Year 2 of my 2-year project

Value-added products from lactose-hydrolyzed skim milk

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Motivation

- NYS: ~ 63 M lbs NDM in 2017, up from ~ 13 M lbs in 2007
- USA is the world's largest ***single-country producer & exporter of NDM/SMP*** (>1 MMT/y)
- Most exported without any value addition - ***low returns to dairy farmers and processors***.

- ***No value-added, non-dairy product in the market that contains SMP as the major ingredient !***

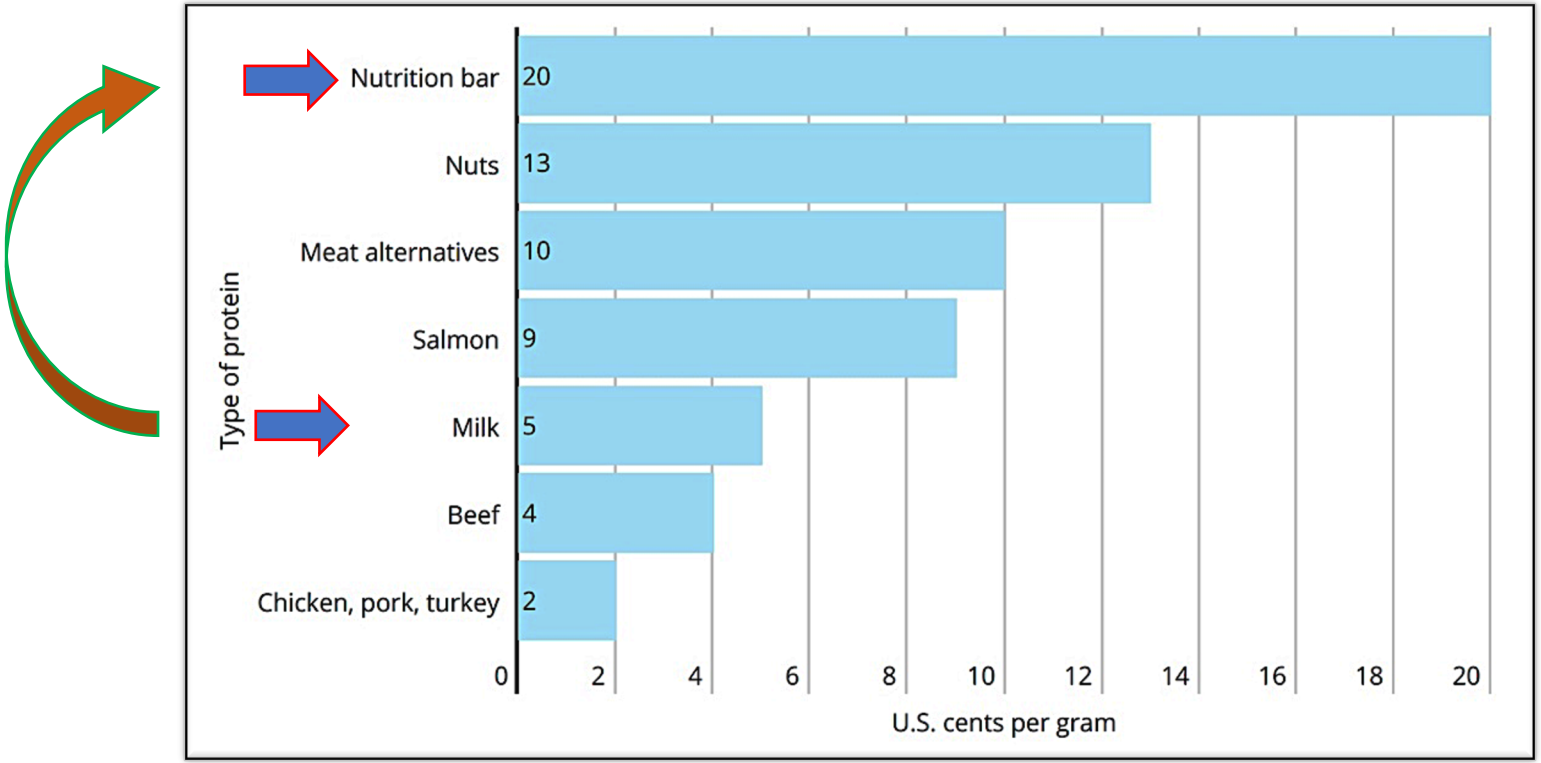
- Fluid milk
- Cottage cheese
- Starter culture
- Yogurts, Ice cream

