35º Congreso Latinoamericano de Química, Río de Janeiro, Brasil

Synthesis and characterization of gelatin/montmorillonite/hydroxyapatite nanocomposites: preliminary biocompatibility tests

[1]Maby M. Martínez, [1]Lotero, M, [1]Rosero-Moreano. M, [2]Jiménez, F. N. G, [2]Giraldo, L. R, [2]Hincapié, D. F, [3]Rodríguez, Y. [3]A Lellesch, L.
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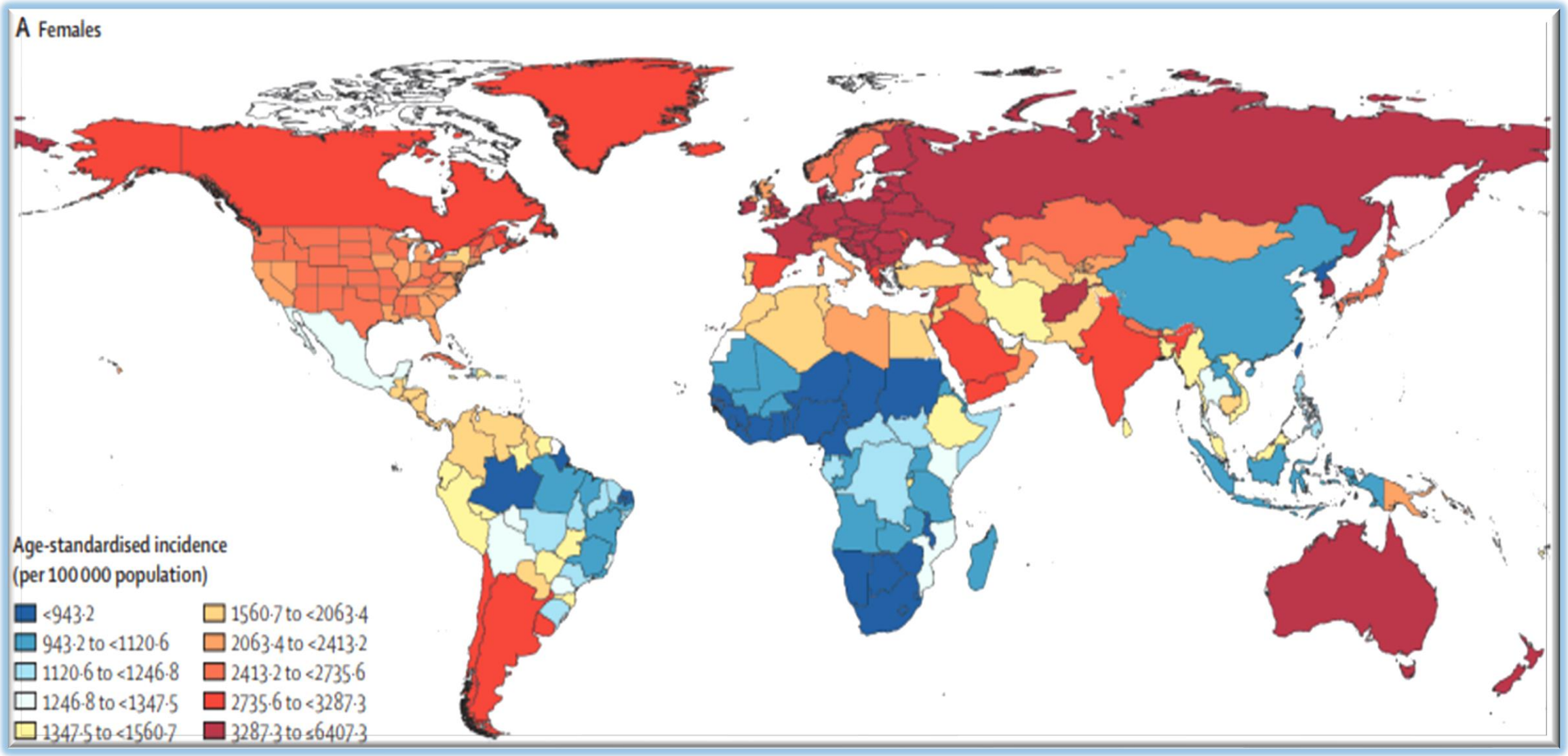
Investigation groups



The pooled cost for treatment in hospital for a hip fracture was estimated to be US$10075, and total health and social care costs for one hip fracture after 12 months amounted to a global mean of $43669

GBD 2019. ***Fracture Collaborators***. 2019

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Autograft

Take from a healthy bone of the same person

Allograft

Frozen donated bone

Biomaterial

Ceramic

Metal

Nanocomposites

Sahlin-Platt. ***Odontological Dissertations***, Series No 119 . 2011

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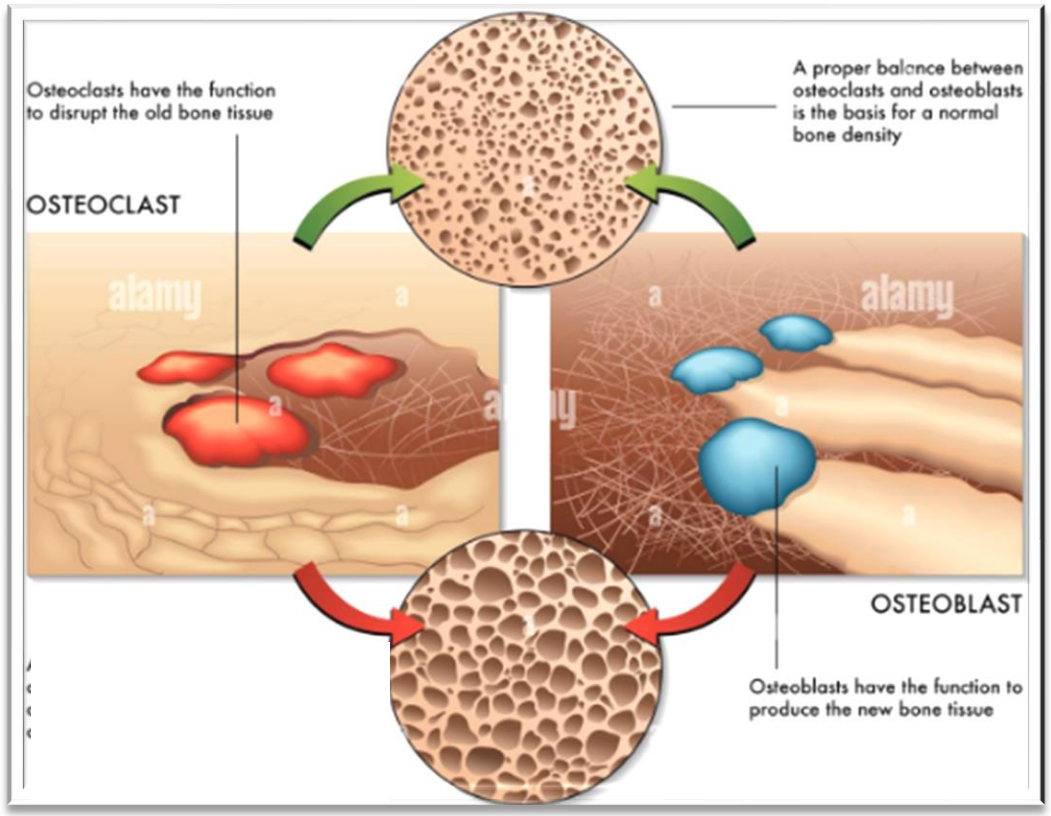
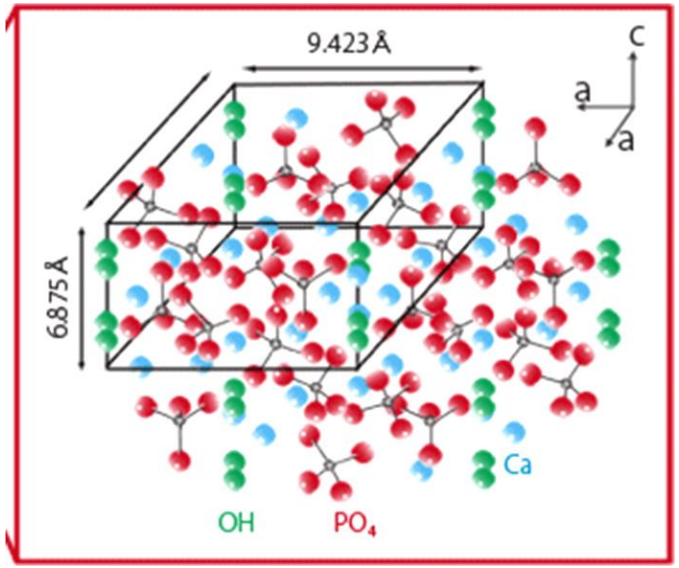
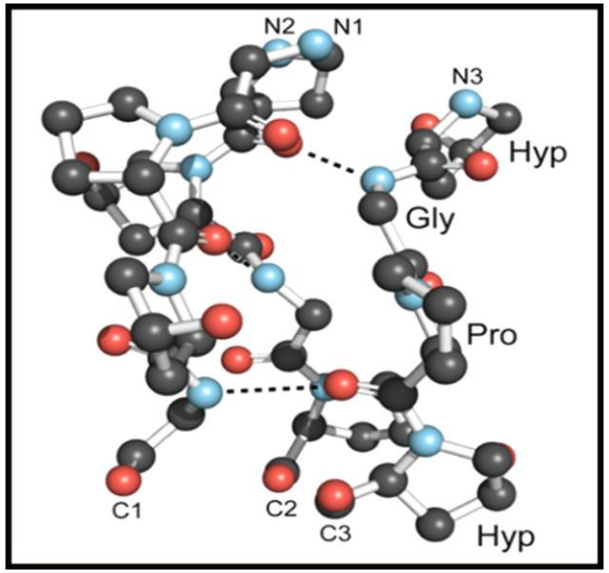
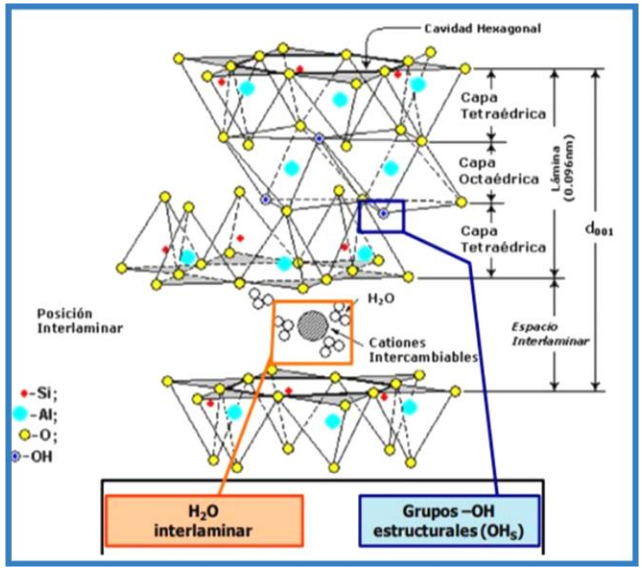


