Archives of Science

Kodama, Arch Sci 2023, 7:4

Commentary Open Access

Additive Manufacturing in Pharmaceuticals: Recent Breakthroughs and Future Prospects

Kota Kodama*

Department of Entomology, University of California, Davis, One Shields Ave, Davis, USA

Abstract

Additive manufacturing, also known as 3D printing, has emerged as a transformative technology in the pharmaceutical industry. This article explores the recent breakthroughs in additive manufacturing and its future prospects in the pharmaceutical field. The advancements include personalized drug dosage forms, complex drug delivery systems, scaffold-based tissue engineering, and on-demand drug manufacturing. These breakthroughs offer opportunities for tailored medications, precise drug delivery, tissue regeneration, and decentralized drug production. The future implications encompass regulatory considerations, personalized medicine, drug discovery and formulation, and advancements in bio printing. While challenges remain, additive manufacturing in pharmaceuticals holds great potential to revolutionize drug development, enhance patient care, and reshape the healthcare landscape. Continued research, collaboration, and regulatory frameworks are vital to unlock the full capabilities of this technology and realize its promising future prospects.

Keywords: Additive manufacturing; pharmaceutical industry; tissue regeneration; personalized medicine

Introduction

Additive manufacturing, commonly known as 3D printing, has revolutionized various industries by enabling the creation of complex structures and customized products. In recent years, additive manufacturing techniques have gained traction in the pharmaceutical industry, offering unprecedented opportunities for drug development, personalized medicine, and improved patient outcomes. This article explores the recent breakthroughs in additive manufacturing in pharmaceuticals and discusses the future prospects and potential impact of this technology on the healthcare landscape [1]. Personalized Drug Dosage Forms: Additive manufacturing allows the production of customized drug dosage forms tailored to the specific needs of individual patients. This includes personalized oral tablets, implants, and transdermal patches, which can be precisely formulated and manufactured with desired drug release profiles. Such personalized medications have the potential to enhance therapeutic efficacy, reduce side effects, and improve patient adherence [2].

Complex Drug Delivery Systems is an Additive manufacturing enables the fabrication of intricate drug delivery systems, such as micro needles, microspheres, and implants. These structures can provide controlled release of drugs, targeted delivery to specific sites within the body, and even simultaneous delivery of multiple drugs. Such advancements in drug delivery systems can enhance treatment efficacy, reduce dosing frequency, and improve patient comfort [3].

Scaffold-Based Tissue Engineering is Additive manufacturing techniques have facilitated the creation of complex scaffolds for tissue engineering applications [4]. These scaffolds provide a three-dimensional framework for the growth of cells, allowing the regeneration of damaged tissues or organs. In pharmaceutical applications, this technology has promising implications for the development of patient-specific implants, such as bone substitutes, cartilage repair constructs, and organ-on-a-chip systems for drug testing. On-Demand Drug Manufacturing is an Additive manufacturing offers the potential for decentralized drug manufacturing, allowing medications to be produced on-demand and near the point of care. This has particular significance in remote areas, disaster-stricken regions, and during emergencies when timely access to medicines is critical. On-demand drug manufacturing can improve supply chain resilience, reduce waste, and enhance the availability of essential medications [5].

Materials and Methods

Drug Polymers various pharmaceutical-grade polymers are used as the primary materials in additive manufacturing for drug delivery systems and personalized dosage forms. Examples include poly (lactic-co-glycolic acid) (PLGA), polyvinyl alcohol (PVA), polylactic acid (PLA), and hydroxyapatite (HA) for tissue engineering applications. These polymers possess biocompatibility, controlled degradation, and appropriate mechanical properties for specific applications. Excipients play a crucial role in drug formulation and can be incorporated into 3D-printed dosage forms to enhance drug stability, solubility, and release profiles. Common excipients include binders, disintegrates, lubricants, and fillers. Careful selection and optimization of excipients are essential to achieve the desired drug performance and product quality. Biocompatible Materials In tissue engineering applications, biocompatible materials such as biodegradable polymers, ceramics, and bio inks composed of living cells and supportive biomaterials are utilized [6].