- Confectionary
- Meat products
- Prepared mixes
- Ice cream

- Bakery
- Meat products
- Prepared mixes

- **36-38%** of NDM **protein** and **~ 50 %** is **lactose**
- ***~ 70%*** of the world population is ***lactose intolerant***
- ***Hydrolyzed lactose during extrusion polymerizes galactose into GOS, a soluble dietary fiber***

Average U.S. price (¢) per gram of protein



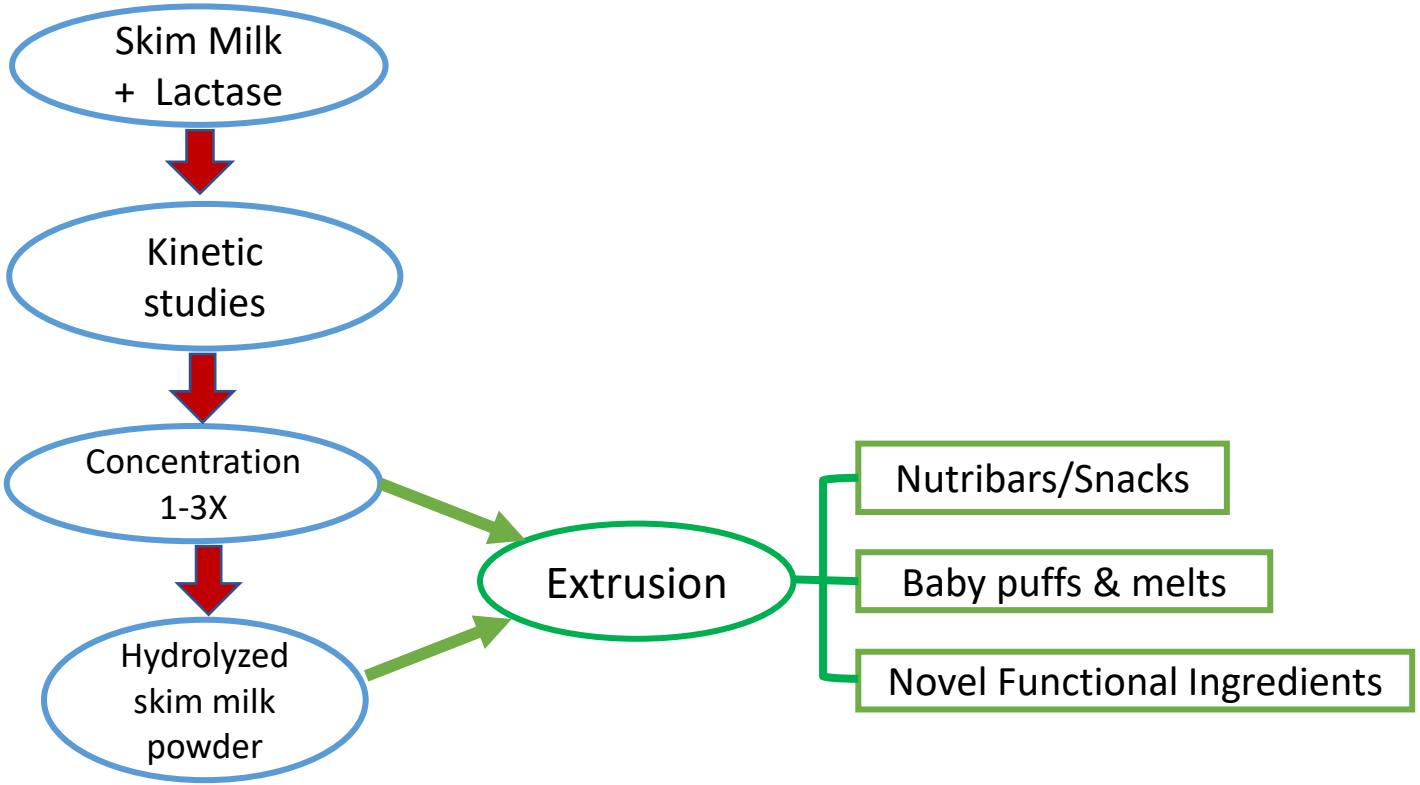
Nielsen Product Insider, 2019

Specific Objectives:

Objective 1: Determine the effects of adding lactose-hydrolyzed skim milk concentrate/powder and extrusion processing parameters on product quality.