Hidroxyapatite (HA)



Gelatin (Gel)

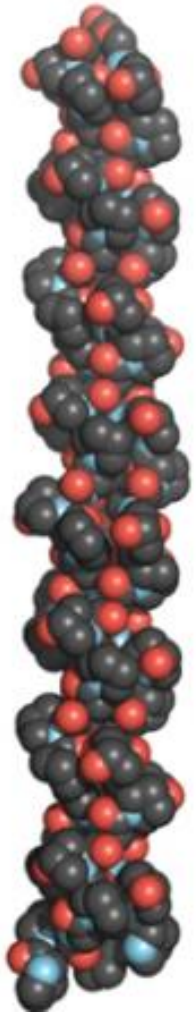


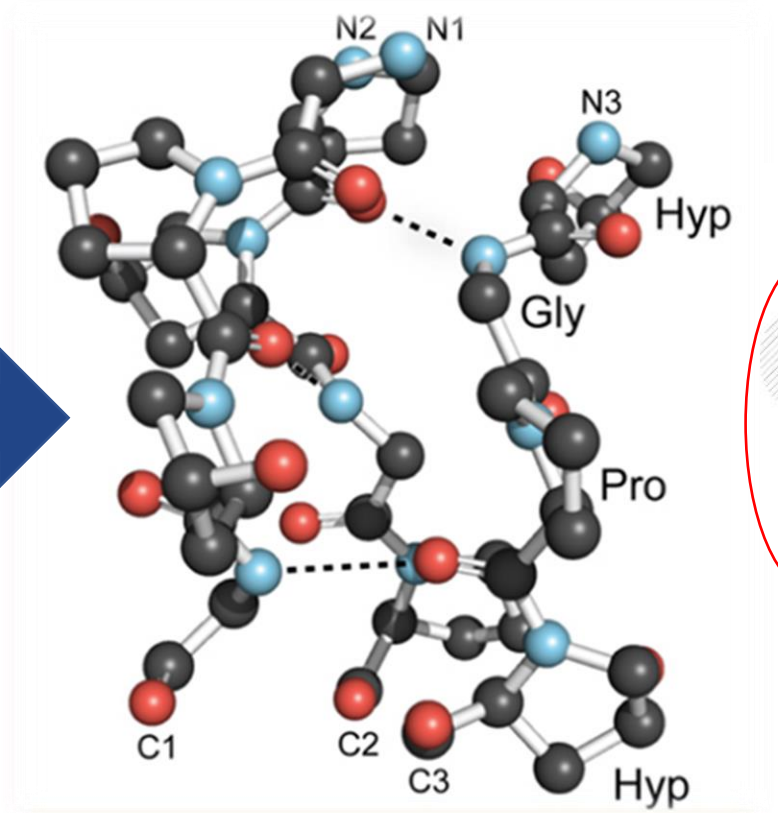


Montmorillonite (MMT)

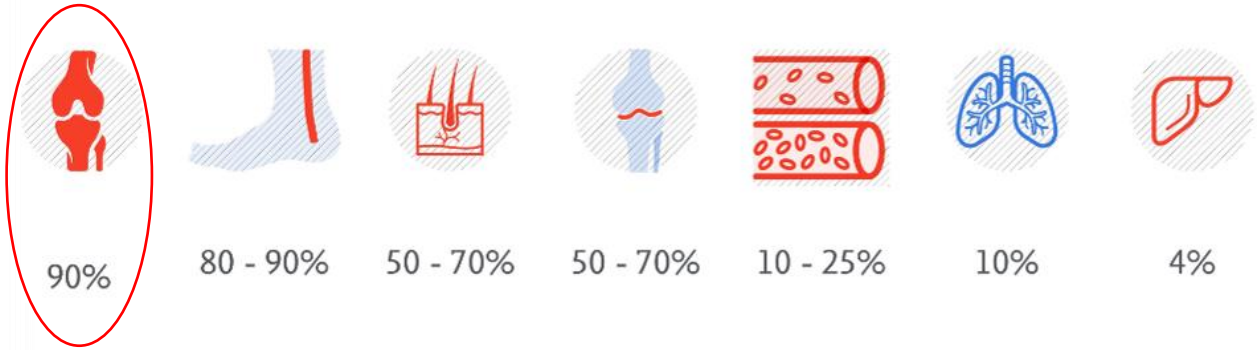
Sahlin-Platt. ***Odontological Dissertations***, Series No 119 . 2011

Gelatin eases bone cell adhesion and proliferation



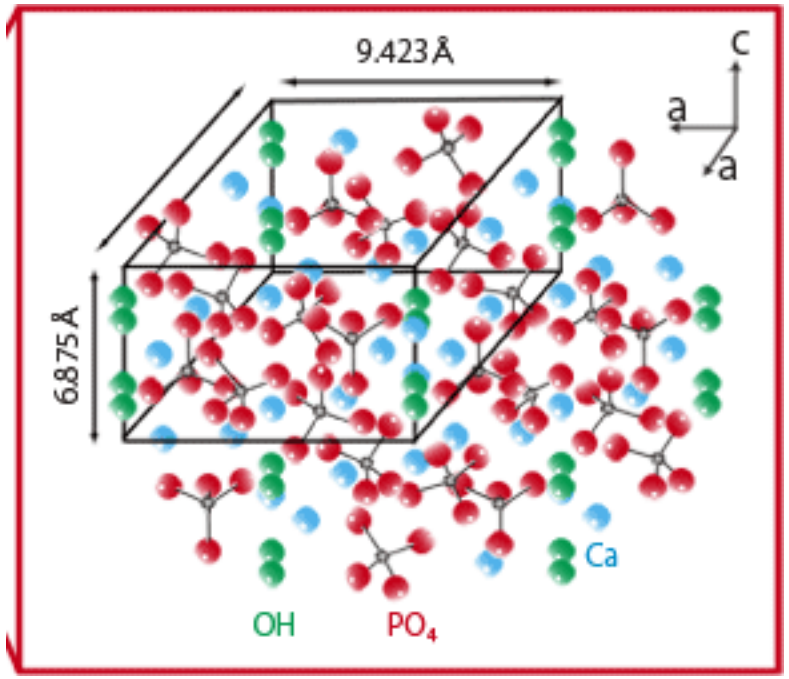


approximate collagen content in different tissues (percentage of dry matter)

