

# Whey lactose conversion to rare sugars

*- Dairy applications towards a sustainable environment*

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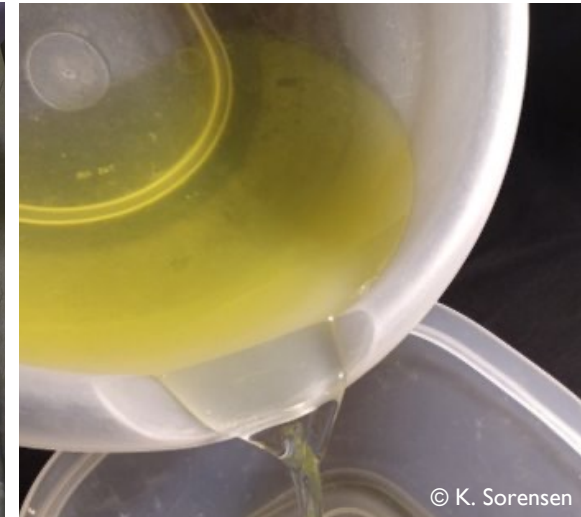


# Whey Processing

- Whey: lactose (4.5%), protein (0.6%)<sup>1</sup>
  - Sweet whey (pH 5.9-6.6)
  - Acid whey (pH 4.3-4.6)
- Environmental/Sustainability problems
- Filtration:
  - Protein (WPC)
  - Lactose and hydrolyzed lactose
  - Fermented milk beverages
  - Prebiotics
  - Bioactive compounds



Sweet whey and curd  
(cheese make)



Acid whey (yogurt make)

