

Upcycling Plant-Based Beverage Residues (Okara) from Soy and Oat

Aim – Improve the circular economy of plant-based beverages

Okara is a fiber and protein rich residue from the plant-based beverage industry. The aim was to find strategies to extend the shelf life of soy and oat okara and to find appropriate food applications to reduce the waste of okara, thus improving the circular economy of plant-based beverages. The focus has been on high-pressure processing and low-moisture and high-moisture extrusion cooking (expanded snacks and high-moisture meat analogs).

Conclusions

- A 600 MPa treatment successfully extended the shelf life up to 2 weeks for soy okara, and almost 4 weeks for oat okara at 4 °C.
- Dried oat okara could be incorporated successfully up to 30% in a snack prototype. A tipping point was found when the oat okara content reached 40%.
- Dried oat okara and hempseed protein were successfully co-extruded into a high-moisture meat analog, where dried oat okara could contribute up to 64% of the total protein.

Low-moisture extrusion: Expanded snacks

It was investigated if dried oat okara could be co-extruded with corn grits into an expanded snack prototype. Five formulations of corn grits and dried oat okara ratios (100:0, 90:10, 80:20, 70:30, and 60:40) were extruded at three different feed moistures (fm, 14%, 16%, and 18%). The results are presented in Fig. 1.



High-moisture extrusion: High-moisture meat analogs

It was investigated if dried oat okara could be co-extruded with hemp protein concentrate into a high-moisture meat analog. Three different screw speeds (500, 700, and 900 rpm) and feed moistures (49%, 52%, 54%) were evaluated at two different temperature profiles (40-70-110-130 °C and 40-70-120-150 °C). The high-moisture meat analogs from the highest temperature profile are presented in Fig. 2.

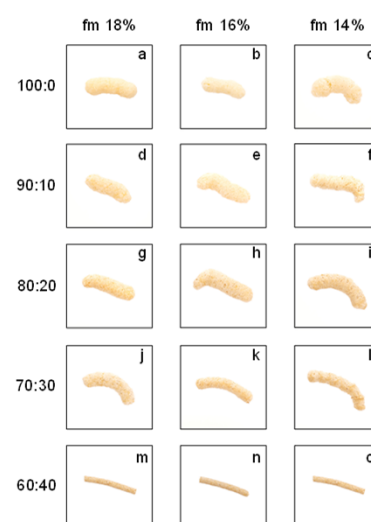


Fig 1. Expanded snacks, co-extruded with corn grits and dried oat okara.

High-pressure processing

High-pressure processing studies were performed on soy and oat okara, where 200 MPa, 400 MPa, and 600 MPa were tested. The shelf life was evaluated after 2 and 4 weeks (at 4 °C) on total aerobic count, yeast and mold, and lactic acid bacteria. The results for total aerobic count is presented in Fig 3.

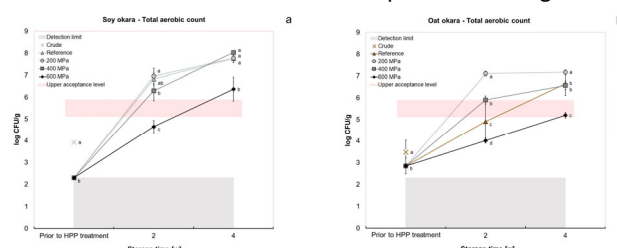


Fig 3. The total aerobic count for soy okara (a) and oat okara (b).

Feed moisture	49%	52%
700 rpm		
900 rpm		

Fig 2. High-moisture meat analogs based on dried oat okara and hemp protein, produced with a temperature profile of 40-70-120-150 °C.