Preparation and Bioactivity evaluation of bioresorbable biphasic calcium phosphate microspheres for hard tissue engineering

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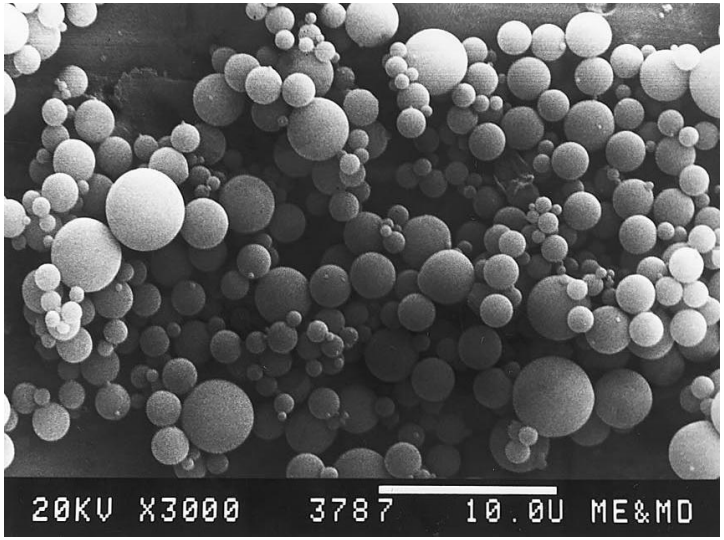
Outline of Presentation

- Introduction
- Materials and Methods
- Result and Discussion
- Conclusion

Microspheres

- One of the most effective approaches for achieving novel drug delivery dosage forms such as sustained release, controlled release is microencapsulation.



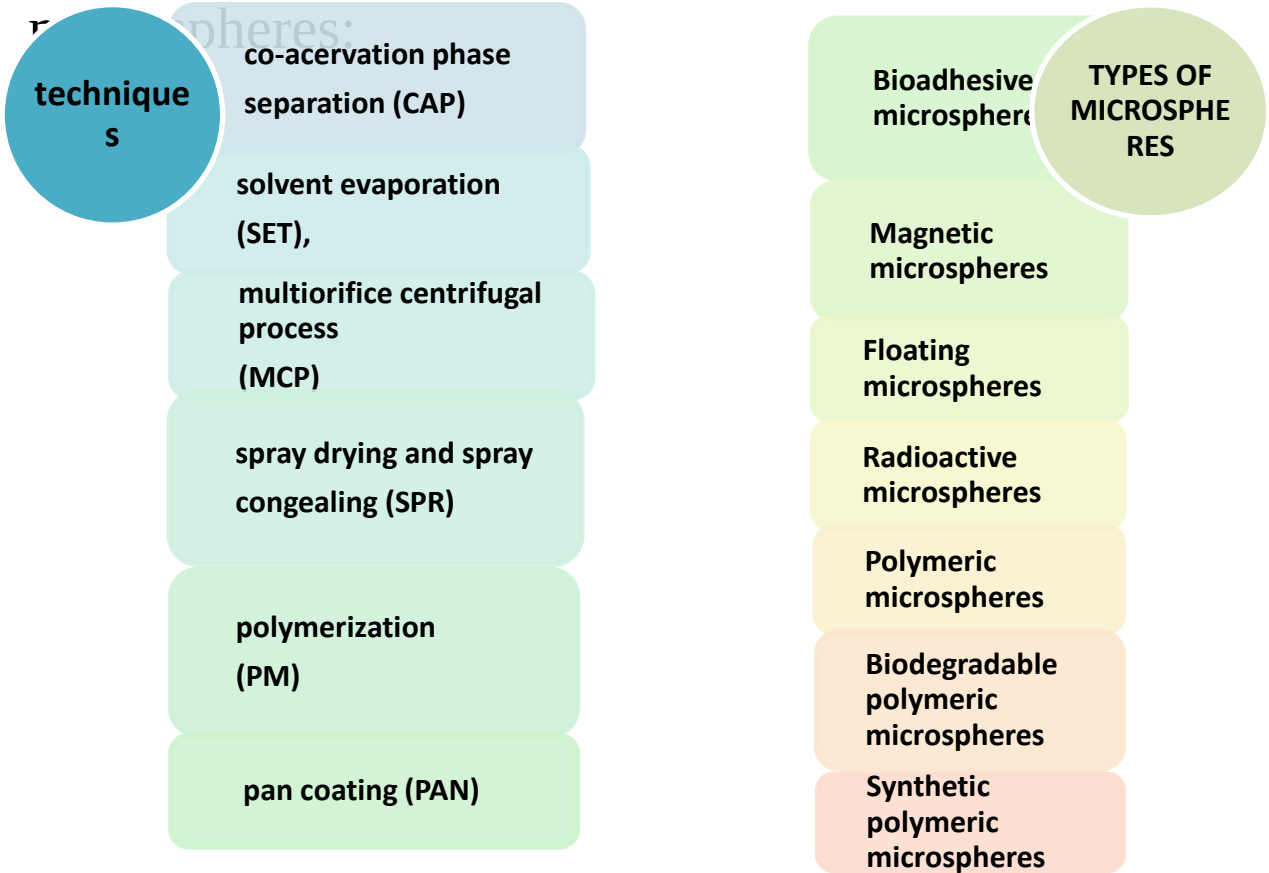
- **advantages over traditional methods:**
- First, drug release rates can be tailored to the needs of a specific application.

Second, controlled release systems provide protection of drugs, especially proteins, that are otherwise rapidly destroyed by the body.

Finally, controlled release systems can increase patient comfort and compliance by replacing frequent (e.g., daily) doses with infrequent (once per month or less)injection.

Polymerics microspheres

- Polymers microspheres, such as poly(lactideco-glycolide) (PLGA) is resorbable but their bioactivity is compromised.
- A number of techniques are available for the preparation of [illegible]pheres:



Bioceramic microspheres

- Ideal bioceramic microspheres for bone regeneration need to be bioactive and degradable, but at the same time possess a controlled drug-release ability. *The main disadvantage of the currently available microspheres is their failure to combine these properties.*

- ceramic microspheres, such as hydroxyaptite (HAp) ceramics, are bioactive, but they lack the controlled porosity, which to some extent influences the controlled drug release.

Bioceramics

- Ceramics used for the repair and reconstruction of diseased or damaged parts of the musculo-skeletal system, termed bioceramics, may be bioinert (alumina, zirconia), resorbable (tricalcium phosphate), bioactive (hydroxyapatite, bioactive glasses, and glass-ceramics), or porous for tissue ingrowth (hydroxyapatite-coated metals, alumina).

