SUMMARY

The aim of this doctoral dissertation was the development and comprehensive characterization of composite biomaterials intended for applications in bone tissue engineering and surgery. The study focused on the fabrication of materials based on hydroxyapatite (HAp) and selected synthetic polymers, modified with bioactive additives (collagen and clindamycin) to impart regenerative and antimicrobial properties. It was hypothesized that appropriately designed composites would exhibit favorable physicochemical, mechanical, and biological properties, aligned with current clinical demands, particularly in the context of treating bone defects associated with osteoporosis. In the initial stage of the study, the ceramic phase was synthesized using a wet precipitation method, with optimization of reaction conditions in terms of phase purity, porous structure, and biocompatibility. The resulting material was compared to commercially available hydroxyapatite, demonstrating clear advantages resulting from the controlled synthesis process. Subsequently, polymer-ceramic composites were developed using PVA, PVP, and PEGDA, with an analysis of their stability, morphology, wettability, roughness, and mechanical properties. In the following stages, functionalization of the materials was carried out: the incorporation of fish or bovine collagen improved their surface and mechanical properties, while the addition of clindamycin conferred antimicrobial activity against *Staphylococcus aureus*. The evaluation of biological properties included cytotoxicity testing, assessment of pro-inflammatory activity, and an in vitro wound healing model. The obtained results confirmed the absence of cytotoxic effects and a positive influence of the developed materials on cell proliferation and regenerative processes.

The most promising solution proved to be the composite containing synthetic HAp, bovine collagen, and clindamycin. The study confirmed the feasibility of designing composite biomaterials with properties tailored to specific clinical applications. The developed materials constitute a potential basis for further research toward their use in regenerative medicine, with particular emphasis on the treatment of bone defects and the prevention of peri-implant infections.