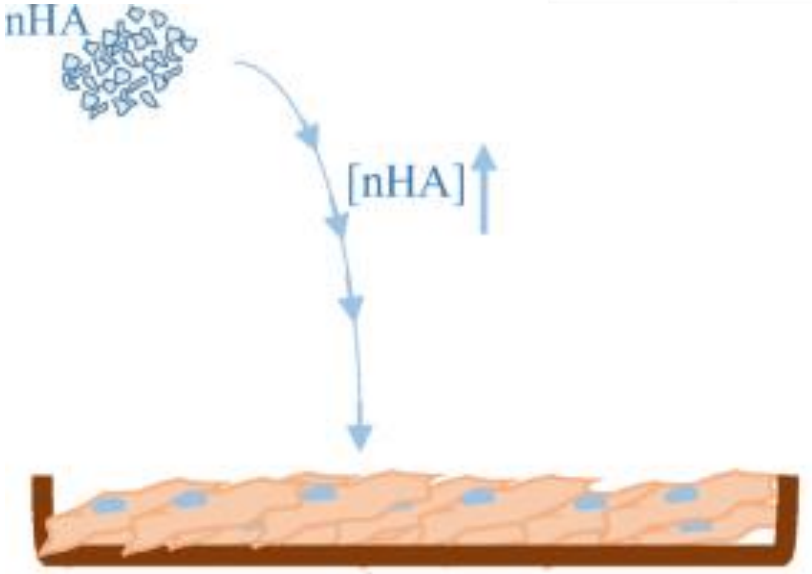


Shoulders MD *et al.*, ***Annu Rev Biochem***. 2009;78:929-58.

Hydroxyapatite

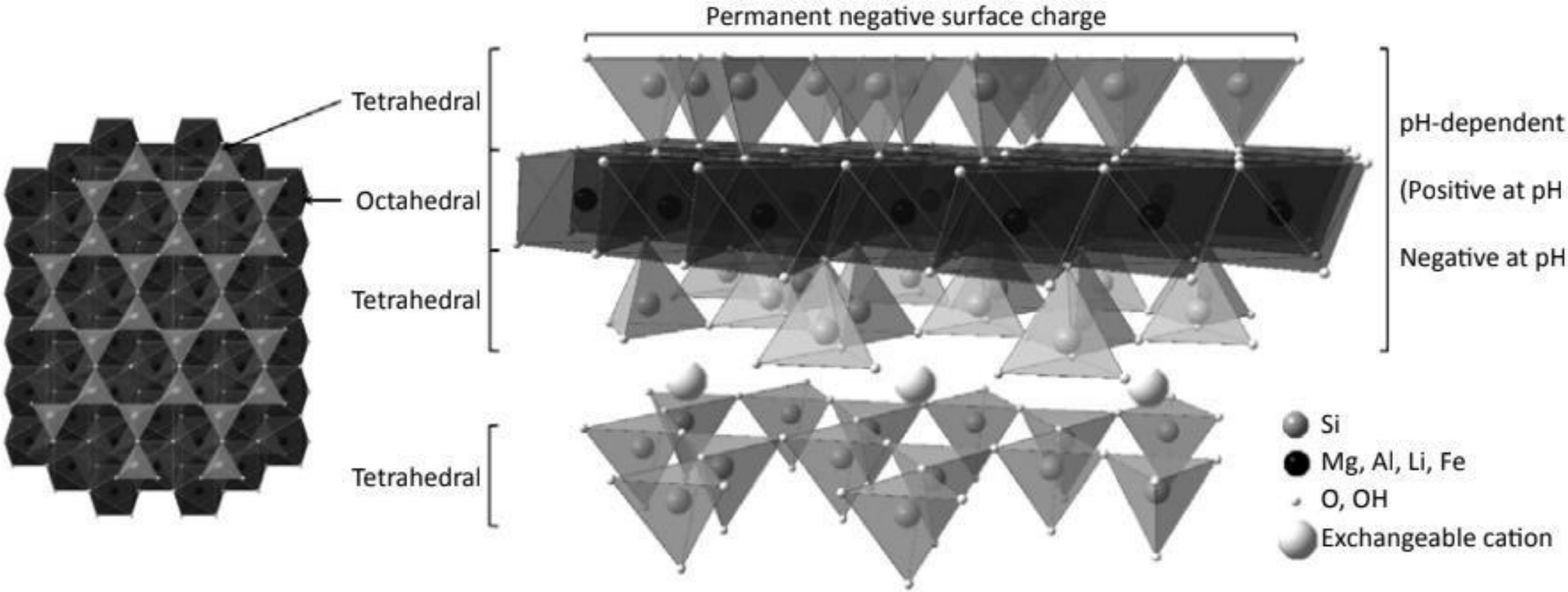


Approximately, 20 nm wide and 80 nm long



García-Garduño JRG. ***RevEspCiencQuímBiol.*** 2017.

Montmorillonite



Mousa, M. ***Biomaterials.*** 2017.

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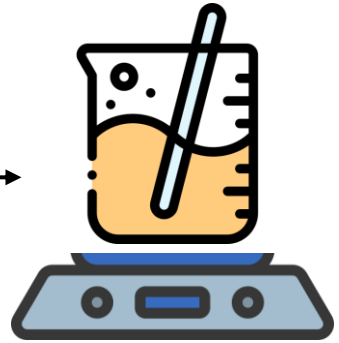
Materials and Methods

hydrate →

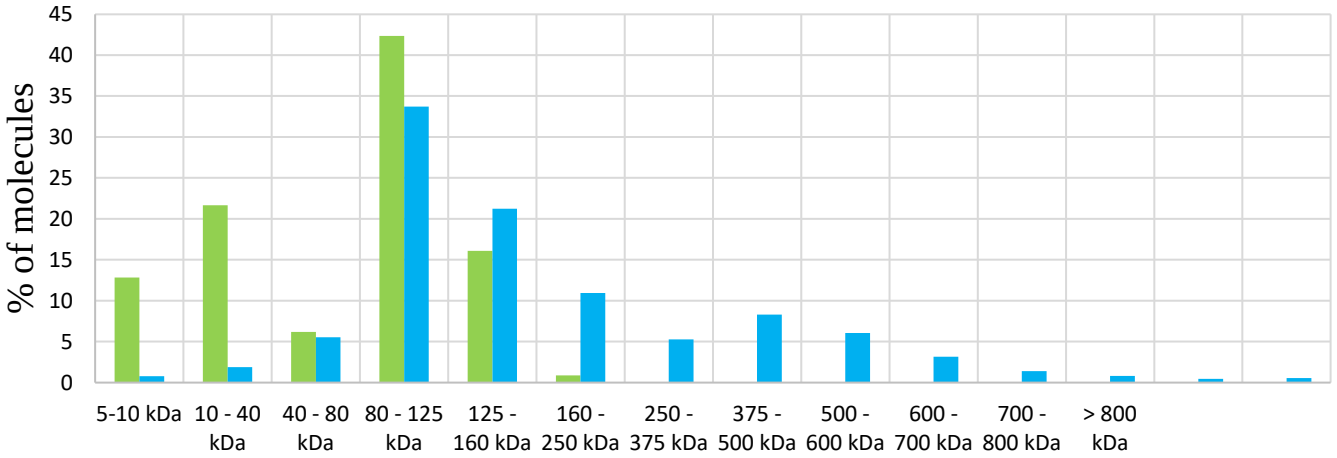


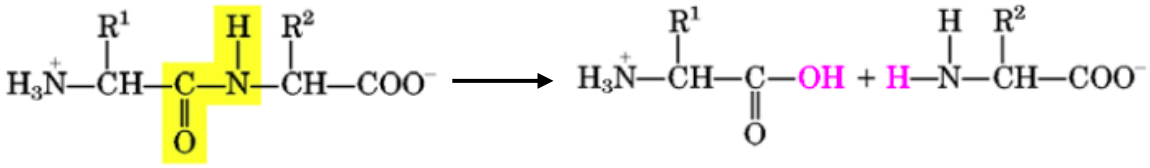
Gelatin hydrolysis

hydrolysis →

inactivate enzyme →

Distribution of MM





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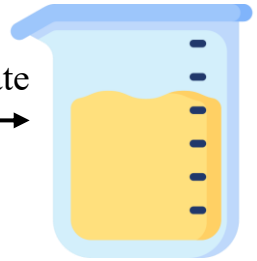
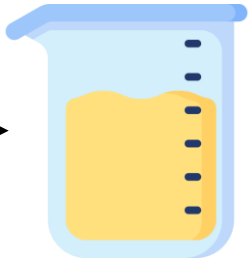
H_2O + polyphosphate