- The mechanisms of tissue bonding

to bioactive ceramics are beginning

to be understood, which can result

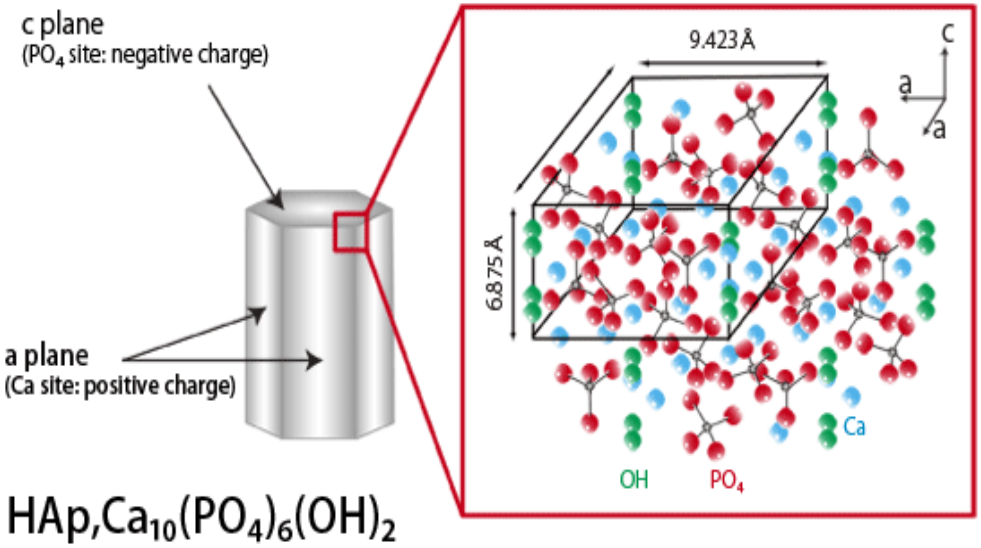
in the molecular design of bioceramics

for interfacial bonding with

hard and soft tissues.

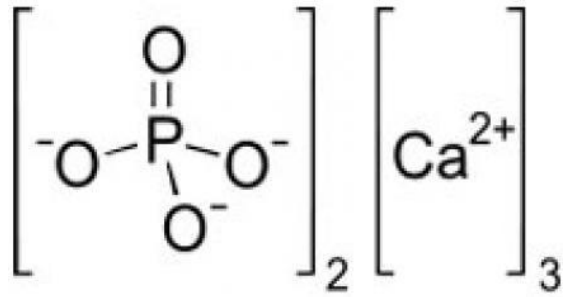
Hydroxyapatite

- $Ca_{10}(PO_4)_6(OH)_2$
- The greatest potential for bone substitution
- can develop tight bonding with bone tissue
- exhibits osteoconductive behavior
- Bioresorption
- has no adverse effects on the human organism
- High biocompatible cerami



tricalcium phosphate

- $Ca_3(PO_4)_2$
- used in the clinical field
- for the repair and reconstruction of diseased or damaged parts of human body
- It serves as a rich source for calcium and phosphorus, which can be easily assimilated and absorbed
- Beta-tricalcium phosphate is highly biocompatible and creates a resorbable interlocking network wi[illegible]ıote healing

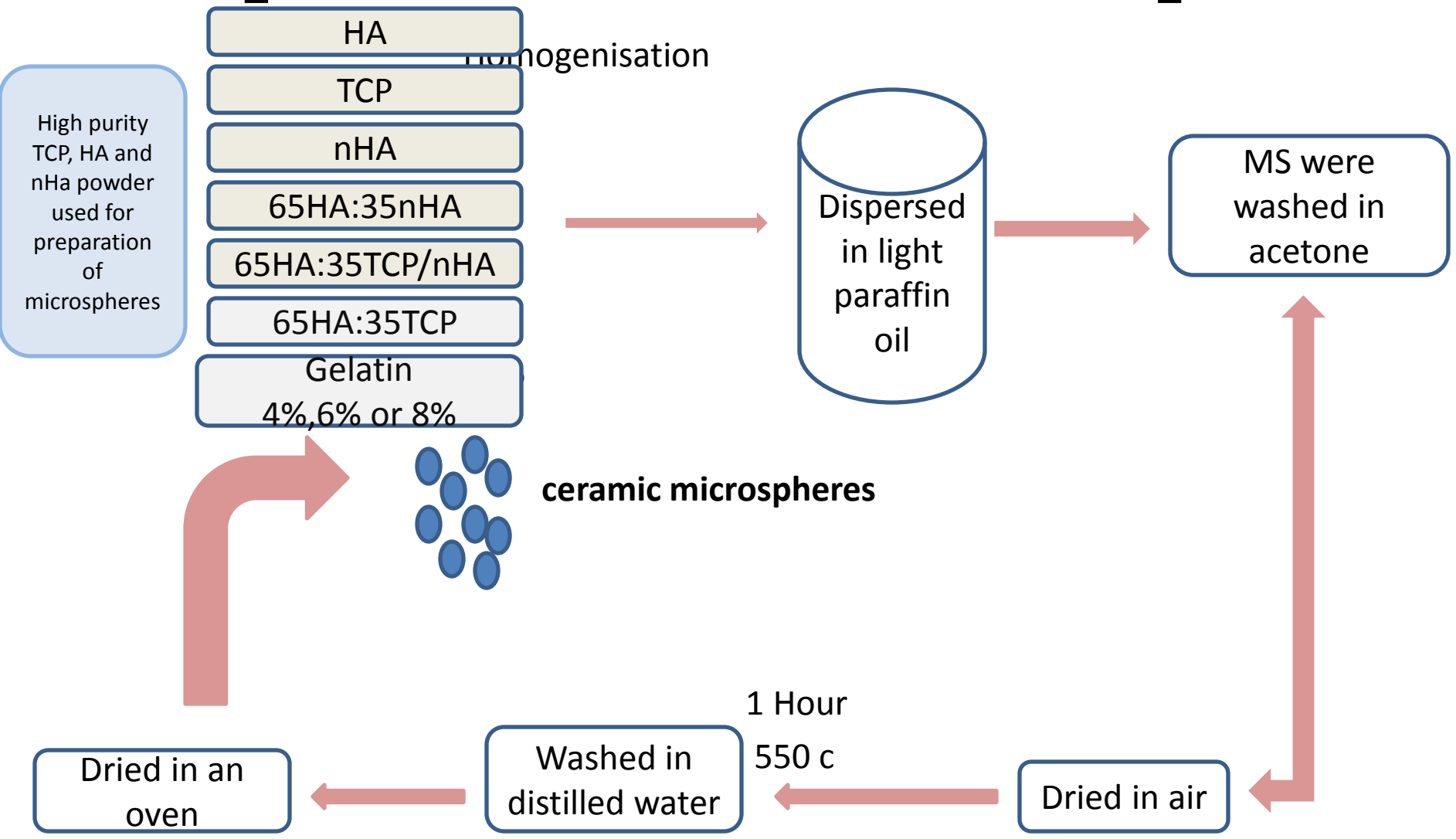


In our project

We got to the bottom of the resorbable ceramics microspheres such as biphasic calcium phosphate, which are ideal condidates as drug delivery system.

Materials and method

Preparation of BCP microspheres



- The in vitro bioactivity of the microspheres was assessed by incubating the microspheres in a simulated body fluid.

- The synthesised BCP powder and microsphere samples were characterised by X-ray powder diffraction (XRD) method.

- The morphology of the BCP granules and microspheres were observed under a scanning electron microscopy .

Result and Discussion

SEM result

- The shape and surface morphology of the microspheres, as observed by SEM are shown in an image.
- BCP microspheres that formed in 6% gelatine is shown in Fig.1. show considerable agglomeration and are uniformly spherical with smooth surface.
- The BCP microspheres that formed in 4% gelatine have sharp corners and are irregularly shape as shown in Fig.2.
- The BCP microspheres that formed in 8% gelatine to be highly agglomerated as shown in Fig.3.

