The scaffolds were also developed by fabricating polyether-ether-ketone (PEEK) 3D-printed and modified with molybdenum disulfide (MoS_2) nanosheets and HAp nanoparticles. This is to overcome the limitations of its bio inertness and poor osteogenic properties for conventional PEEK scaffolds in treating malignant bone tumors (Dai et al., 2023). Furthermore, research is also being developed by filling Crocin (Cro) in a 3D printing matrix in a composite consisting of Chitosan (CH), collagen (Col), and HAp, which will be applied in the field of bone tissue engineering (BTE). 3D printing has shown potential applications in the field of bone tissue engineering (BTE) through the use of precise bone replacement scaffolds (Jirofti et al., 2023).

Several factors, such as deformity, osteoporosis, or tumors, can cause bone injuries and defects. Therefore, it is necessary to have a scaffold that has good biocompatibility, good mechanical performance, and controllable degradation properties. This scaffold provides an appropriate basis for tissue growth and cell proliferation (Ma et al., 2017; Yu et al., 2018; Zaky et al., 2017). Some types of scaffolds have been applied to repair bone defects, bone defect repair and regeneration, and bone tissue engineering.

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CHAPTER IX
GENERAL CONCLUSION

Biowaste from fish bone waste can be made into biomaterials such as hydroxyapatite (HAp), which can be used as a scaffold for tissue engineering. Optimal use of fish waste will support zero waste efforts and achieve the SDGs. HAp obtained from rabbitfish (*Siganus* sp.) bones is a cost-effective and environmentally friendly biomaterial source. The HAp content shows the presence of calcium and phosphorus as the primary constituents. Furthermore, the strontium (Sr) element is detected. Analyzing the characteristics of the resulting HAp demonstrated its potential application in bone regeneration and drug delivery. HAp is widely used as a coating for conventional implant materials such as titanium; even this combination continues to be innovated with the addition of one or more other elements such as iron, strontium, cerium, boron nitride, manganese, tannin, wollastonite, simvastatin, and others. The use of 3D printing technology is an innovation in the manufacture of HAp-based scaffolds, and one of its advantages is that it can personalize bone regeneration. HAp-based scaffolds offer a versatile and effective solution to treat various bone defects resulting from congenital anomalies, injuries, trauma, infections, or tumors. Its excellent biocompatibility, bioactivity, hydrophilicity, and nontoxic properties make HAp a valuable biomaterial in the field of orthopedics. Moreover, achieving an ideal balance between biocompatibility, biodegradability, and mechanical strength is an ongoing challenge. As technology advances, it offers comprehensive solutions that include biocompatibility, biodegradability, mechanical resistance, and adaptability to a wide range of clinical scenarios. Furthermore, the development of innovative HAp-based scaffolds represents a significant step toward improving medical interventions in bone-related disorders.