# THE USE OF FOOD INDUSTRY BY-PRODUCTS FOR DRUG FORMULATION

**Nikolina Janton[1], Gordana Matijašić[2]**

[1] Small Molecules Center of Excellence, Particle Engineering, Pliva Croatia d.o.o., Prilaz baruna Filipovića 27, 10000 Zagreb, janton.nikolina@gmail.com

[2] Faculty of Chemical Engineering and Technology, University of Zagreb, Trg Marka Marulića 19, 10000 Zagreb

## Introduction & purpose

Nowadays, most research is focused on reducing the negative impact of human activity on the environment. One option is to reduce the amount of waste generated during production. Since it is often difficult or impossible to completely prevent waste generation, it is necessary to properly dispose of it. The food industry belongs to the group of polluters. However, food production generates by-products with high nutritional value. Such by-product are white potato starch and cheese whey. [1,2] Starch is increasingly used in the drug formulation for capsule production and cheese whey as a cheap source of lactose and protein in the pharmaceutical industry. In this study, crystalline celecoxib (CLX) was used as a model drug, which was characterized as a cohesive powder with bioavailability problems. [3-5] Potato starch (PS) was used for filament development and 3D printing of capsules using fused deposition modeling (FDM). Cheese whey (CW), on the other hand, was used in wet granulation along with celecoxib.

## Experimental

PS and plasticizer (glycerol/sorbitol and water) mixtures were prepared by blending and left at room conditions to stabilize for 24 hours. The threads used for printing, were prepared at 100 °C by hot melt extrusion in a twin-screw extruder. The screw speed was 170 rpm and nozzle diameter was 1.75 mm. Granulation of CW and CLX (1:1) was performed on a laboratory mixer-granulator Diosna P1-6 with polyvinylpyrrolidone (PVP) and 96% ethanol. Obtained wet material was dried using fluid bed dryer until loss of drying value (at 105°C) reached about 1.0% – 1.2%. Powder properties of the samples were monitored on TA-XT2 Texture analyser for flowability and on Freeman technology instrument for compressibility properties. The morphological structure of obtained materials was determined using a scanning electron microscope.

## Results

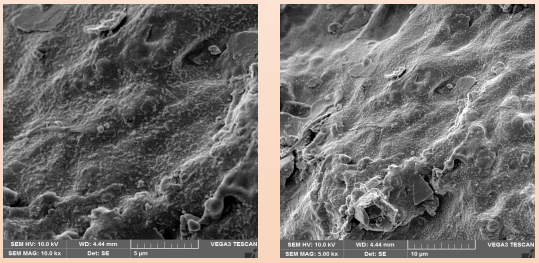


**Figure 1.** SEM micrographs of the filament surface obtained from PS : glycerol : water (70:30:25, %w/w)

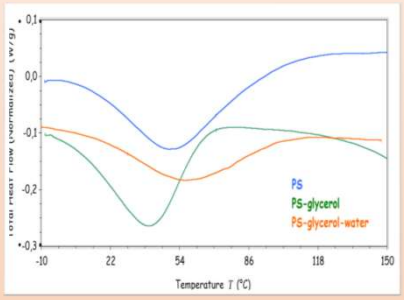
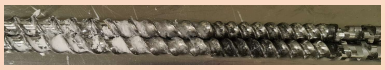



**Figure 2.** DSC thermograms of PS mixtures with glycerol and water

- PS : sorbitol (80:20, %w/w) and PS : sorbitol : water (80:20:25, %w/w) mixtures caused extruder screw clogging at the beginning of mixing area



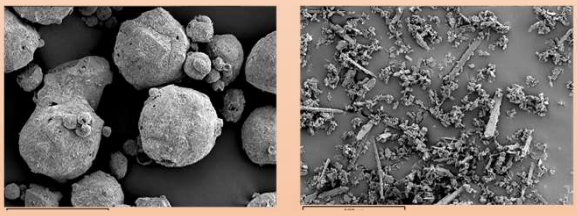


**Figure 3.** SEM micrographs of CW (left) and CLX (right), mag. 500x

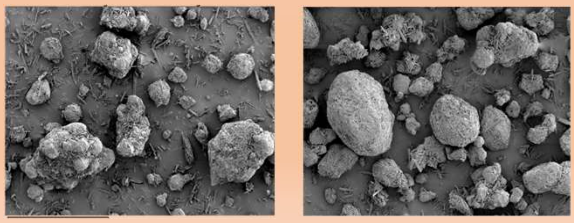


**Figure 4.** SEM micrographs of CW+CLX (left) and CW+CLX+0.2%PVP (right), mag. 100x

**Table 1.** Texture analysis and compressibility test results of CLX before and after granulation

| Sample | Bulk density, g/mL | Hausner ratio | Carr index, % | Flow character | CBD, g/ml | CPS, % @ 15 kPa |
|---|---|---|---|---|---|---|
| CLX | 0.3435 ± 0.04 | 1.97 ± 0.12 | 49.18 ± 0.04 | Very, very poor | 0.55 | 57.3 |
| CLX+CW | 0.5456 ± 0.02 | 1.35 ± 0.04 | 25.80 ± 0.02 | Poor/ cohesive | 0.53 | 20.9 |
| CLX+CW+ 0.02% PVP | 0.5233 ± 0.04 | 1.32 ± 0.09 | 24.21 ± 0.05 | Passable | 0.58 | 15.9 |
| CLX+CW+ 0.2% PVP | 0.5694 ± 0.07 | 1.19 ± 0.17 | 16.91 ± 0.11 | Fair | 0.59 | 8.1 |

## Conclusion

- The surface of obtained filament is rough as it can be seen on SEM images (Figure 1.).
- Glycerol addition did not significantly affect the melting temperature of PS (Figure 2.).
- Screw configuration used in this study was not suitable for PS mixtures with sorbitol.
- By the addition of CW, bulk density of CLX increased from about 0.34 g/mL to 0.55 g/mL.
- Hausner ratio and Carr index values decreased by the addition of PVP as binder resulting with better flow properties of the material (Table 1.).
- Celecoxib is more compressible compared to other samples indicating cohesive properties of the powder.

**Literature**

[1] N. Raj, N. Dalal, V. Bisht, U. Dhakar, Appl. Sci. 9 (2020) 1718-1724
[2] F. J. Teiweira, H. O. Santos, S. L. Howell, G. D. Pimentel, Pharmacological Research 2019, 144, 245–256.
[3] Z. Misic, K. Muffler, G. Sydow, M. Kuentz, J. Pharm. Sci. 101 (2012) 4516-4528.
[4] M. S. Sarwar, A. Ghaffar, Q. Huang, M. Khalid, A. Anwar, A. M. Alayoubi, M. Latif, Int. J. Biol. Macromol. 241 (2023) 124598.
[5] R. A. Khaire, P. R. Gogate, Whey Proteins, in C. Galanakis, Proteins: Sustainable Source, Processing and Applications, 1st Edition, Elsevier Inc., New York, 2019, 214.

FKIT MCMXIX

20 international conference Ružička days
TODAY SCIENCE – TOMORROW INDUSTRY
September 18–20, 2024 | Vukovar, Croatia

teva