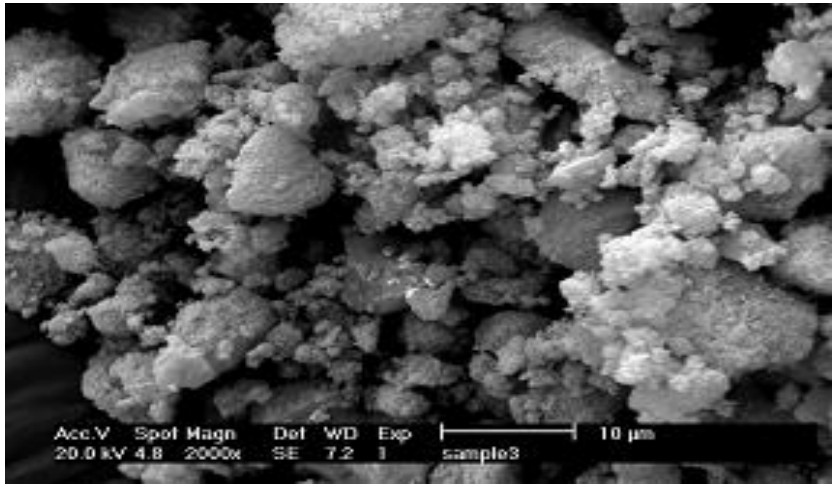


Fig.1 SEM micrographs of 6BCPMS

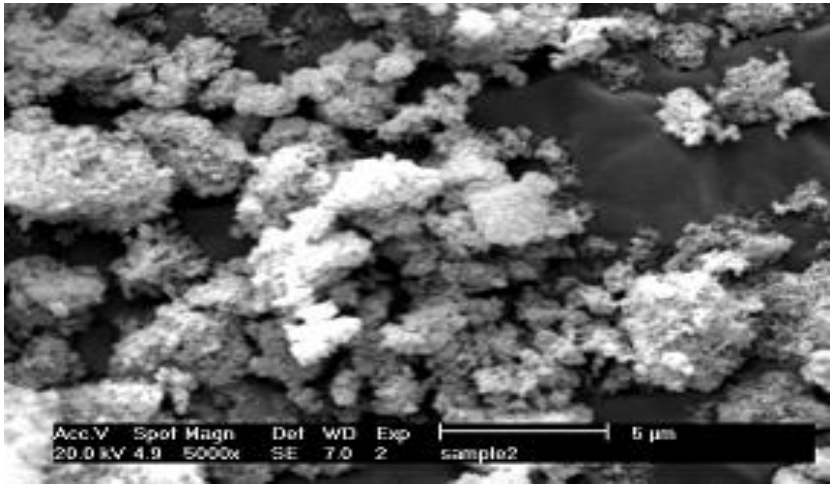


Fig.2 SEM micrographs of 4BCPMS

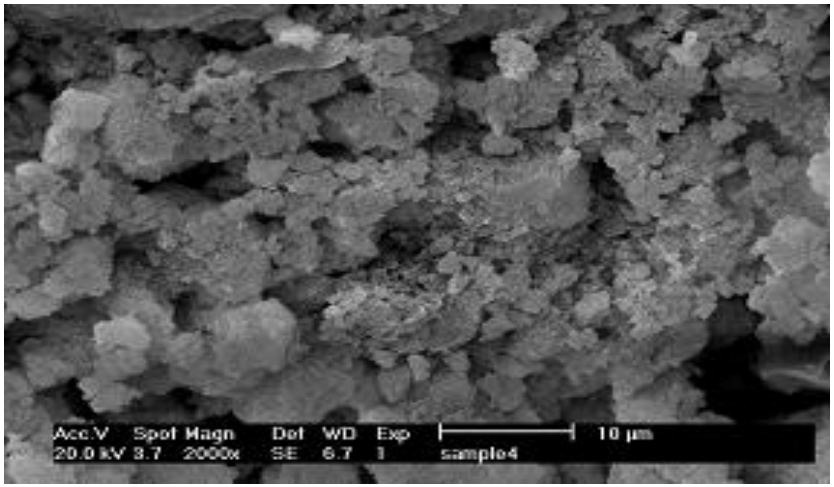


Fig.3 SEM micrographs of 8BCPMS

The hydroxyapatite microspheres: 6%: The microspheres appeared spherical in shape. Most of the microspheres had quite uniform surface morphology, 8%:seem to be agglomerated