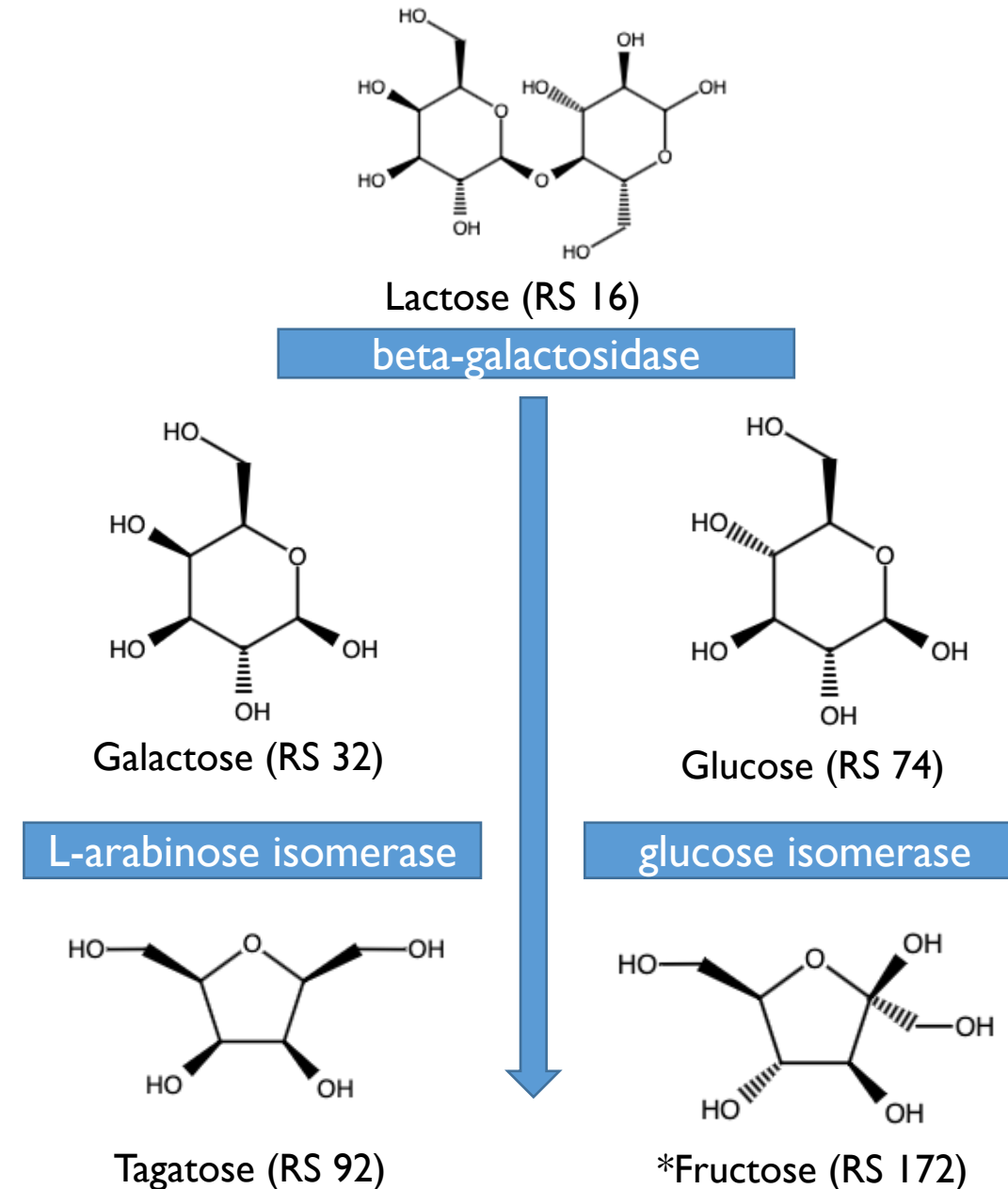


Lactose powder from sweet whey  
filtration/crystallization process.



# Rare sugars & Enzymatic steps

- Tagatose and allulose
  - Relative sweetness (RS)
  - Calories
- Enzymatic conversion<sup>2</sup> (Fig. 1)
- Current status:
  - Tagatose/allulose sugar labeling
  - Food grade of enzymes
  - Commercial availability
  - Previous research



