia

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Thank you for your
attention

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