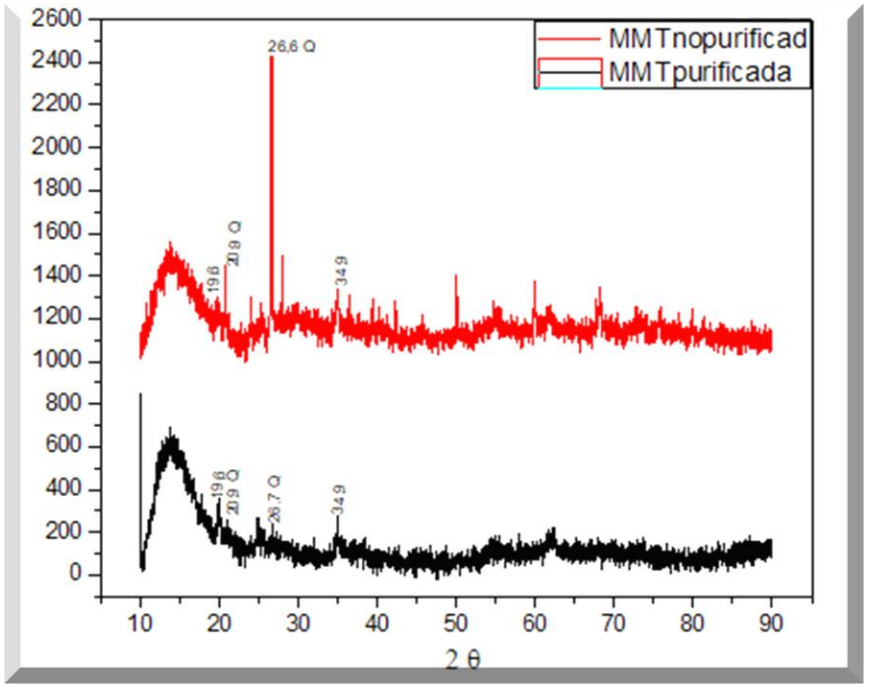
90 min

8 h

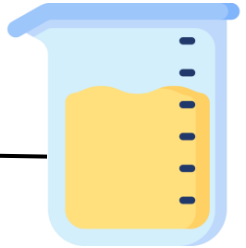


decant

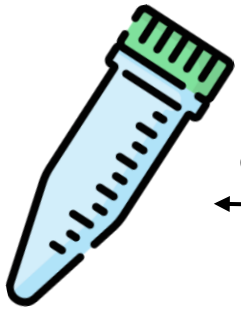
Purification of Montmorillonite



acidify



centrifuge



drying

Vargas et al. ***Rev. mex. cienc. Geol***. 2008

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Investigation groups

Synthesis of Hydroxyapatite

$(NH_4)H_2PO_4$ (0,025 M)

$Ca(NO_3)_2$. $4H_2O$ (0,04 M)

$Ca(NO_3)_2$ (0,025 M)

pH= = 7 – 8, 48 h

Wash

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Synthetic procedures

MMT + HA → 50 mL sln 0.1M acetic acid → Wash (NaOH 0,1 M) → Gel → 10% MMT/HA – 90% Gel → Shake 24 h → Dry 24 h, 40 ºC → (MMT/HA) + Gel

MMT + HA + Gel → 50 mL sln 0.1M acetic acid → 10% MMT/HA – 90% Gel → Shake 24 h → Wash (NaOH 0,1 M) → Dry (24 h, 40 ºC) → MMT/HA/Gel

Olad *et al*., ***Ceramics International***. 2014

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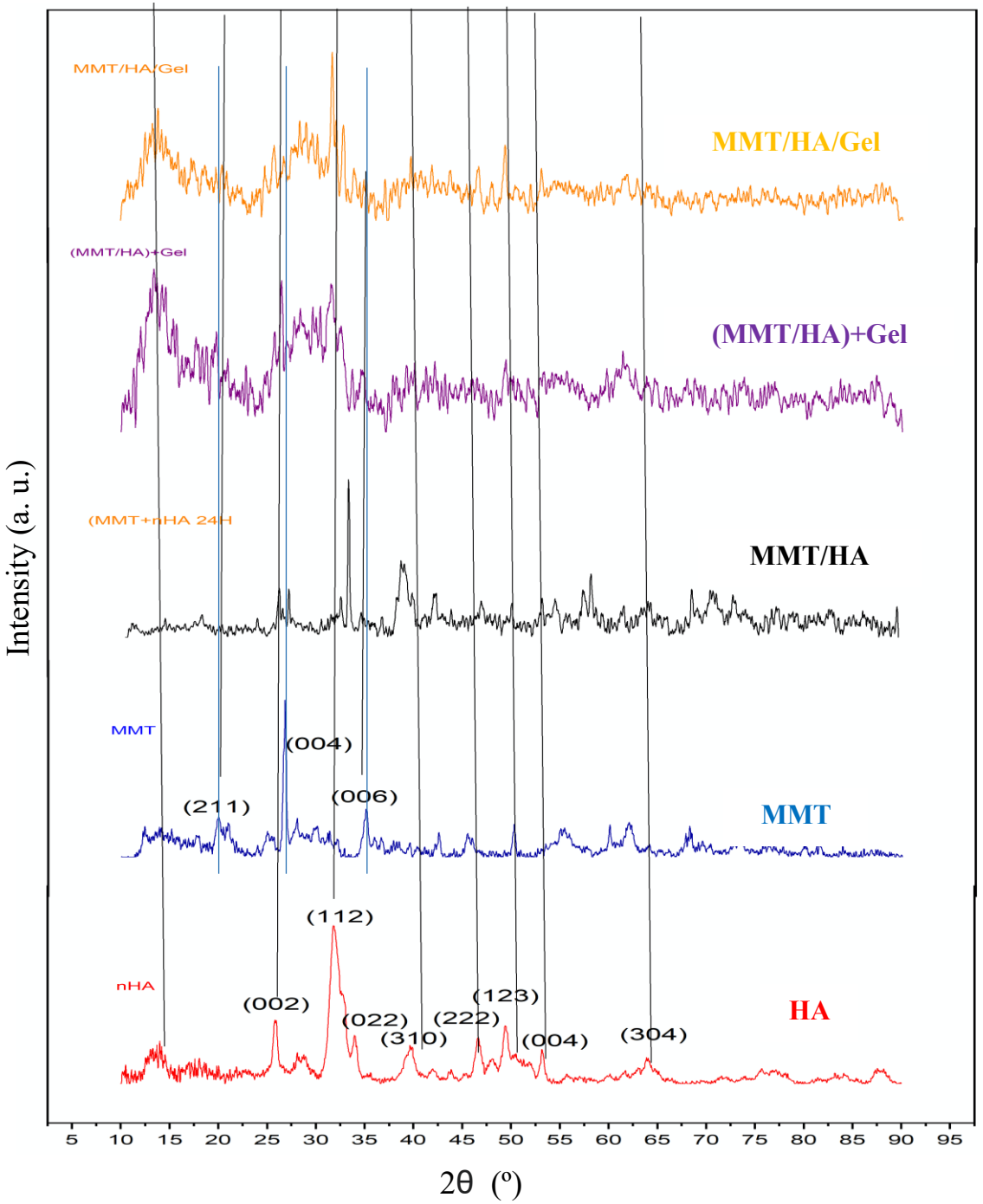
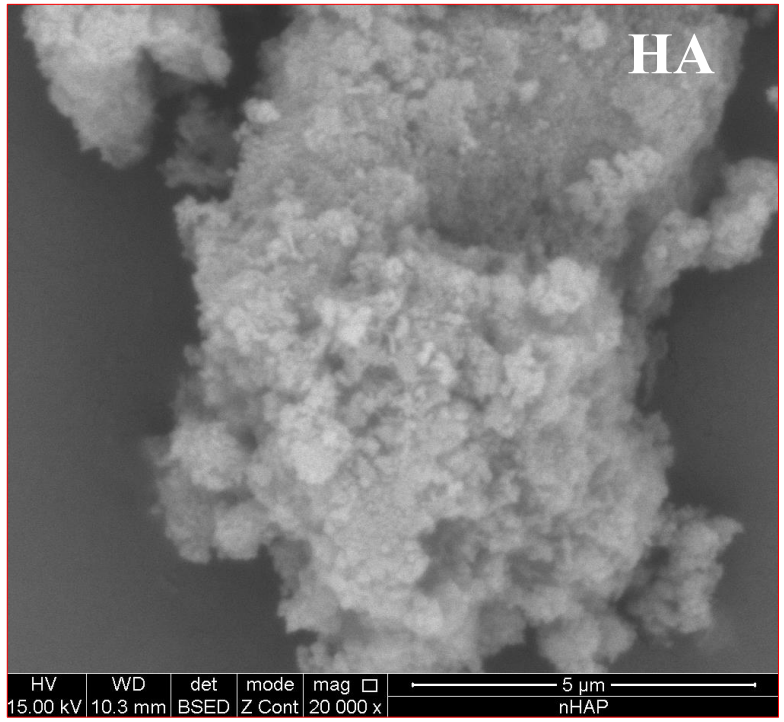
Investigation groups