Objective 2: Compare the physico-chemical attributes of extruded prototypes (nutribar and baby puffs/melts) with their commercial counterparts

Research Plan



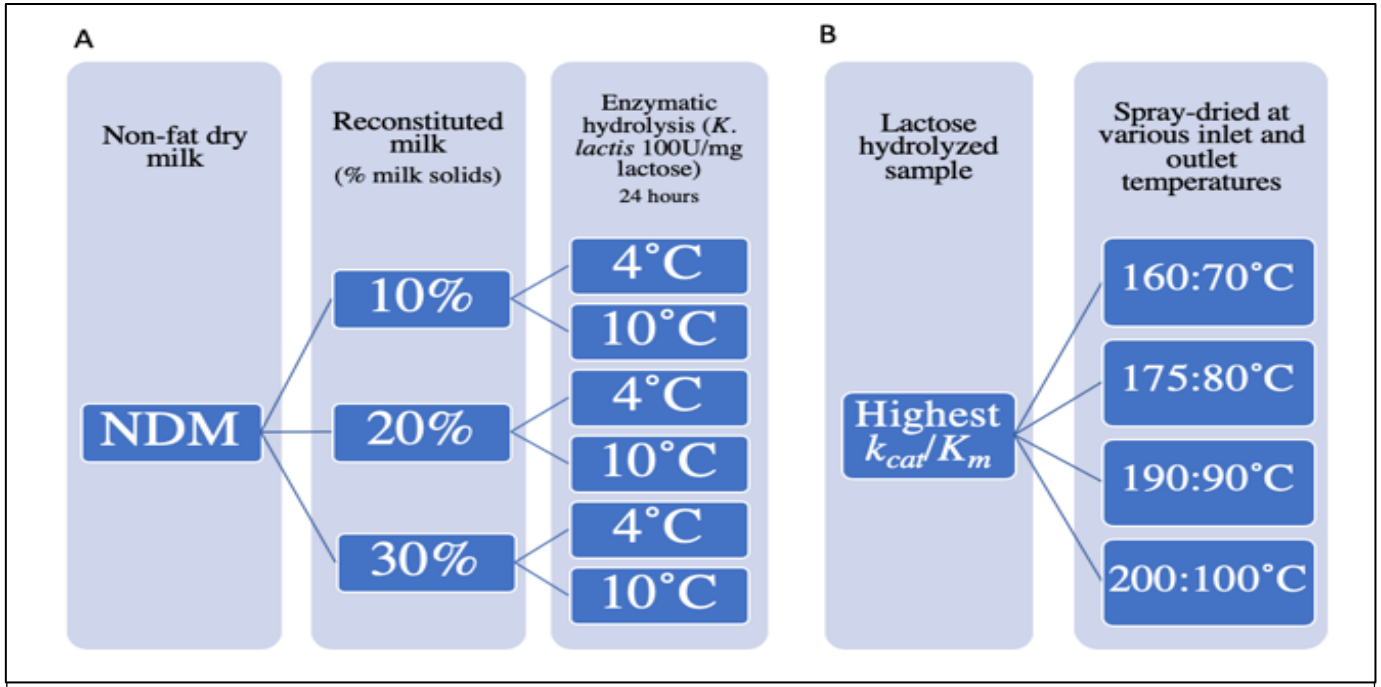
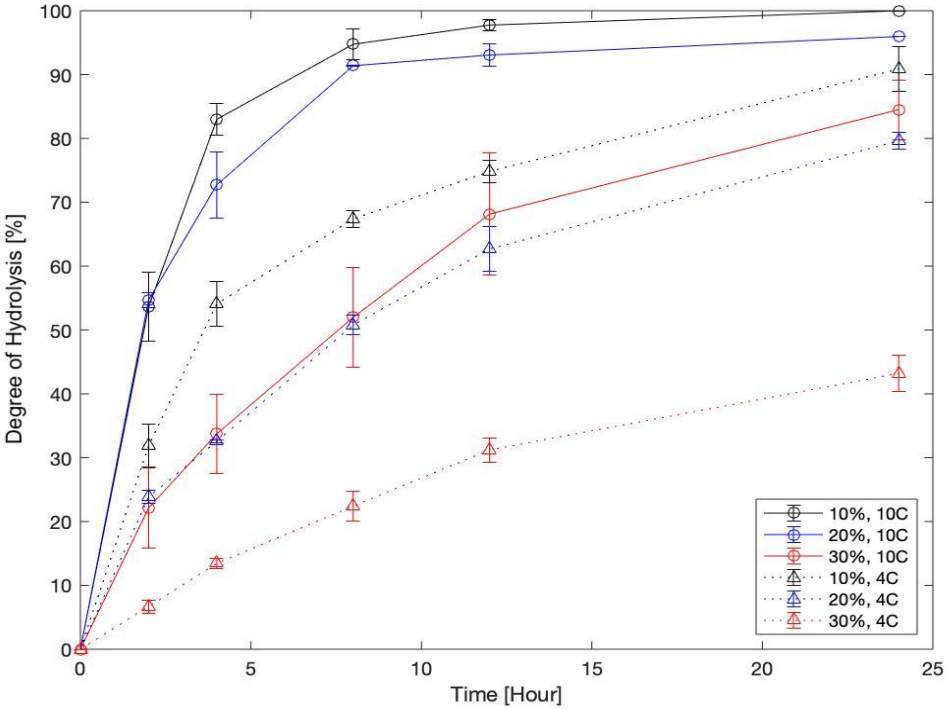


