Usability study in characterizing pectin isolated from apple pomace as a circular scaffold material.

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PROJECT IDEA

The cell-cultured meat industry has been facing a scaffolding issue for a long time now. Scaffolds should consist of materials engineered to cause desirable cellular interactions to contribute to the formation of new functional tissues. They should ideally permit cell attachment, differentiation, and maturation in a specified manner and allow for continuous media perfusion, analogous to the vascularization of actual tissue. A scaffold offers many promising features and possibilities but also comes with difficulties and issues. This project shows promising results and offers a possible new approach to the scaffolding issue in cell-cultured meat, that should be explored in more depth.

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APPLE POMACE AS STARTING MARTERIAL

Apple pomace is commonly known to be a significant by-product of industrial apple processing, mainly juice, cider, and sauce production. Nearly 25 – 30 % of the fresh fruit body ends up as apple pomace, resulting in a large amount of waste. This research project aims to tackle the design and production of scaffolds, using an innovative 3D-printing technique combined with the isolation of pectin from apple pomace, to produce a stable and edible scaffold consisting of pectin and other ingredients

PROCESS STEP: PECTIN EXTRACTION

Additionally, the purpose is to prove the idea of validating the production process, starting from pectin isolation from apple pomace, over ink formulation, and ending with the 3D-printing process of the scaffolds.

Pectin is considered a structural heteropolysaccharide, with a plethora of potential benefits. It is generally, divided into two categories, low methylated pectin (LMP) with a degree of esterification (DoE) <50%, and high methylated pectin (HMP) with a DoE >50%. LMP gels with the addition of sugar, which is the basis of the ink formulations. The pectin isolation was performed using dilute-acid extraction, followed by alcohol precipitation.

PROCESS STEP: 3D PRINTING

The ink formulations, based on In et. al (2021) but finally adapted to the water binding capacity of the used ingredients, consisted of varying amounts of gelatin, pectin, and water, while sugar and citric acid remained constant.

The 3D-printing process was conducted and adjusted on a Procusini 3.0 commercial 3D printer.

Rheological and textural analyses were performed on the solid and liquid states of the ink formulations, as well as the printed scaffolds. A Pectin characterization was done by titration.

Process optimization in all three aspects shows the possibility to print a stable grid design with some of the formulations. Preliminary analytical results imply an observable difference between the ink formulations.

SUMMARY

The goal of this project was to successfully validate a proposed process chain, including the isolation of pectin from apple pomace, the characterization of the pectin, and then its use to formulate ink recipes used to 3D print structurally stable scaffolds and objects, which could then be analyzed for their rheological and textural properties.

The use of apple pomace is an essential factor for making use of an already abundant waste product containing valuable biomaterials. Overall, the isolation of pectin was unsuccessful, at least to the required standard.

Meanwhile, scaffolds and cylinders were successfully 3D printed, depending on their ink formulations. Rheological and textural characteristics varied according to the varying recipes. However, the 3D printing process remained nearly the same for all formulations, proving its validity and showing its potential. In a combination of different concentrations, gelatin and pectin were able to build and print structurally stable structures with varying printing characteristics. Three of the used formulations showed promising results regarding observable printability structural characteristics.

The pectin concentration was found to positively affect the products' hardness and gumminess, while gelatin partially influenced the rheological properties. Overall, parts of the investigation showed success and proved the potential applicability in the industry and maybe even other research fields.

Fig. 1: Used dried apple pomace for the pectin extraction.

Fig. 2 Wet and dried pectin, resulting from the isolation of apple pomace..