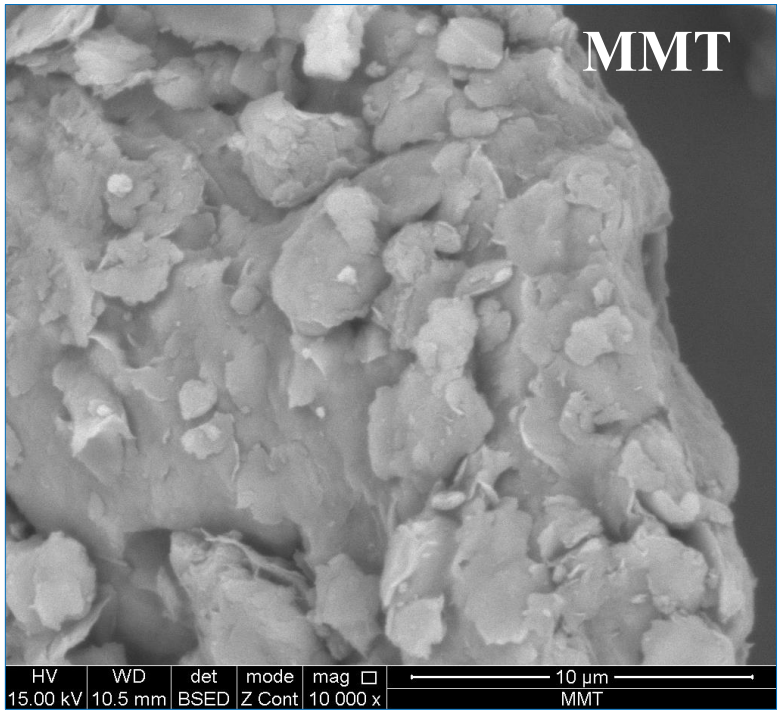
Results

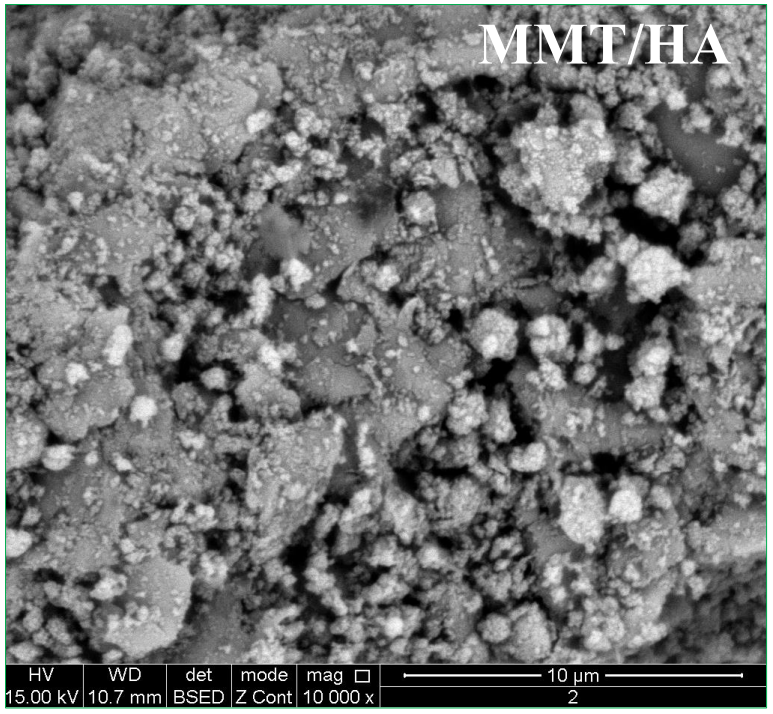
X-Ray Diffraction

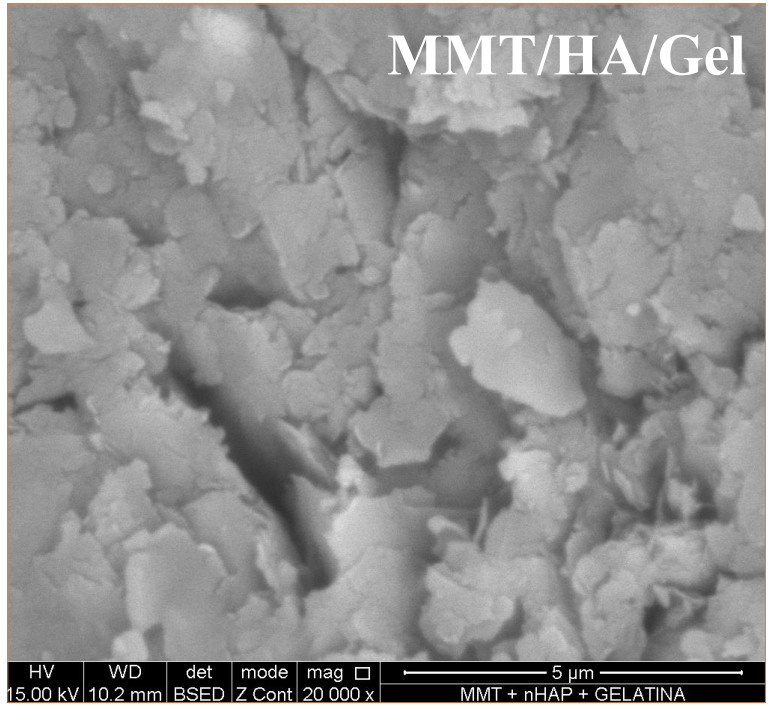


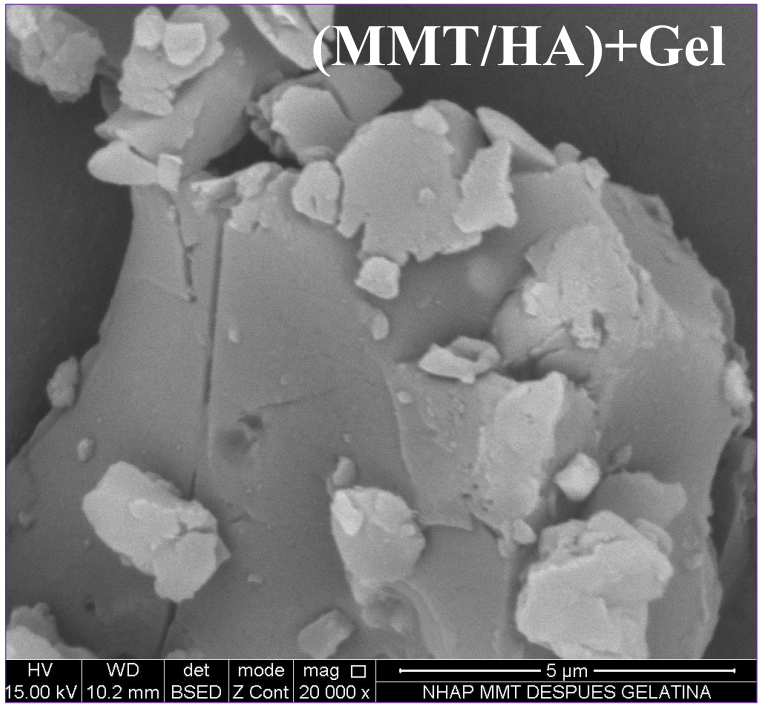
Scanning Electron Microscopy



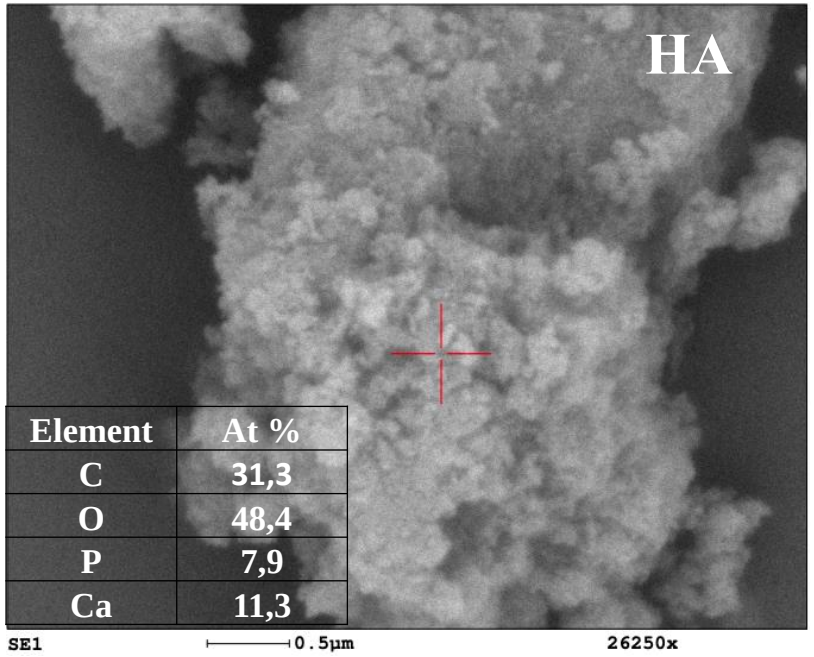