Fig. 3. Lactose hydrolysis using reconstituted nonfat dry milk of three different total solids

Degree of lactose hydrolysis at different milk solid concentrations and temperatures



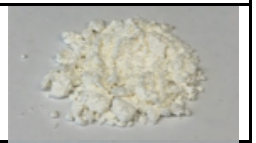
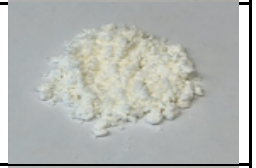
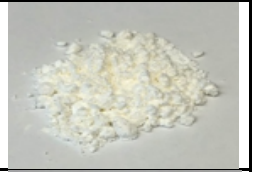
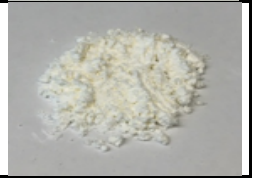
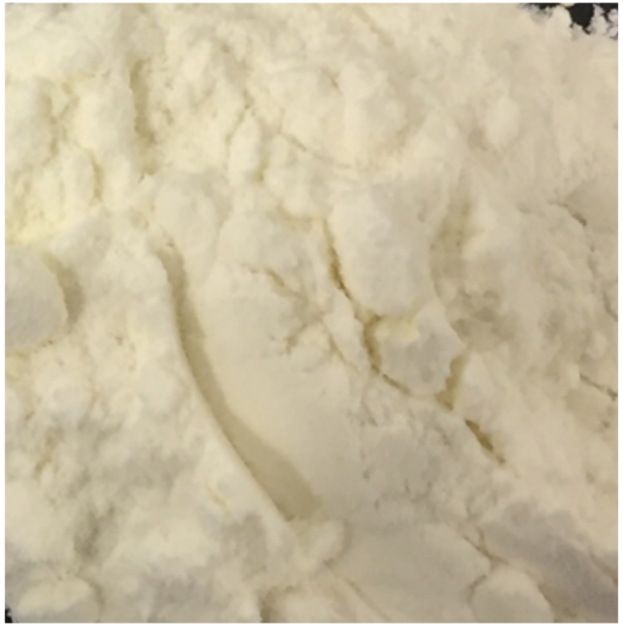
Inlet & outlet temperatures	YI	*L**	*a**	*b**	Image
160:70°C	3.61 ± 0.07[d]	98.27 ± 0.21[a]	-0.77 ± 0.01[a]	2.48 ± 0.04[d]	
175:80°C	4.13 ± 0.12[c]	97.70 ± 0.16[a]	-0.88 ± 0.06[b]	2.80 ± 0.11[c]	
190:90°C	4.55 ± 0.14[b]	98.01 ± 0.18[a]	-0.98 ± 0.05[b]	3.12 ± 0.09[b]	
200:100°C	5.49 ± 0.20[a]	98.16 ± 0.16[a]	-1.24 ± 0.07[c]	3.77 ± 0.13[a]	