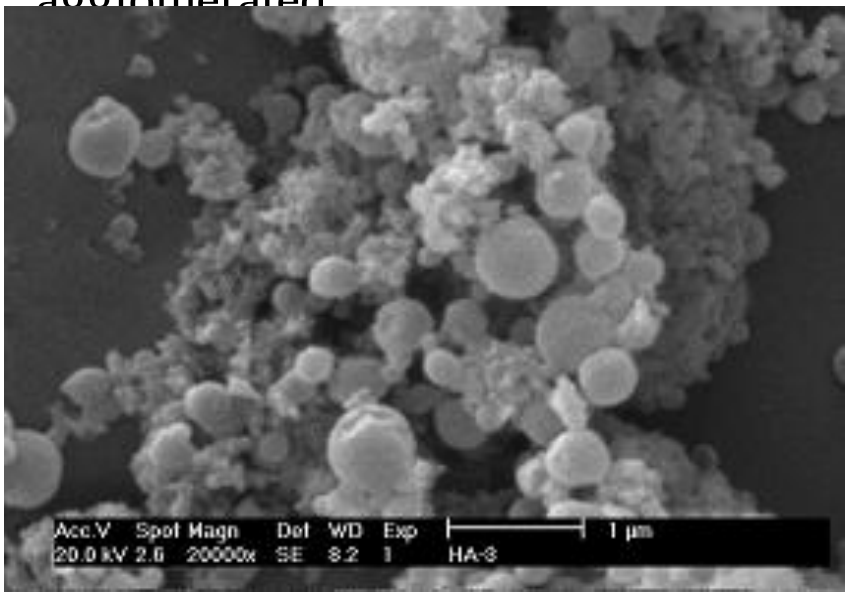


Fig.4 SEM micrographs of 6HAMS

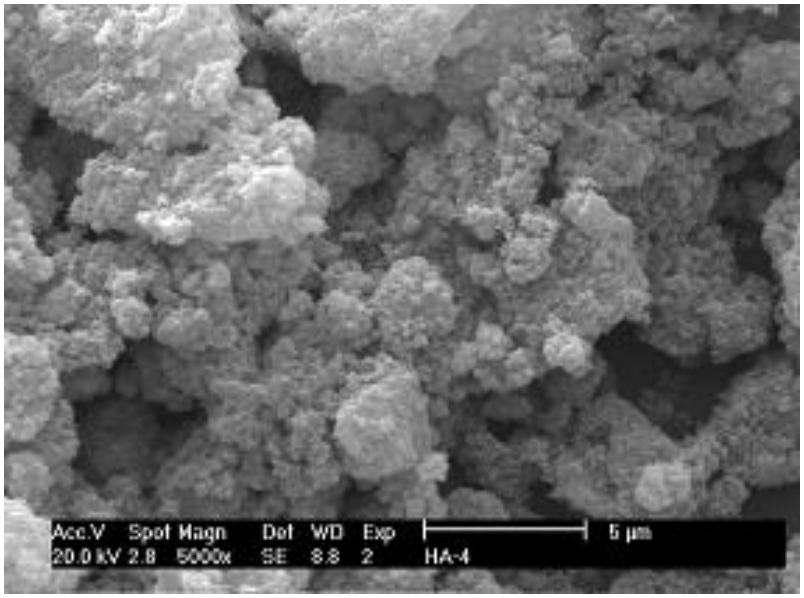
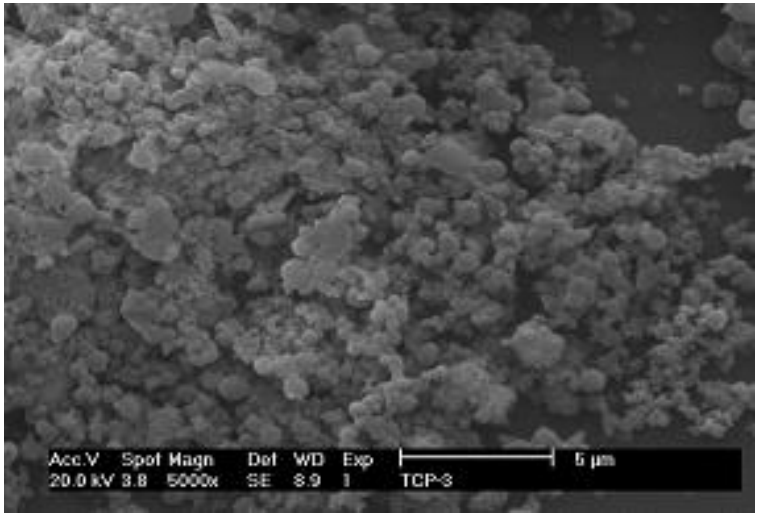


Fig.5 SEM micrographs of 8HAMS

tricalcium phosphate microspheres: 6%:appeared spherical in shape but not as good as 6HAMS,8%:have sharp corners and are irregularly shaped



6 SEM micrographs of 6TCPMS

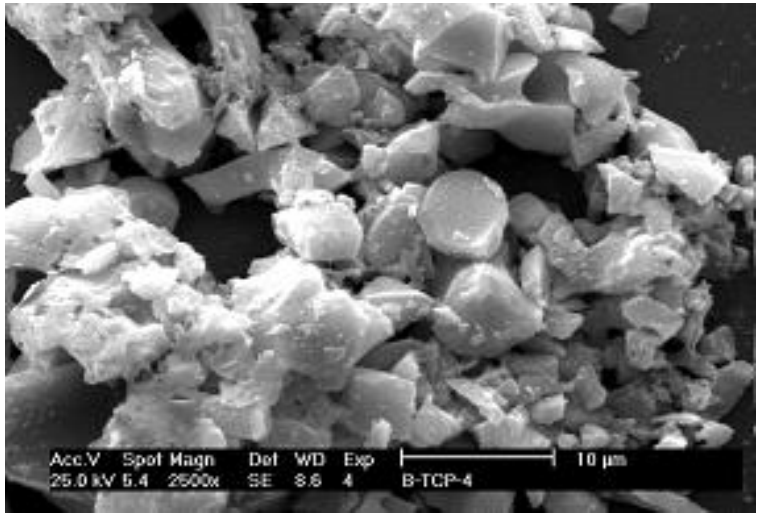


Fig.7 SEM micrographs of 8TCPMS

The nanohydroxyapatite microspheres that formed in 6% and 8% gelatin appeared spherical in shape and quite uniform surface morphology

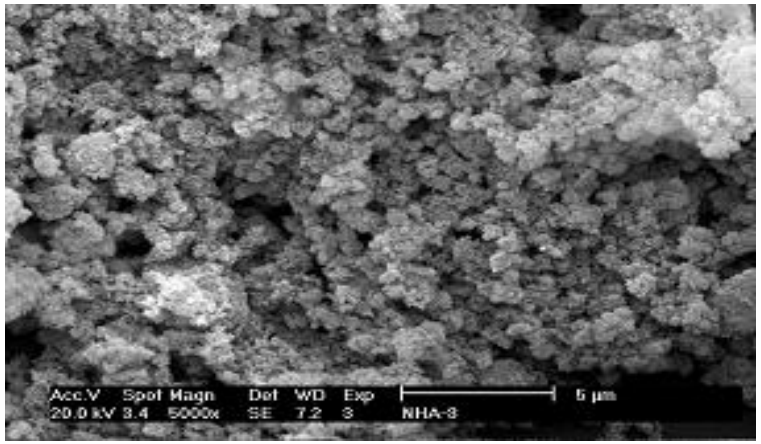


Fig.8 SEM micrographs of 6nHAMS

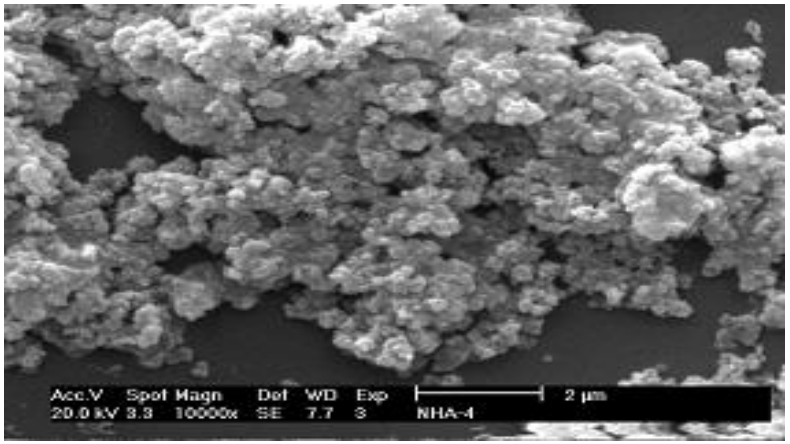


Fig.9 SEM micrographs of 8nHAMS

The nHA:HA=65:35 that formed in 6% and 8% gelatine, are uniformly spherical with smooth

