3D-Printed Buccal Films for Transmucosal Antidepressant Delivery and Personalized Dose Tapering

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Major depressive disorder (MDD) affects over 332 million people worldwide and is a leading cause of disability. Duloxetine is a widely prescribed antidepressant; however, discontinuation is often complicated by withdrawal symptoms such as anxiety, nausea, and insomnia. Because duloxetine is available only as fixed-dose capsules, patients attempting gradual tapering resort to opening capsules and manually counting or weighing tiny pellets to approximate smaller dose reductions. Additionally, duloxetine's oral administration limits bioavailability to 50% and presents swallowing challenges that can cause patient distress and disadherence. This study aims to develop 3D-printed buccal films for personalized duloxetine delivery, providing an alternative route that increases bioavailability, eliminates the need for swallowing, and enables accessible individualized dosing and drug tapering. Non-medicated films were produced using a polymer matrix of hydroxypropyl methylcellulose (HPMC) and sodium alginate, with sucrose incorporated to enhance taste. Films were successfully printed and demonstrated precise dimensional fidelity across multiple prints. Swelling studies in PBS at 37.5 °C showed rapid initial hydration followed by slower swelling over 20 minutes, indicating suitable swelling behavior. Folding endurance testing on 3 films revealed high mechanical flexibility, with one film tolerating 597 folds and two exceeding 600 folds, highlighting excellent durability. These findings establish SSE 3D printing as a promising platform for personalized duloxetine delivery. With future drug incorporation, this approach could be implemented in hospitals and psychiatric clinics to provide a more adaptive, tolerable, and patient-centered alternative for the millions with MDD.

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