Table 1. Color characteristics of lactose hydrolyzed skim milk after spray drying

Hydrolyzed & Spray Dried NDM

? Color

Lactose-hydrolyzed NDM



Commercial NDM

Extruded Milk Protein/Skim milk Puffs

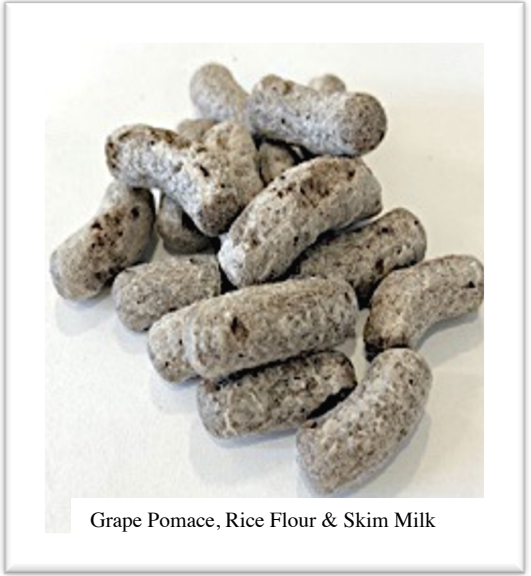
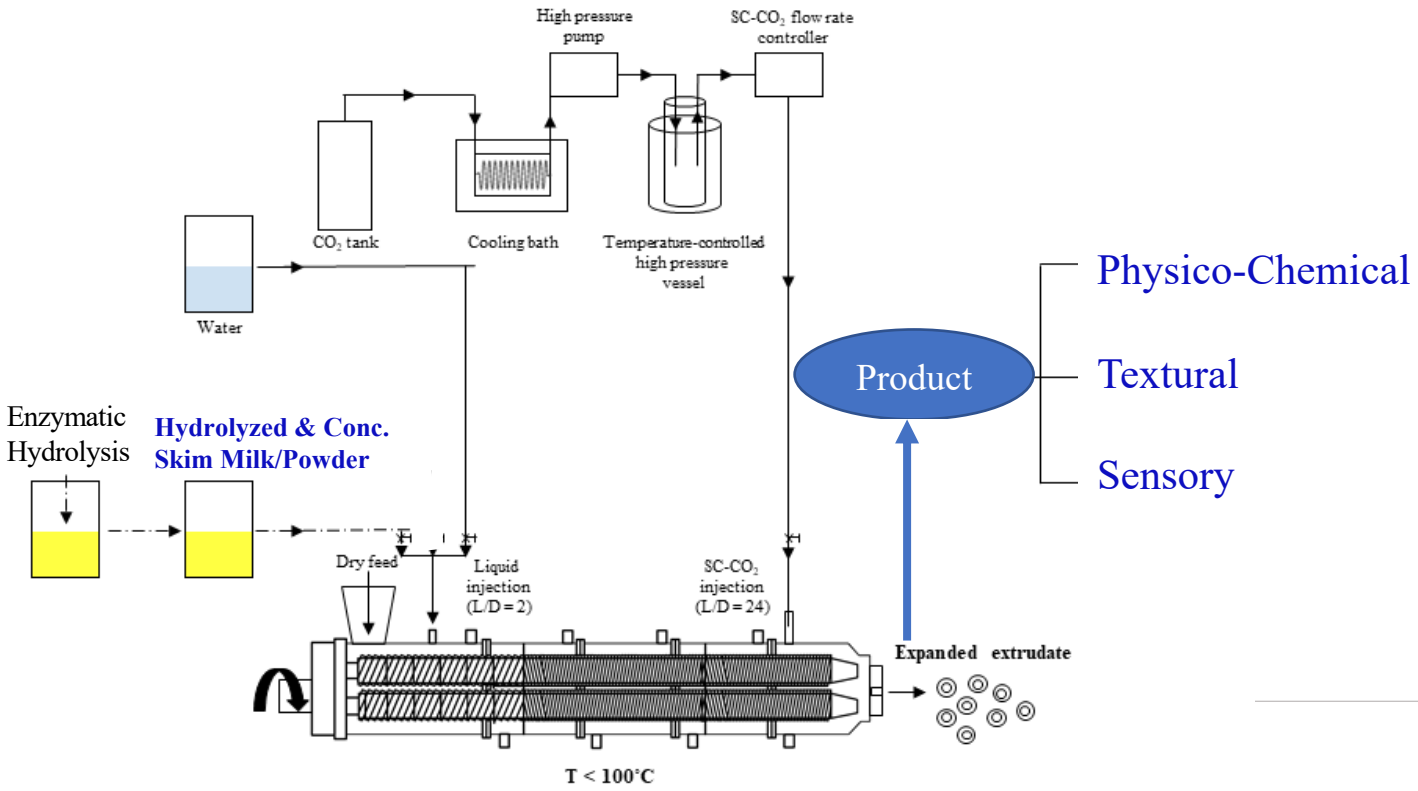