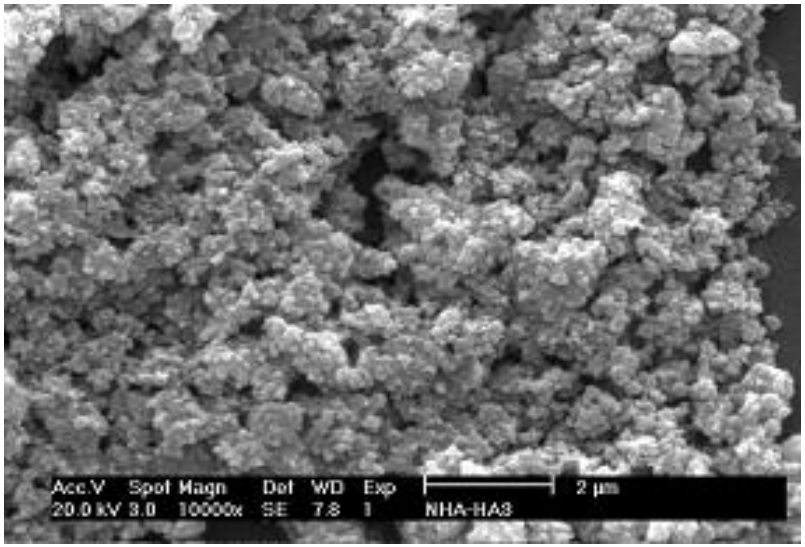


Fig.10 SEM micrographs of 6nHA:HAMS

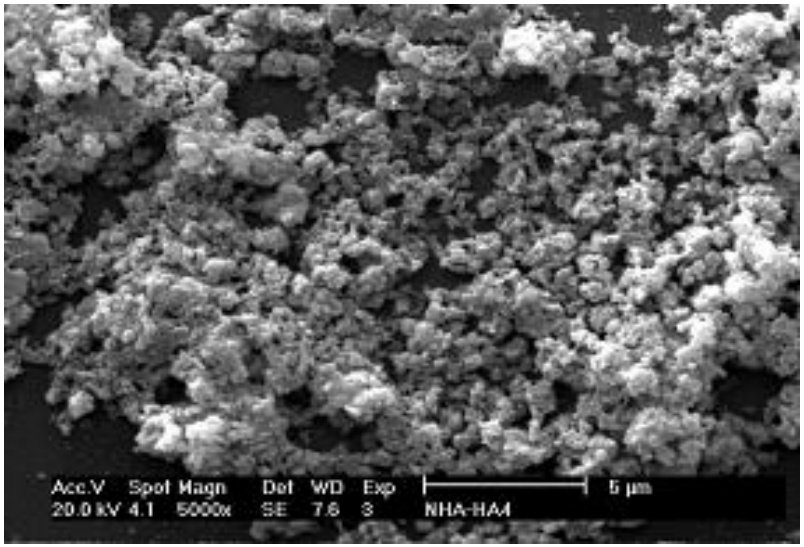


Fig.11 SEM micrographs of 8nHA:HAMS

The combination of HA, nHA and TCP make the last group microspheres of this study. The image shows the most perfect spherical microspheres with fairly uniform surface morphology.

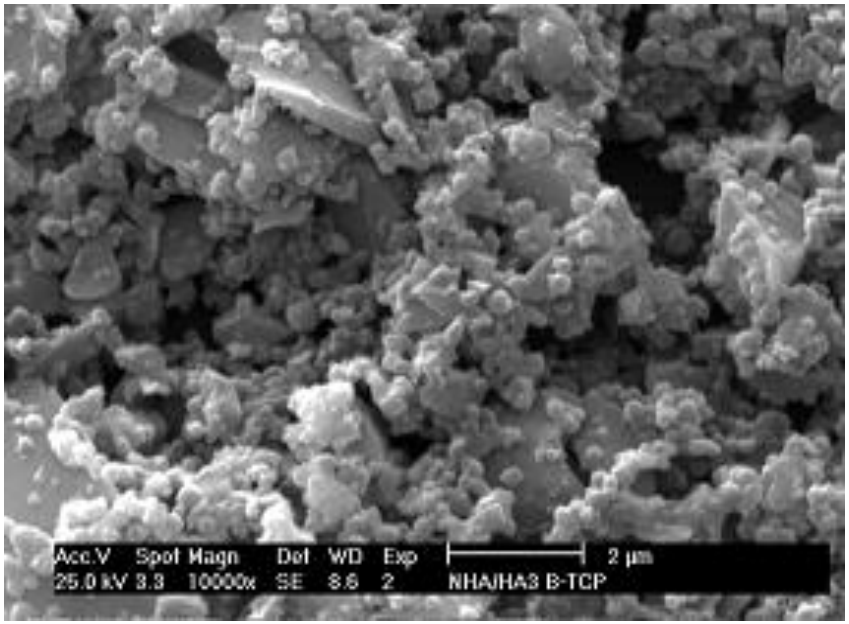


Fig.12 SEM micrographs of 6nHA:HA:TCPMS

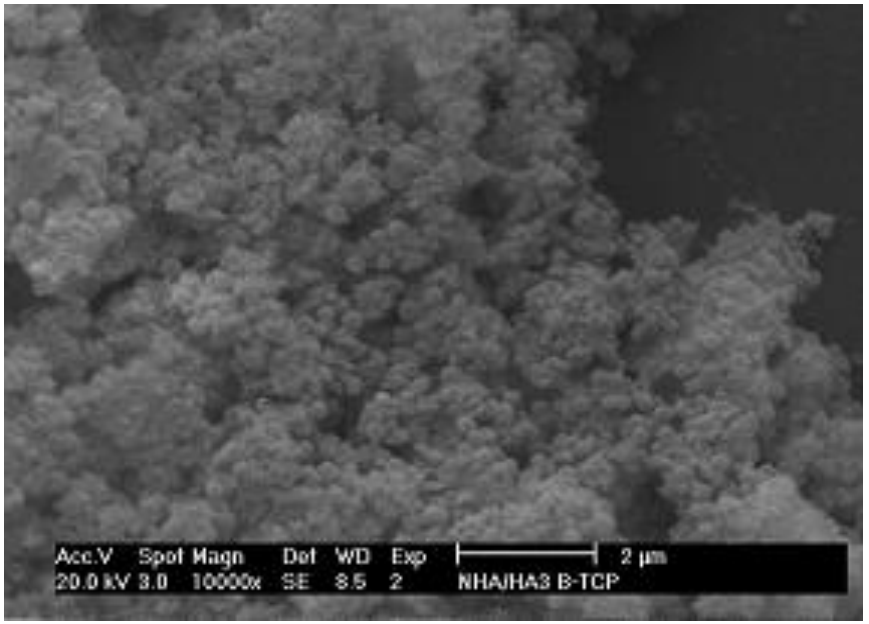


Fig.12 SEM micrographs of 8nHA:HA:TCPMS

XRD result

- The XRD pattern of the BCP microspheres formed with various amounts of gelatin is shown in Figs.15. patterns look similar to that of the starting BCP powder as also shown in the same figure for comparison and consists of both the peaks of HA and TCP phases but without other impurities.

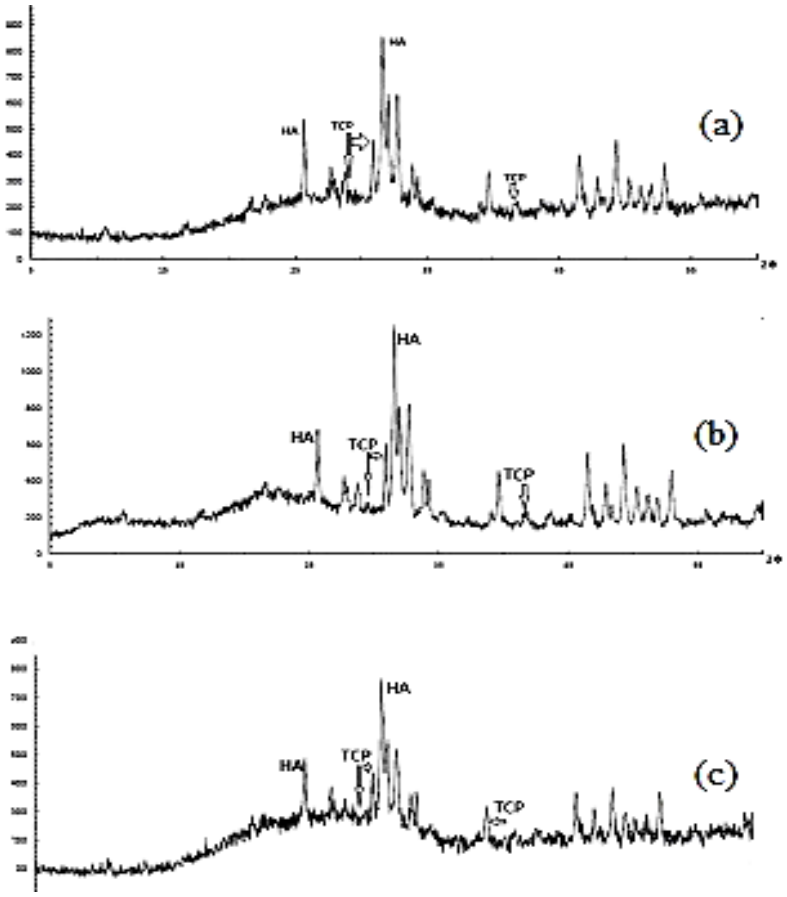


Fig.15XRD of BCP65 powder (a) 4BCP65 (b) 6BCP65 (c) 8BCP65

- The XRD pattern of as synthesised (The combination of HA, nHA and TCP)

