

COMPARATIVE ANALYSIS OF CULTIVATION TECHNIQUES FOR MCF-7 TUMOR CELLS: AGAROSE SEEDING, ALGINATE MIXING, AND 3D BIOPRINTING

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ABSTRACT

Abstract text: The development of 3D tissue models has provided a more physiologically relevant platform to study cancer biology and test therapeutic interventions compared to conventional 2D cell culture systems. This study was designed to explore and evaluate three different methods to create a 3D biomimetic hydrogel platform for the growth of MCF-7 human breast cancer cells. Three different methods were used to engineer 3D-printed sodium alginate hydrogels for the formation of tumoroids. The results demonstrated that the 3D-printed hydrogel scaffold facilitated cell-cell interactions and facilitated the development of a tumor microenvironment. Furthermore, quantitative analysis using ImageJ revealed that Method 3, a FRESH printing method, provided the most suitable environment for the proliferation and growth of MCF-7 cells into tumoroids, allowing the study of tumor growth, invasion, and response to therapy in a controlled and reproducible manner. This system, as evidenced by qualitative microscopy images and quantitative ImageJ analysis, highlights its promise for applications in drug screening, therapeutic planning, and personalized medicine. Further optimization and characterization of this platform could lead to more accurate and reliable in vitro cancer models, reducing reliance on animal studies and advancing cancer therapy approaches.

Keywords: 3D Bioprinting; Agarose; Alginate; Hydrogel; MCF-7 breast cancer cells; Tumor; Tumoroid.

INTRODUCTION

Cancer remains a global health challenge. In 2022, it was responsible for close to 10 million deaths worldwide [1]. The global burden of cancer is expected to increase to 35 million new cancer cases by 2050 due to the growth and aging of the population. This alarming statistic emphasizes the need for innovative research and treatment strategies. The complexity of cancer, characterized by its genetic diversity and heterogeneity of its cellular and molecular processes, presents a challenge to researchers and clinicians [2]. Despite advances in our understanding of cancer biology, the translation of this knowledge into effective therapeutic interventions remains problematic. Traditional animal studies have advanced our understanding of cancer biology and helped the development of therapeutic interventions. However, these studies are not without limitations. The high cost of animal maintenance, the long duration of experiments, and the ethical considerations associated with animal use are key challenges [3]. Furthermore, physiological differences between humans and animals often result in poor translation of research findings to clinical applications. For example, mice, the most used model in cancer research, have a significantly faster metabolism and shorter lifespan compared to humans, which can lead to discrepancies in drug metabolism and toxicity profiles [4]. Furthermore, genetic and immunological differences between humans and mice can result in differential responses to cancer therapies [5]. These limitations emphasize the need for alternative research models that can accurately recapitulate human cancer biology while addressing the ethical concerns associated with animal use.

Tissue engineering, a rapidly evolving field that combines principles of biology, chemistry, and engineering, offers an alternative to traditional animal studies. This multidisciplinary approach aims to develop functional substitutes for