Fig. 4. Milk protein concentrate-based extruded puffs: conventional steam (left) vs high pressure extrusion and skim milk puffs with grape pomace

Year-2 Process development and analysis



New Project

Development of quick, in-mouth dissolving, milk protein-rich extruded baby foods

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Motivation?

According to ADPI-2018:

- *68% of the U.S. population is seeking more protein in their diet*
- *Share of milk protein has decreased from ~85-90% to <60%*
- *Alternative proteins entrants include pea, rice, almond, etc.*
- *Milk protein is the gold standard of protein nutrition*

Design and develop new products to enhance utility & create new markets!!

Project is based on a low-temp extrusion process!!!

Extruded Puffs - Baby's first finger food

NUTRITION FACTS

About 6 servings per container **Serving size**		~~60 pieces~~ (7g/about 1/4 cup)
Amount per serving **Calories 25**		
	Infants through 12 months % DV*	**Children 1-3 % DV***
Total Fat 0g	0%	0%
Sodium 0mg		0%
Total Carbohydrate 6g	6%	4%
Total Sugars 1g		
Includes 1g Added Sugars		4%
Protein 0g	0%	0%
Iron 1.4mg	10%	20%
Vitamin E 0.5mg	10%	8%
Thiamin 0.05mg	15%	10%
Niacin 0.6mg	15%	10%
Vitamin B6 0.05mg	15%	10%

Not a significant source of saturated fat, *trans* fat, cholesterol, dietary fiber, vitamin D, calcium, and potassium.

*% DV =% Daily Value

Create in-mouth dissolving, milk protein-based puffs

Premiumizing Milk Protein !!!

- Convenient, melts in the mouth
- Starch-based, low nutrient density

Geriatric food!!!

Product Novelty & Deliverables

- Dry, long shelf-life, light weight, low transport cost product
- Requires no water addition for consumption
- Quick, in-mouth dissolution, in <30 seconds
- Contains protein with complete amino acid profile
- Consumer acceptable, with good nutritional & sensory properties
- Other uses: Elderly and dysphagia patients; may be nutritionally fortified for specific applications

Specific Objectives:

Objective 1: Establish the supercritical fluid extrusion process protocols for production of MPC85-rich quick dissolving puffs.

