Fabrication and Characterization of 3D Printed Solid Oral Dosage Forms

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Abstract

The pharmaceutical industry has been positively impacted by the 3D printing technique. Nevertheless, it has been poorly investigated. This study, was focused on fabricating solid oral dosage forms manufactured with corn and potato starch to obtain a 3D printed tablet. The starches underwent powder characterization to evaluate raw material consistency. Subsequently, the starches were mixed with water as solvent and heat was applied to produce the starch-based inks used in the 3D printer. However, preliminar manufactured tablets showed poor uniformity in their characteristics.

This study sheds light on improving the accessibility for the patient, waste reduction, and personalized medicine. Being able to fabricate a tablet utilizing biopolymers and 3D printing technique will contribute in an innovative way to society and to the pharmaceutical industry.

Introduction

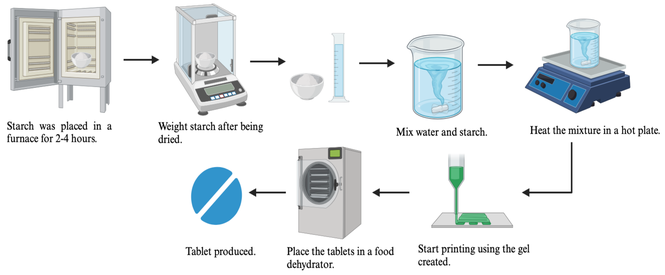
- The use of corn and potato starch used as the main component to produce a 3D printed tablet.
- Development of personalized medicine in ways of dosage management for specific groups or better intake of medication.
- This study aims to descale large manufacturing, reduce the carbon footprint of moving the supply chain, and improve the accessibility for patients.

Objective

- Manufacture pharmaceutical tablets using biopolymers and 3D printing process.

Methodology

- Starch-based inks were formulated for the use of the 3D printer.
- Starch powder was characterized by using the tap density and angle of repose method to determine if it fit for the gel ink.
- Prior to the process of printing, computer programs such as Tinker CAD and UltiMaker Cura were used to design the tablet and set parameters.



Data and Results

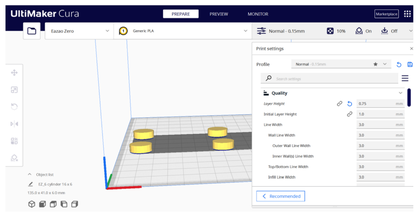
Raw Material	Repose Angle	Initial Volume (mL)	Final Volume (mL)	Bulk Density (g/mL)	Tap Density (g/mL)	Compressibility Index	Hausner Ratio
Corn Starch	41	91.5	61.0	0.44	0.66	33.3	1.50
Potato Starch	35	57.5	47.0	0.70	0.85	18.2	1.22

Flow Property	Angle of Repose (degrees)
Excellent	25–30
Good	31–35
Fair—aid not needed	36–40
Passable—may hang up	41–45
Poor—must agitate, vibrate	46–55
Very poor	56–65
Very, very poor	>66

Compressibility Index (%)	Flow Character	Hausner Ratio
≤10	Excellent	1.00–1.11
11–15	Good	1.12–1.18
16–20	Fair	1.19–1.25
21–25	Passable	1.26–1.34
26–31	Poor	1.35–1.45
32–37	Very poor	1.46–1.59
>38	Very, very poor	>1.60

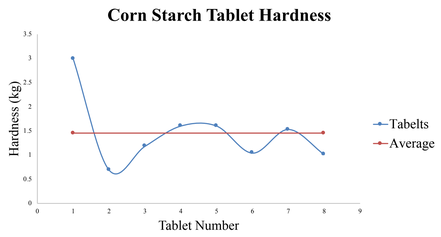
- Powder characterization results were compared with the index tables and demonstrated that the corn starch had a passable flow property.
- On the other, the potato starch states that it had a good flow property.

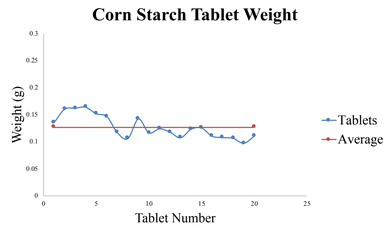
Tablet Progress



- Computer programs were used to design the tablet before printing.
- The progress of tablet uniformity is shown in the second and third image.

Tablet Hardness and Weight Analysis





- Standard Deviation Sample Hardness**: 0.70051**
- Standard Deviation Weight Population**: 0.02051**

Tablet	Dissolution Time
1	> 1 hour
2	> 1 hour
3	> 1 hour
4	> 1 hour
5	> 1 hour
6	> 1 hour

Tablet	Disintegration Time
1	22:55 min
2	36:29 min
3	40:23 min
4	> 1 hour
5	> 1 hour
6	> 1 hour

Conclusion

- Successful 3D printing of starch gels-based tablets.
- Starch-based preliminary tablets were characterized in terms of weight uniformity, hardness, disintegration, and visual dissolution. Uniformity in tablet characteristics was not reached.
- Starch-based inks were produced. However, it is necessary to improve the starch based inks consistency.

Future Work

- Optimize solution preparation, 3D printing process, and printing parameters.
- Add an Active Pharmaceutical Ingredient to the tablet formulation and characterize the new tablets.

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References

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