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CLAY MINERALS AS INGREDIENTS OF INK AND BIOINKS INTENDED FOR 3D PRINTING AND BIOPRINTING

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Three-dimensional printing (3DP) is an additive manufacturing technique that creates a physical three-dimensional piece from a digital computer design. One of the most important advantages of 3DP lies in its versatility, demonstrated by the wide variety of 3DP techniques currently available and the plethora of materials that can be used, to the possibility of adapting the dimensions and shape of the 3D construct just by changing the digital design to be printed. 3DP has influenced a significant number of areas. Regarding the pharmaceutical field, 3DP has opened a new door to the development of tailor-made dosage forms and medical devices (Desu et al., 2021). 3DP has even adapted to the idiosyncrasies of tissue engineering and regenerative medicine, enabling the production of anatomical models (acellular scaffolds) (Wang and Yang, 2021) and tailor-made 3D tissues and organs (cellular scaffolds) (Agarwal et al., 2020). In the last case, ink formulations are based on biocompatible and biodegradable polymers with high water content like gelatin, alginate, chitosan, fibrinogen, collagen, etc. However, their low mechanical resistance compromises their functionality and handling. At this point, there is a need for biocompatible ingredients to improve the limitations of the aforementioned polymeric ingredients. Among the potential candidates, inorganic materials like clay minerals (natural and synthetic) have proven their usefulness as mechanical reinforcement and rheology additives of different polymers (Ruiz-Hitzky et al., 2013). Moreover, they are naturally occurring materials with recognized biocompatibility and bioactivity, revealing them as optimal candidates for this cutting-edge technology. The pairing of “clay minerals” and “3DP” is a rather recent field of study. For the particular case of 3D bioprinting and tissue engineering, the number of publications dealing with clay minerals is still scarce but those already published highlight that these ingredients are useful as rheology modifiers, can favor cell adhesion/orientation and, mostly, as mechanical reinforcement (Garcia-Villen et al., 2021). Notwithstanding the aforementioned advantages, the use of inorganic materials as ingredients of inks and bioinks still has certain limitations that need to be addressed. Close collaboration between geochemists/mineralogists and experts in regenerative medicine could prove particularly fruitful in counteracting some of the current limitations in this field of study.

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