This pattern same as BCP, show broad bands, the heated HA:nHA:TCP sample consists of all three the peaks of HA, nHA and TCP phases and without any impurities. Broad peaks around the characteristic peak regions indicate that the HA:nHA:TCP is microcrystalline in nature.

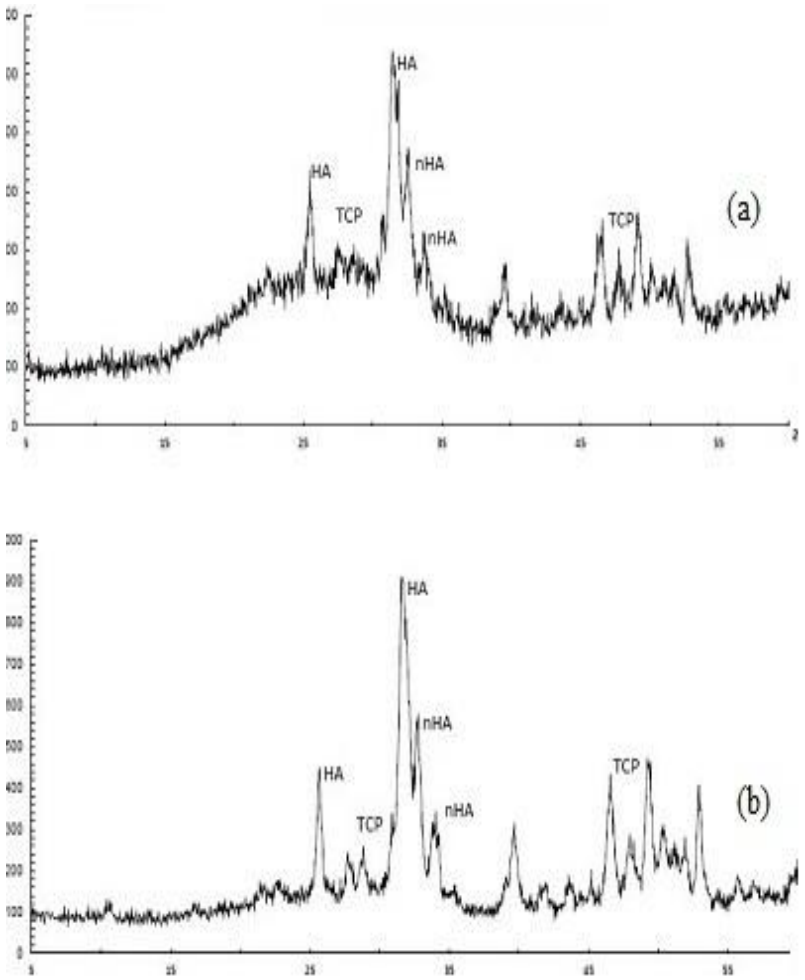


Fig.16 XRD of nHA:HA:TCP powder (a) 6 nHA:HA:TCP (b) 8 nHA:HA:TCP

- The XRD pattern of the nHA:HA samples is shown in Fig.17.

this samples follow the same rule as the other ones. They consists of both the peaks of nHA and HA phases and without any impurities.

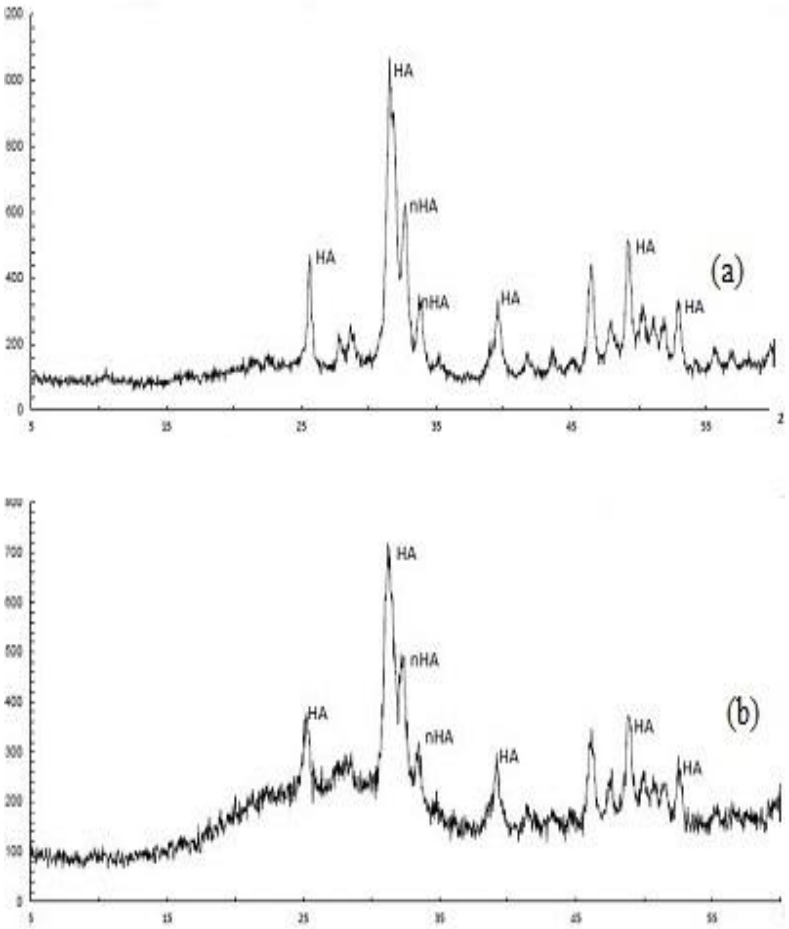


Fig.17 XRD of nHA:HA powder
(a) 6 nHA:HA
(b) 8 nHA:HA

- The XRD pattern of HA, nHA and TCP microspheres are shown in Figs.18,19,20. Their pattern are as same as synthesised of pour HA, nHA and TCP, gelatine and paraffin oil have no effect on them.

All the patterns look similar except with the difference in the relative intensities of the HA and TCP phases.