Sample Concentration	Printed Products
24.1 g/L pectin – 83.9 g/L gelatin	
28.5 g/L pectin – 84.5 g/L gelatin	
31.9 g/L pectin – 85.1 g/L gelatin	
24.1 g/L pectin – 104.9 g/L gelatin	
28.5 g/L pectin – 105.6 g/L gelatin	
31.9 g/L pectin – 106.4 g/L gelatin	

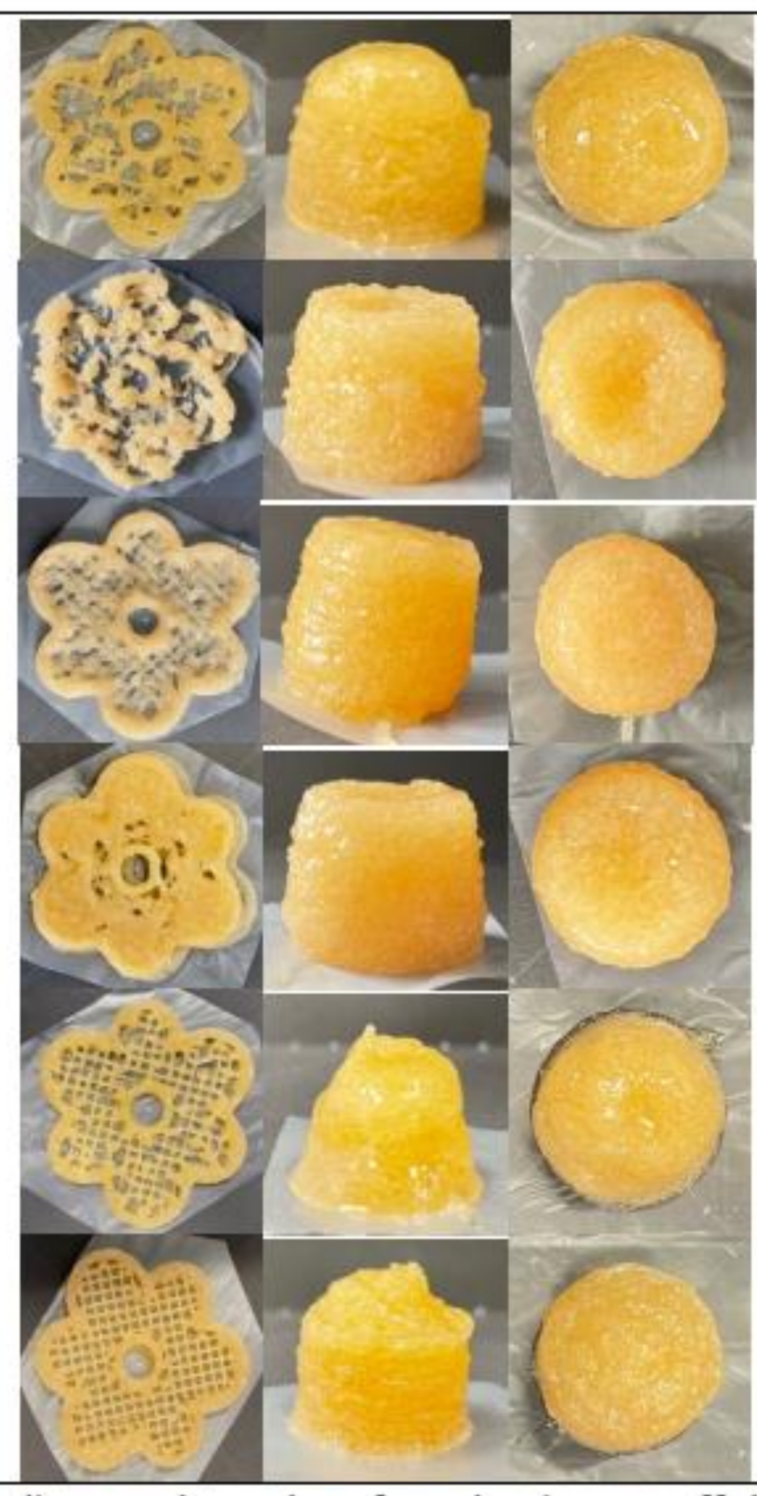

Fig. 3: 3D printing results. Functioning printing parameters, each product's success, cylinder height, and printing observations are analyzed.

LITERATUR

In, J., Jeong, H., Song, S., Min, S. C., Determination of Material Requirements for 3D Gel Food Printing Using a Fused Deposition Modeling 3D Printer. Foods, 2021