Objective 2: Quantify the effect of selected functional ingredients (SHMP and SLSA) on the hydration and disintegration properties of MPC based extruded puffs

Objective 3: Evaluate the physico-chemical and sensory properties of the final products

Process Flow Diagram

MPC + Buttermilk powder
+ Fruit or Vegetable

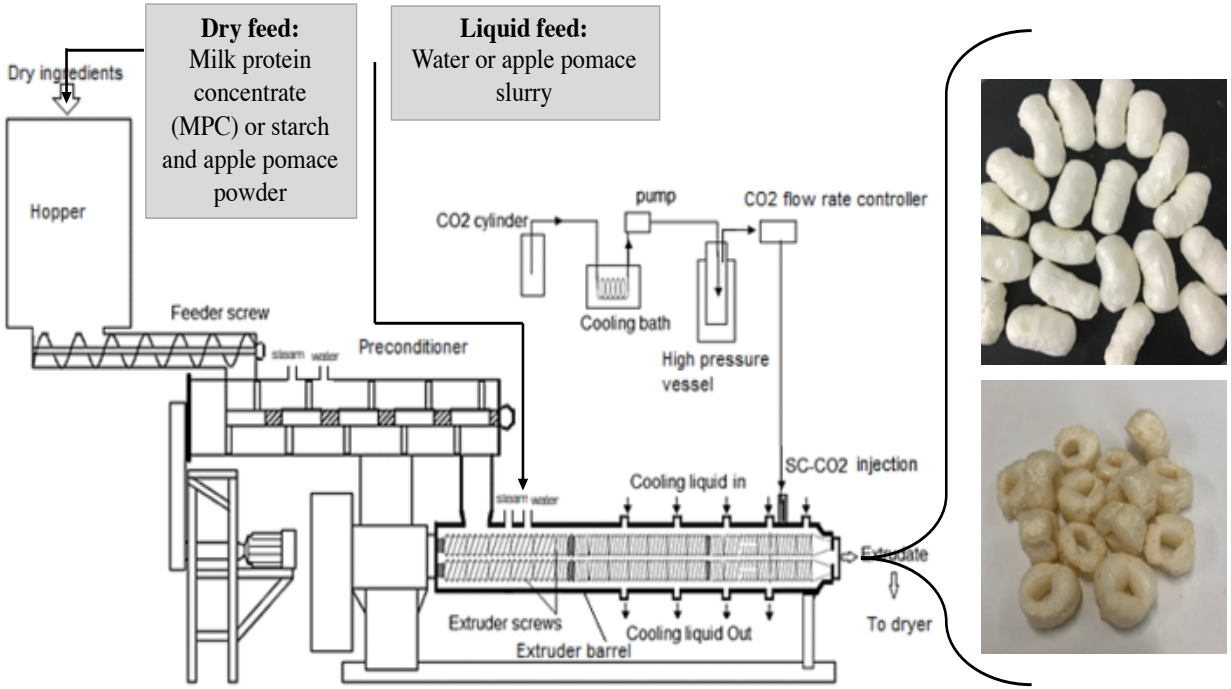
↓

Extruder

↓

Quality Evaluation

- Texture, color, flavor, GOS
- Shelf-life
- Demo to stakeholders



MPC & Apple Slurry-based Formulations:
Milk protein concentrate (82%), sugar (13.7%), apple pomace slurry (1.8%)and sodium hexametaphosphate (0.5%)

Figure 1. Milk protein concentrate-based ***quick-dissolving*** extrudates made using a high-pressure extrusion system

Physico-Chemical and Sensory Properties Evaluation

1. Radial Expansion Ratio

$$RER = \frac{D_e^2}{D_d^2}$$

2. Piece Density

$$PD \frac{g}{cm^3} = \frac{mass\ of\ extrudates}{volume\ of\ extrudates}$$

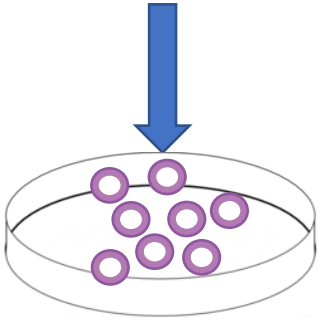
3. Porosity

$$Porosity\ (\in) = \frac{Particle\ Density\ - Piece\ Density}{Particle\ Density}$$

4. Hardness

Maximum force during compression up to 70% strain

1 mm/s
10 g trigger force
70% strain



5. In-mouth Dissolution

Water hydration, followed by hardness and solubility evaluations.

6. Sensory attributes

Hedonic testing

Thank You

For your support