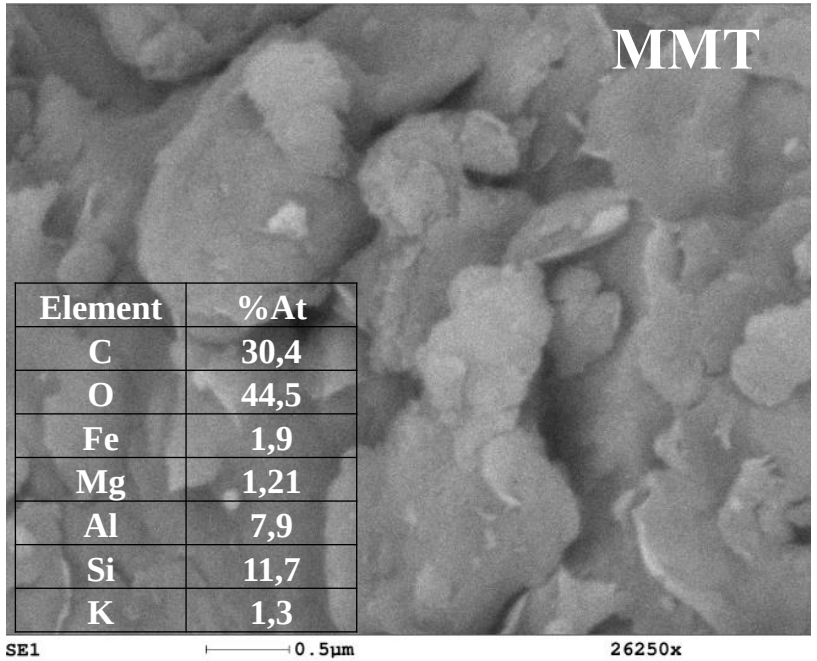




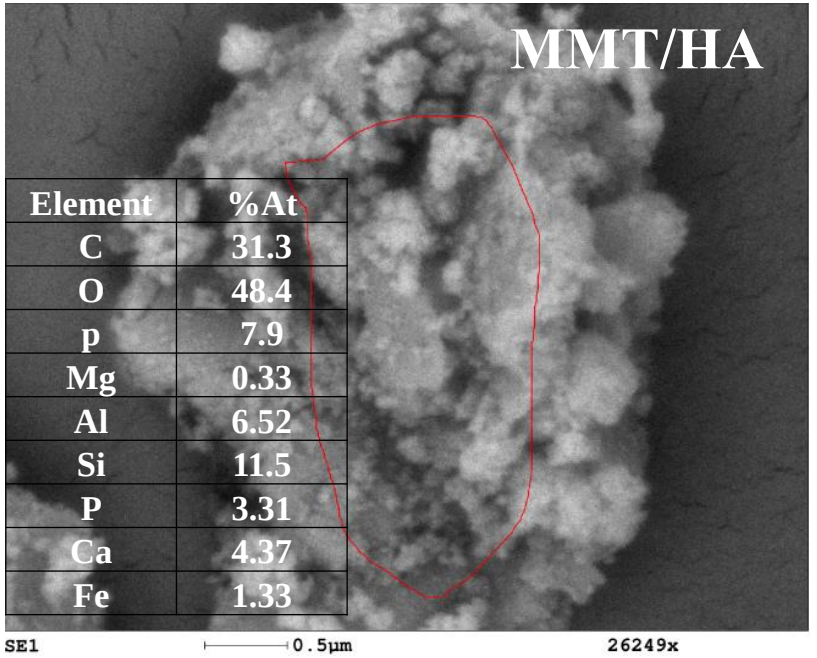
Scanning Electron Microscopy-EDS



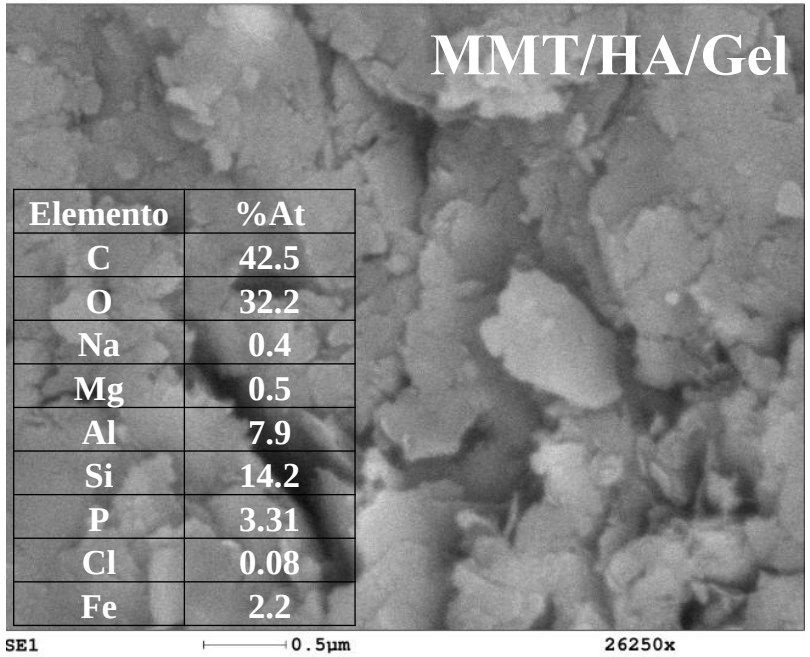
Element	At %
C	31,3
O	48,4
P	7,9
Ca	11,3



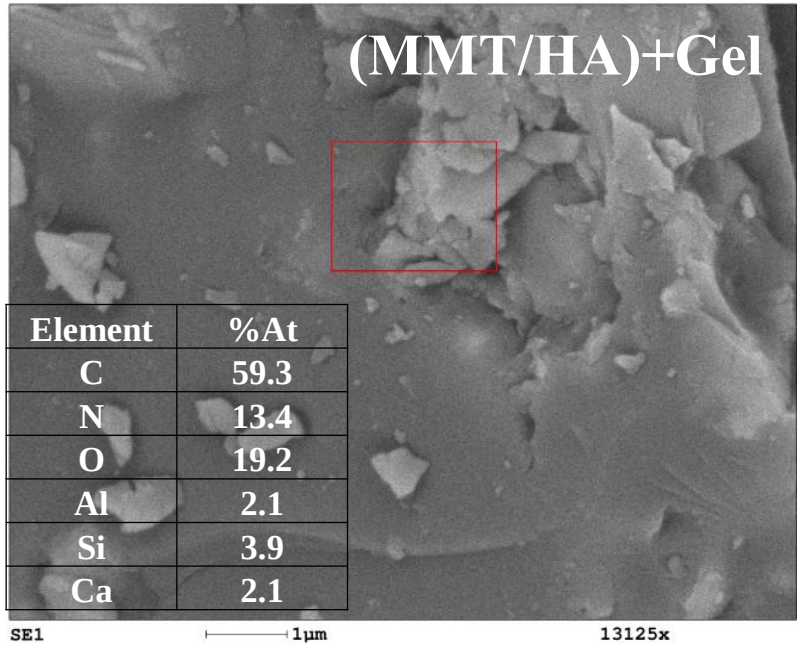
Element	%At
C	30,4
O	44,5
Fe	1,9
Mg	1,21
Al	7,9
Si	11,7
K	1,3