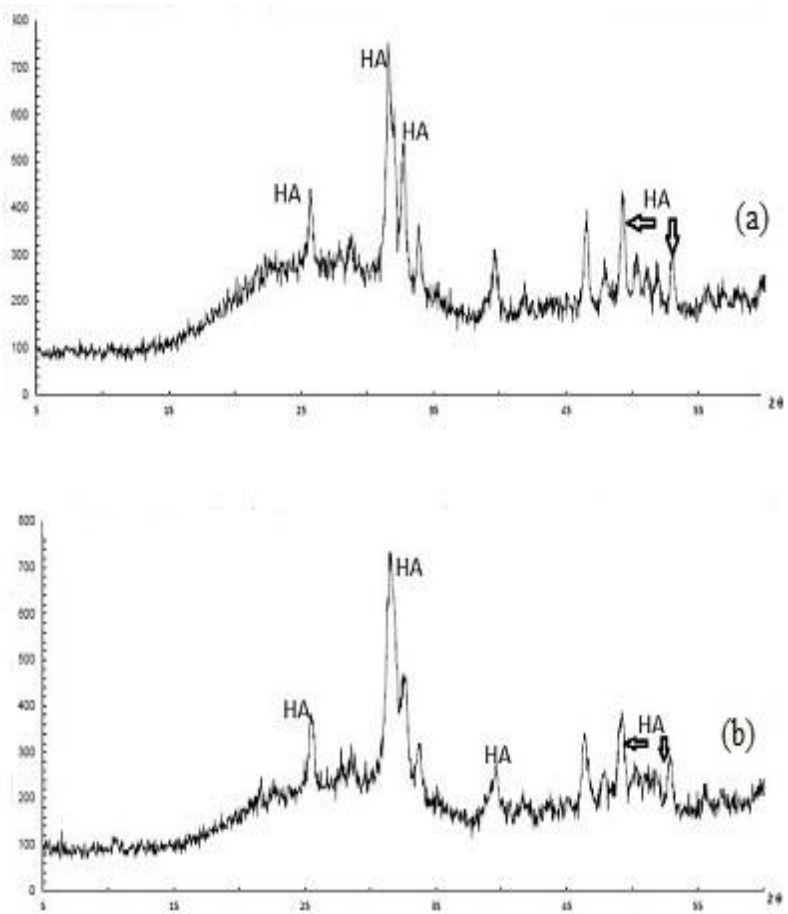


Fig.18 XRD of HA powder (a) 6HA (b) 8HA

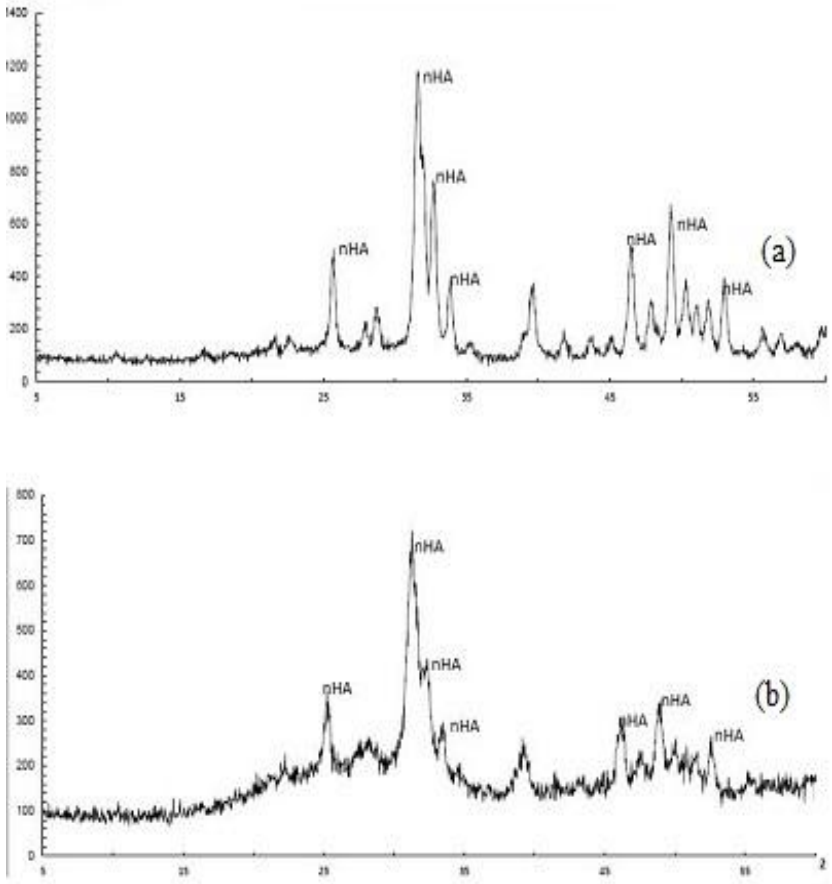


Fig.19 XRD of nHA powder (a) 6nHA (b) 8nHA

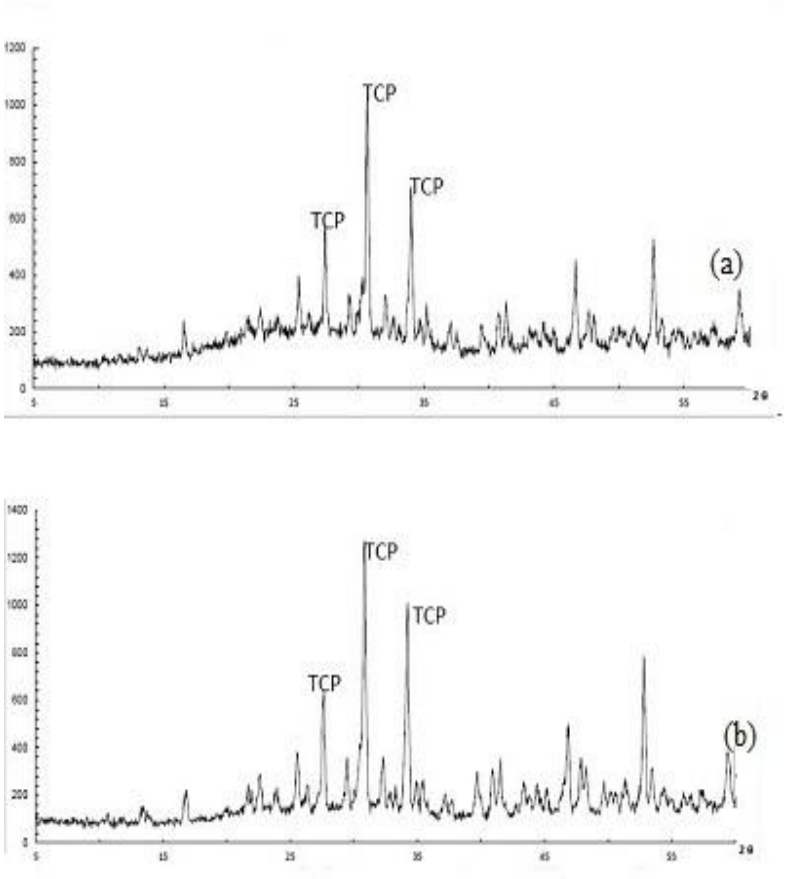


Fig.20 XRD of TCP powder (a) 6TCP (b) 8TCP

- The EDXA spectrum in Figs.21,22 for BCP microspheres which formed in 6% gelatine shows the atomic composition of the precipitates after one day and 14 days of immersion. The Ca/P ratio was measured to be one day 2.38, 14 days 2.14, which is similar but slightly (one day: lower, 14 days: higher) than that of stoichiometric HA (2.15)