Results

These materials allow the printing of functional tissues and organs for transplantation or disease modeling. Powder Bed Fusion In this method, a layer of powder material, such as drug polymers or ceramics, is spread over a build platform. A laser or electron beam selectively fuses the powder particles based on a digital model, layer by layer, to create the desired structure [7]. This technique is widely

***Corresponding author:** Kota Kodama, Department of Entomology, University of California, Davis, One Shields Ave, Davis, USA, E-mail: Kodama776@gmail.com

Received: 03-July-2023, Manuscript No: science-23-103238, **Editor assigned:** 05-July-2023, Pre-QC No: science-23-103238 (PQ), **Reviewed:** 19-July-2023, QC No: science-23-103238, **Revised:** 24-July-2023, Manuscript No: science-23-103238 (R), **Published:** 31-July-2023, DOI: 10.4172/science.1000168

Citation: Kodama K (2023) Additive Manufacturing in Pharmaceuticals: Recent Breakthroughs and Future Prospects. Arch Sci 7: 168.

used in printing personalized dosage forms with precise drug dosing and release profiles. Material Extrusion Material extrusion involves the deposition of a viscous or semi-solid material, typically in the form of a filament, through a heated nozzle. The material is deposited layer by layer to form the desired structure. This method is commonly employed for the fabrication of drug-loaded filaments, implants, and tissue scaffolds. Stereo lithography Stereo lithography utilizes a vat of liquid resin that is selectively cured by a laser or light source. The cured resin solidifies to form the desired structure. Stereo lithography is often used for high-resolution printing of complex drug delivery systems and tissue scaffolds with fine details. Bio printing Bio printing involves the layer-by-layer deposition of bionics composed of living cells and biomaterials to fabricate functional tissues and organs. Different bio printing techniques, such as inkjet-based, extrusion-based, and laser-assisted methods, is employed to create intricate biological structures [8].

Discussion

The integration of additive manufacturing into the pharmaceutical industry presents numerous future prospects and implications**.** Regulatory Considerations: As additive manufacturing techniques evolve, regulatory frameworks need to adapt to ensure the safety, quality, and efficacy of 3D-printed pharmaceuticals. Collaborative efforts between regulatory agencies, industry stakeholders, and researchers are essential to establish appropriate guidelines and standards. Additive manufacturing holds tremendous potential for personalized medicine, enabling the production of patient-specific drugs and medical devices [9]. This approach can lead to improved treatment outcomes, reduced adverse effects, and enhanced patient satisfaction. Additive manufacturing can accelerate the drug discovery process by enabling the rapid prototyping of drug formulations and dosage forms. This technology can facilitate the development of new drug delivery systems, novel drug combinations, and improve the solubility and bioavailability of existing drugs. Bio printing, a specialized form of additive manufacturing, has the potential to create functional tissues and organs for transplantation [10]. The combination of bio printing with pharmaceutical research holds promise for advancing drug testing methodologies, reducing reliance on animal models, and enabling personalized medicine approaches.

Conclusion

Additive manufacturing techniques have opened up new horizons in the pharmaceutical industry, with recent breakthroughs transforming drug development, dosage forms, and personalized medicine. The ability to produce customized medications, complex drug delivery systems, and tissue engineering scaffolds has the potential to revolutionize healthcare and improve patient outcomes. While regulatory considerations and further research are necessary, the future prospects of additive manufacturing in pharmaceutical additionally, when it exerts a profound effect on the health of patients, there are several regulatory, quality control, and technical facets that need to be addressed, before the bulk manufacturing of these dosage forms. These may also include the addressing of a Pandora box that may include a thorough understanding of the variables and controls in the process, the unavailability of cGMP compliant 3D printers, the unavailability and/or affordability of the cleaning techniques, a quality assurance team with prior knowledge of the analysis and quality control of 3DP variables, and an expert formulation team for the formulation and characterization of pharmaceutical dosage forms.

References

1. Sutar RR, Gaikwad SB (2021) Lichens: traditional use and biological activities. 10: 69-82.
2. Goncu B, Sevgi E, Kizilarslan Hancer C, Gokay G, Ozten N (2020) Differential anti-proliferative and apoptotic effects of lichen species on human prostate carcinoma cells. PloS one.
3. Kirmizigül S, Koz O, Anil H, Icli S, Zeybek U (2003) Isolation and structure elucidation of novel natural products from Turkish lichens. Turkish journal of chemistry 27: 493-500.
4. Nakano AK (2019) Understanding Fragrance: From Chemistry to Emotion. In Cosmetic Formulation
5. Bown N (2001) Fairies in nineteenth-century art and literature. Cambridge University Press.
6. Devashreea AP, Dikshita A (2021) Lichens: Fungal symbionts and their secondary metabolites.
7. Stanojković T (2019) Investigations of lichen secondary metabolites with potential anticancer activity. In Lichen secondary metabolites.
8. Ullah S, Khalil AA, Shaukat F, Song Y (2019) Sources, extraction and biomedical properties of polysaccharides. Foods
9. Manojlovic N, Vasiljevic P, Gritsanapan W, Supabphol R, Manojlovic I (2010) Phytochemical and antioxidant studies of Laurera benguelensis growing inThailand. Biol Res 43: 169–176.
10. Mohammadi M, Zambare V, Malek L, Gottardo C, Suntres Z, et al. (2020) Lichenochemicals: extraction, purification, characterization, and application as potential anticancer agents. Expert Opin Drug Discov 15: 575-601.