Element	%At
C	31.3
O	48.4
p	7.9
Mg	0.33
Al	6.52
Si	11.5
P	3.31
Ca	4.37
Fe	1.33



Elemento	%At
C	42.5
O	32.2
Na	0.4
Mg	0.5
Al	7.9
Si	14.2
P	3.31
Cl	0.08
Fe	2.2

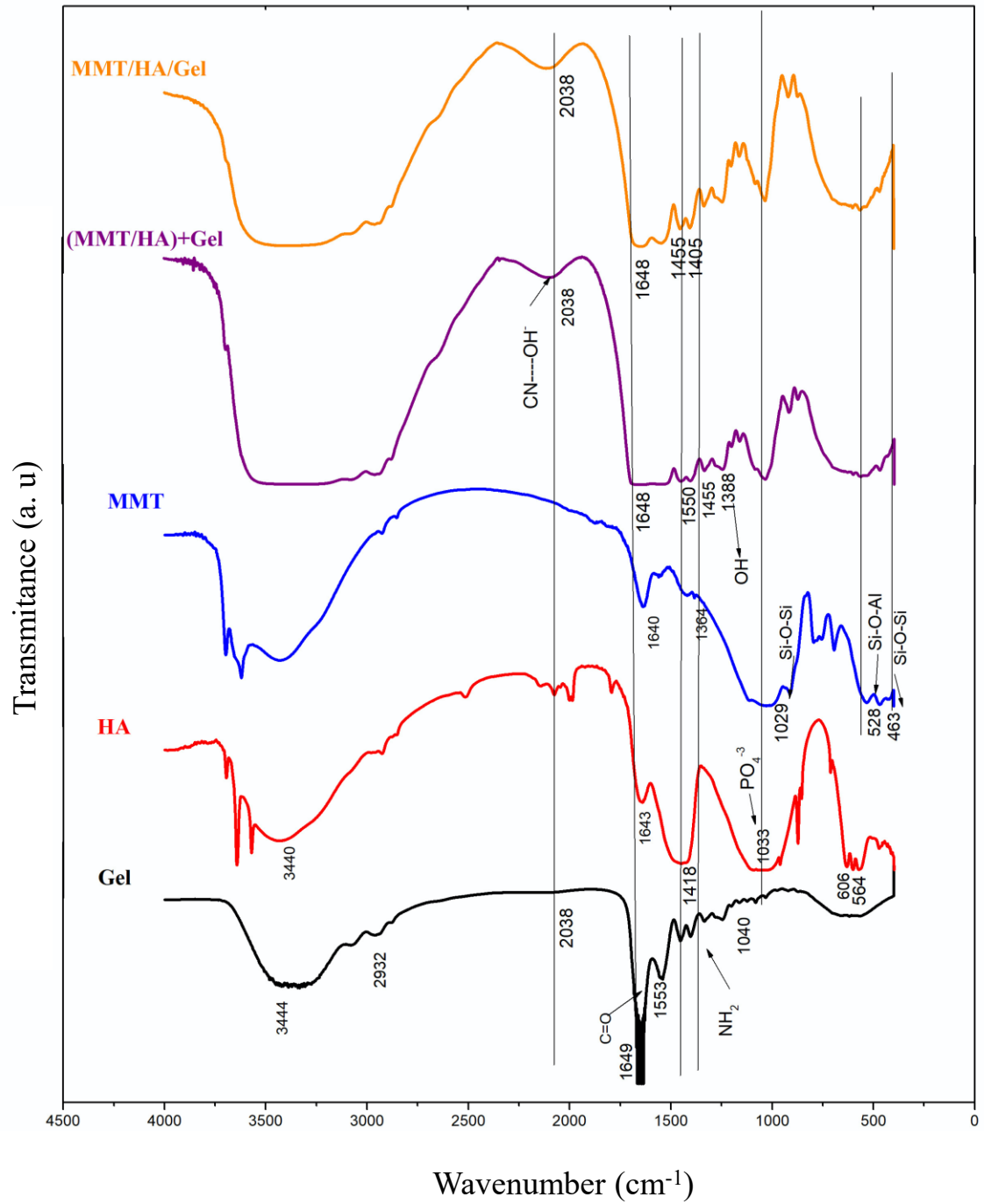


Element	%At
C	59.3
N	13.4
O	19.2
Al	2.1
Si	3.9
Ca	2.1

Fourier-transformed infrared

Vibration	Material MMT (cm^{-1})	Vibration	Material HA (cm^{-1})	Vibration	Material Gel (cm^{-1})
$v_{as}OH$	3000-3700	$v_{as}OH$	3000-3700	$v_{as}OH$	3000-3700
V(H-O-H)	1621	*V*(PO_4^{-2})	1033	C=O	1649
V(Si-O-Si)	1029	*V*(PO_4^{-2})	564	*V*(CN)	1550
V(Si-O-Al)	528	*V*(PO_4^{-2})	564	*V*(CN)	1455

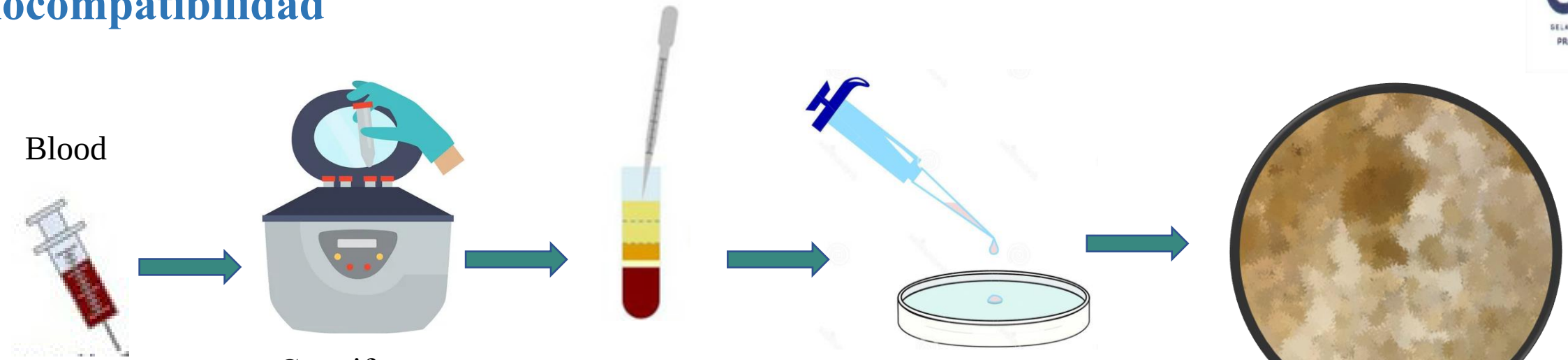
Vibration	Material MMT/HA/Gel (cm^{-1})	Material (MMT/HA) + Gel (cm^{-1})
$v_{as}OH$	3000-3700	3000-3700
OH en MMT/HA	1386	1386
OH ----CN	2038	2038
MMT/HA	1405	1406
MMT/HA	914-840	914-840

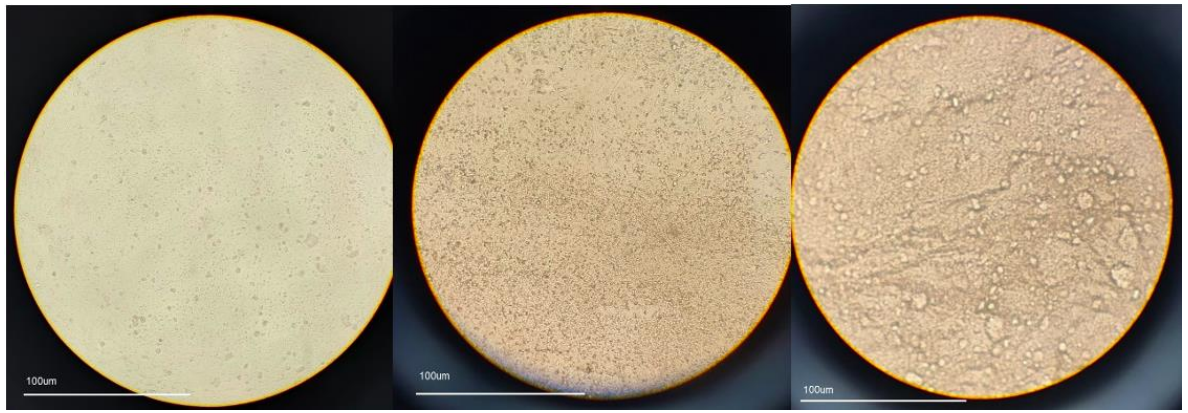


Chaibi *et al*., ***Colloid and Polymer Science***. 2015.
Wang *et al*., ***Chem. Eng. J***. 2020.
Olad *et al*., ***Ceramics International***. *2020*

Biocompatibilidad

In vitro tests with platelet count





Morphological changes of platelets upon treatment with nanohydroxyapatite. (a) 0 min, (b) 180 min and (c) 240min