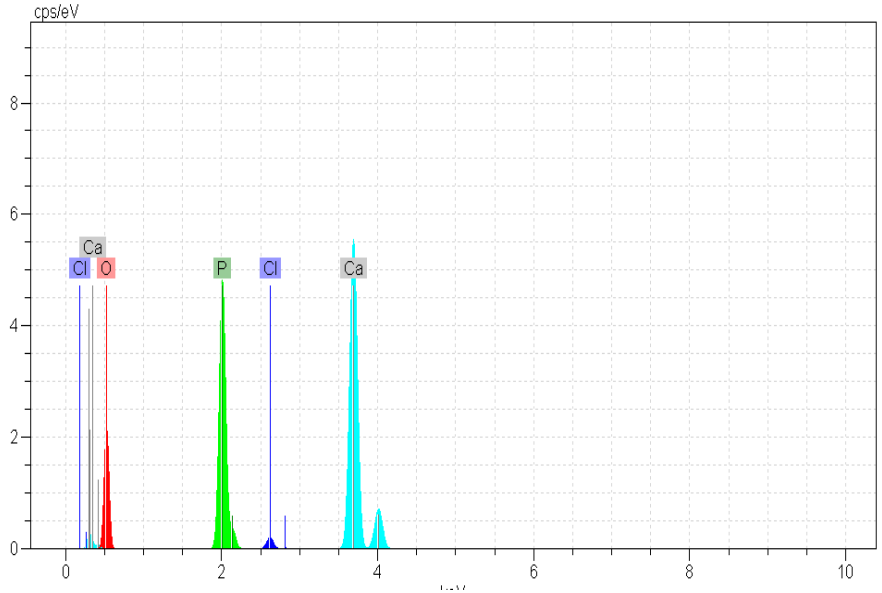


Fig.21. The EDXA analysis of the SBF sample immersed immersed for one days (6BCP65)

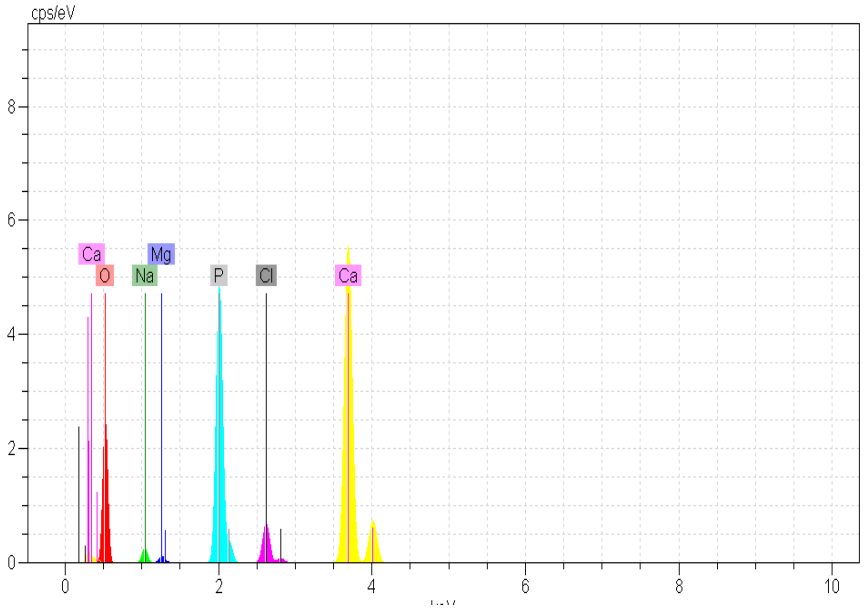


Fig.22. The EDXA analysis of the SBF sample for 14 days (6BCP65)

- The EDXA spectrum in Figs.23,24 for combination of HA, nHA and TCP microspheres which formed in 6% gelatine shows the atomic composition of the precipitates after one day and 14 days of immersion. The Ca/P ratio was measured to be one day 2.40, 14 days 2.24 which is similar but slightly higher than that of stoichiometric HA.

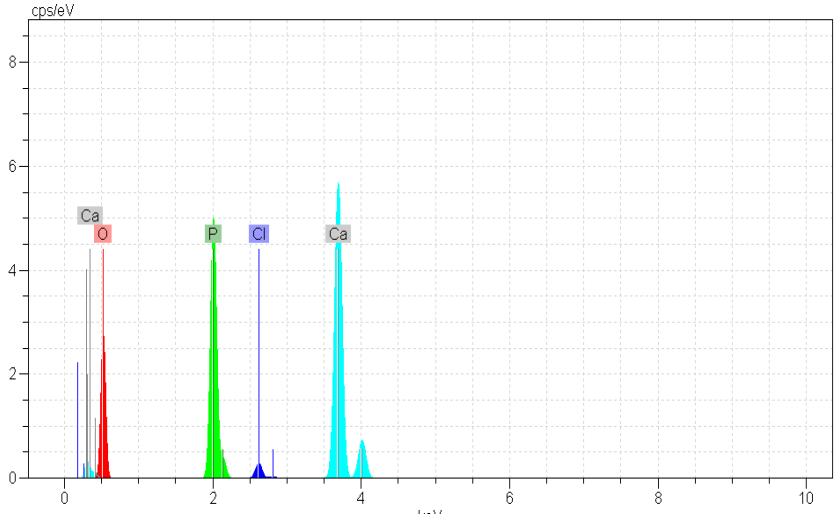


Fig.23. The EDXA analysis of the SBF sample immersed for one day

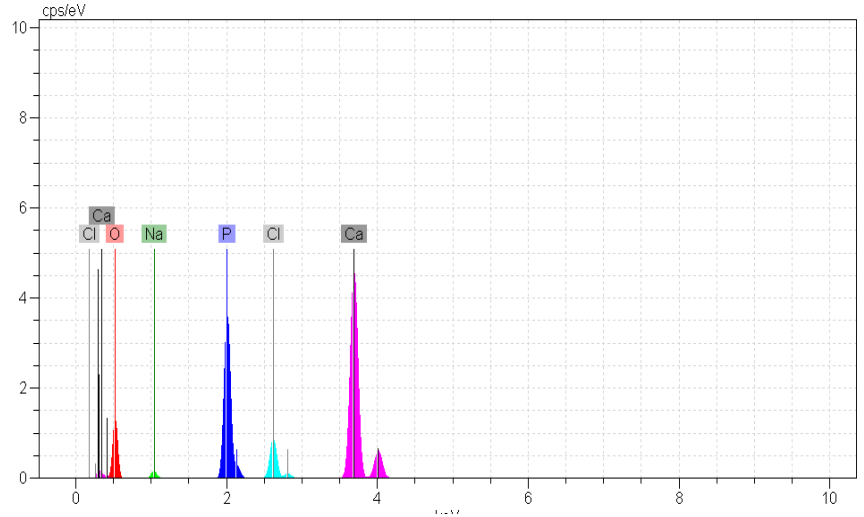


Fig.24. The EDXA analysis of the SBF

immersed (6HA:nHA:TCP)

for 14 days

conclusion

- The present study develop bioactive ceramic microspheres for applications in hard tissue regeneration.
- Best morphology observed in the case of microspheres formed using 6% gelatin.
- Due to the high surface to volume ratio, have a high potential as cell carrier.
- Microspheres property are Osteoinductive and Osteoconductive simultaneously.
- Spherical and smooth surface of the microspheres make them good condidate for drug release.

Thank you for your attention