Short Scientific report on the implementation of the project
PN-III-P1-1.1-PD-2019-0937 (contract no. PD 225 / 2021) entitled
"Biodegradable and Bioactive 3D Composite Scaffolds for Bone Regeneration in Osteoporosis"
Phase 1 – 2021

The main objective of phase 1 – 2021 was to obtain biodegradable 3D composite scaffolds, suitable for the incorporation of bioactive molecules, using and optimized method.

Osteoporosis is sometimes asymptomatic until the patient, often women over the age of 50, develops disastrous late-stage musculoskeletal complications, such as fractures [1]. In normal conditions, bone can regenerate and repair itself, but in this case, the regenerative process is compromised and requires support. The repair or replacements of the damaged or traumatized bone tissue can be accomplished by different grafting methods like autografts, allografts or bone substitutes [2]. Another promising technique for bone repair and regeneration is tissue engineering, which is based on: scaffolds, cells, and signalling molecules [3].

Biomaterials play a critical role in tissue engineering, functioning as artificial extracellular matrices or three-dimensional cell supports, used to repair or regenerate affected tissues. There are several forms of presentation of artificial matrices and scaffolds. They are processed either in the form of macroporous supports, injectable systems, spheres (beads), fibrous and nano-fibrous films and matrices, compact plates, tubes, gels, etc. [4].

Ceramic/polymer composites exhibit the best characteristics of each constituent: the toughness of polymer and stiffness of ceramic. These composites are produced as analogue biomaterials for bone substitute as natural bone is a collagen/apatite composite [5].

Naturally occurring polymers, or biopolymers, are among the most used biomaterials in the manufacturing of 3D scaffolds. Polysaccharides are on a high position in this application due to their easy availability, eco-friendly and non-toxic.

Guar gum (GG), a natural polymer with wide spread in nature, is a cheap source of galactomannan acquired by ground endosperm of *Cyamopsis tetragonolobus* or *Cyamopsis psoraloides* [6]. Due to its glycopolysaccharide structure GG interacts and binds with proteins and lectins in a physiological environment. The carboxymethylation of guar gums, resulting carboxymethyl GG (CMGG), increases their hydrophilicity and solution clarity and increase their solubility in aqueous systems [7].

Alginate is an anionic polysaccharide extracted from different species of brown algae, meaning that can be obtained for a cheap naturally available and affordable source. Depending on the source, its structure is based on a varied ratio of guluronate and mannuronat [8], groups with a high Ca content, which make ALG dressings to act as calcium ion (Ca) donors [9]. It is remarked for some unique properties, like non-toxicity and biocompatibility.

Considering all these theoretical aspects, in this phase biodegradable 3D composite beads have been prepared and characterized as scaffolds for bone regeneration in case of osteoporotic fractures.

The beads from sodium alginate, calcium phosphate tribasic and guar gum/carboxymethyl guar gum (previously prepared [7]), were prepared using ionic crosslinking.

The beads morphology (Scanning Electron Microscopy – EDX), their chemical structure (Fourier Transform Infrared Spectroscopy and X-Ray Diffraction) and their *in vitro* behavior (biodegradation) indicates that the obtained beads can be considered for the proposed application.

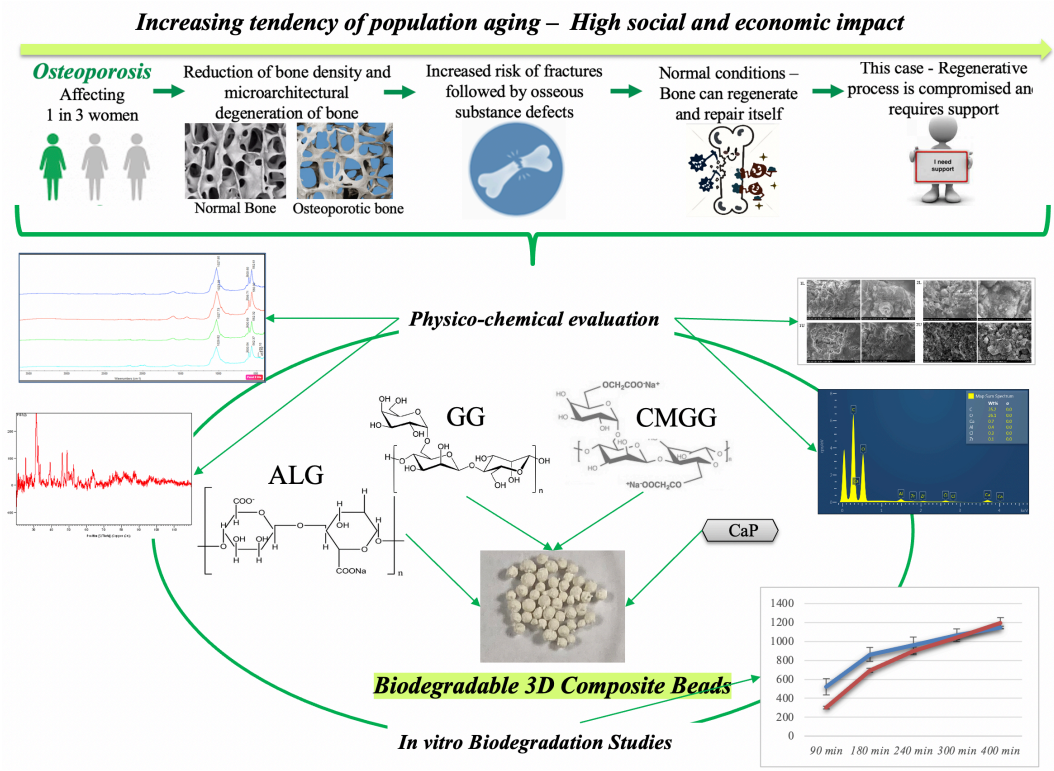

Figure 1. Flowchart for the performed activities in phase 1

The deliverables associated to the objective of phase 1:

- ✓ biodegradable 3D composite scaffolds, suitable for the incorporation of bioactive molecules;
- ✓ 2 poster presentations at international conferences;
- ✓ 1 international prize: Honorable mention for COJOCARU Florina Daniela, Grigore T. Popa University of Medicine and Pharmacy of Iasi, Romania, EU, *Best Poster Contest*, obtained at ***13th International Conference on Nanomaterials - Research & Application – NANOCON2021***, Brno, Cehia, Brno, Czech Republic, October 20th-22nd 2021 (https://www.nanocon.eu/en/contests/)
- ✓ 1 Workshop organized by Florina Daniela Cojocaru at **National Conference of Bioengineering for Students and Young Researchers, 23rd Edition**, April 22-25 2021, online; Title: *New biomaterials for bone regeneration: Theoretical and practic considerations*
- ✓ Participation at a international course
  Title of the course: *STEM CELLS AND REGENERATIVE MEDICINE,* organised by National and Kapodistrian University of Athens, September 20 – December 5 2021; online participation
- ✓ Draft for one research article which will be submitted to Journal of Applied Polymer Science, Wiley Online Library (Q2, Impact Factor 2020: 3,125).
- ✓ 1 activity report.

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