Rajan *et al*., ***Biointerfaces***. 2014

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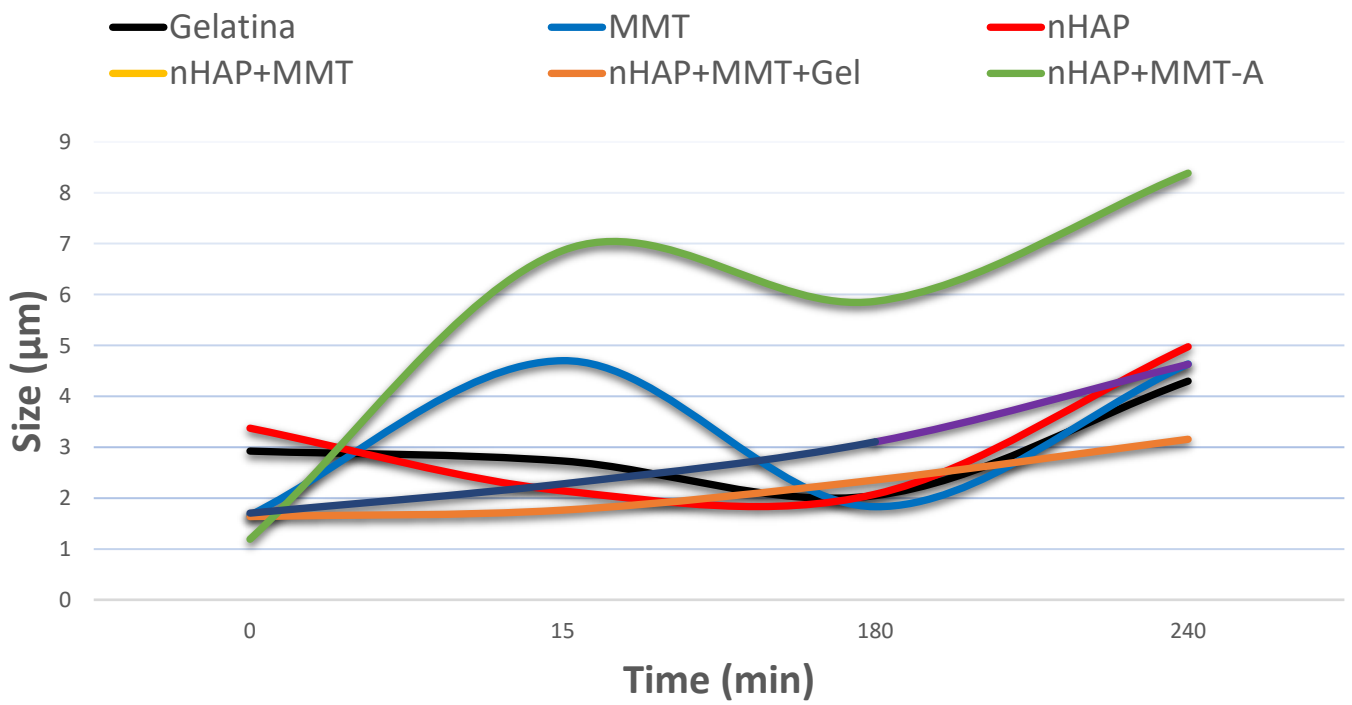
Tests de biocompatibility



Platelets between 1.7 and 4.6 µm were observed with the material (MMT/HAP)+Gel, while platelets between 1.7 and 3, 1 µm were observed with the MMT/HAP/Gel material.

MMT/HAP/Gel material is the one that exhibits a better cellular response.

Conclusiones

- The triads were obtained and their preliminary characterization by FTIR suggests a similarity in their chemical composition, but there are also evidences of a new interaction

- SEM analysis shows important morpholgical differences in these materials, in agreement with the results obtained in the biocompatibility tests.

- The MMT/HAP/Gel triad suggests that it is a more promising material in our attempt to promote them as potential tissue regenerating agents.

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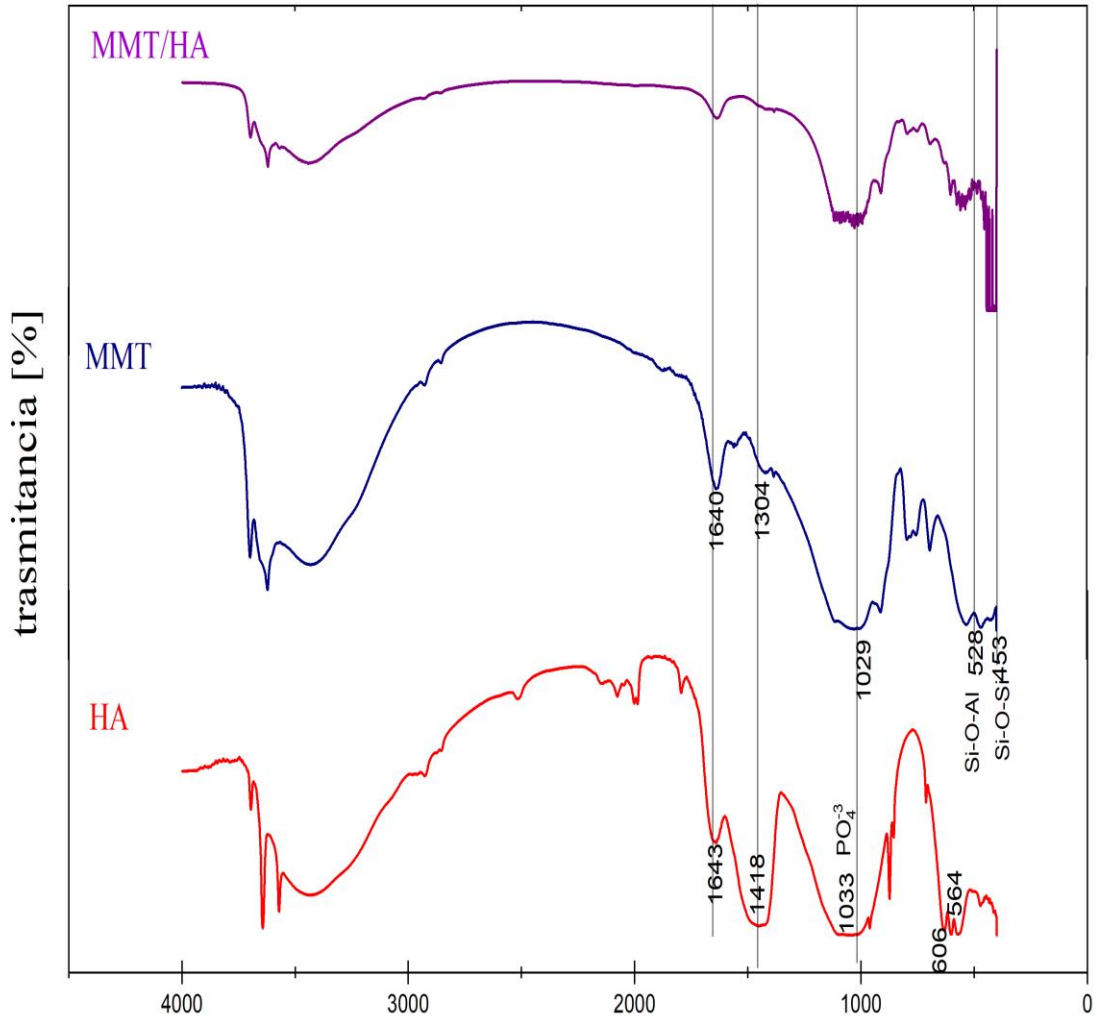
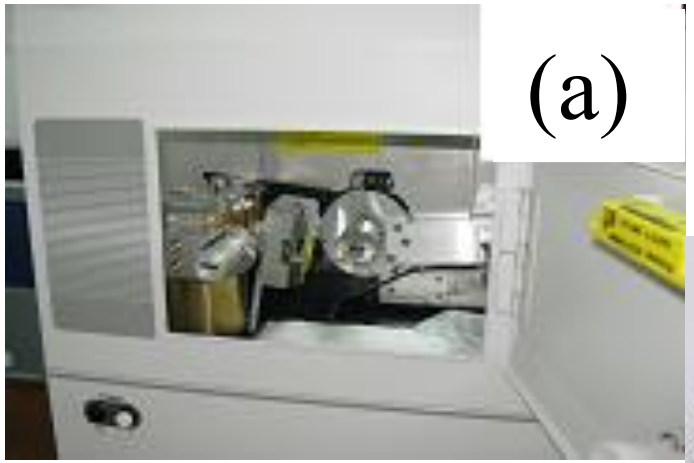

MMT/HA
MMT
HA
trasmitancia [%]
1640
1304
1029
528
453
Si-O-Al
Si-O-Si
1643
1418
1033
PO_4^{-3}
606
564
4000
3000
2000
1000
0

Caracterization



(a)

(b)

(c)

(a) X Ray Difraction, (b) Fourier-transformed infrared (c) Scanning electron microscopy

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