**Figure 1.** Enzymatic conversion in project design; RS: relative sweetness



# Project Outline

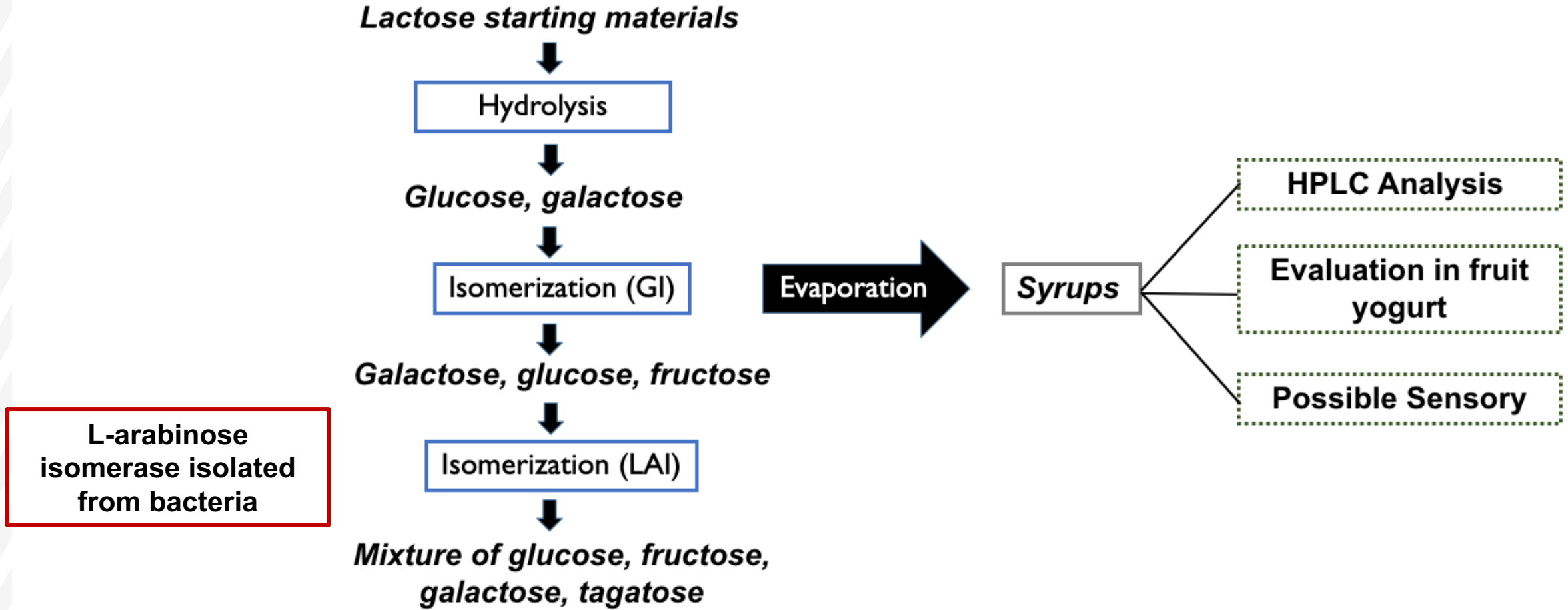


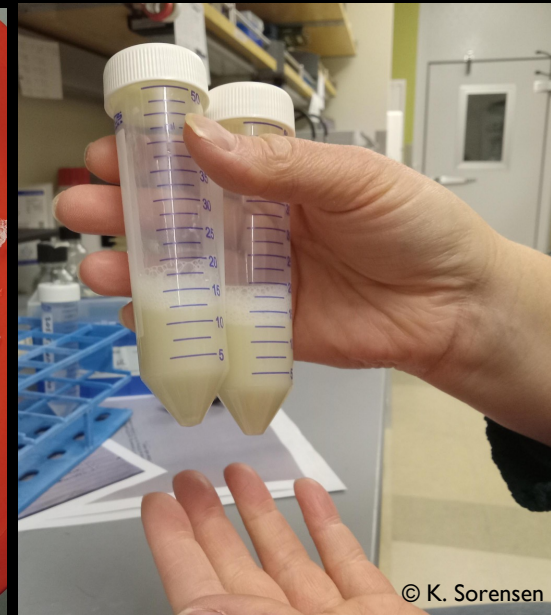
Figure 2. Project design and flowchart. GI: glucose isomerase; LAI: L-arabinose isomerase



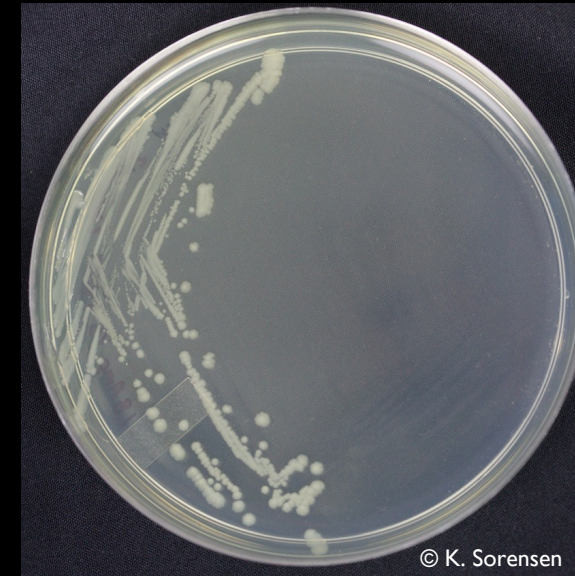


## Current Research

- Performing enzymatic treatment (lactase) of various raw materials
- Culturing *Escherichia coli* containing L-arabinose isomerase enzyme (BYU)
  - Enzymology training
- Selecting/developing a suitable HPLC method



Enzymology shadowing at BYU, February 2023



*E. coli* with LAI plasmid



HPLC for sugar separation



## Takeaway & Impact

- Next steps in current research
- Win-Win Situation
- Future research opportunities
  - Whole cell catalysts
  - Industry
    - Large-scale from whey
    - Milk as raw material

**Table I.** Comparison of sugars (sources: 4, 5, 6, and 7)

	Cost per kg	Relative Sweetness (RS)	Metabolic Absorption	Calories
Sucrose	\$0.91-\$1.35	100	100%	4 cal/g
Lactose	\$0.8-\$0.97	10-20**	100%	2-4 cal/g
Glucose	\$0.56-\$0.58	60-80	100%	4 cal/g
Galactose	\$5-\$50**	30-70**	100%	4 cal/g
Fructose	\$0.39	150-170	100%	4 cal/g
Allulose	\$10-\$15**	70	0%*	~0 cal/g
Tagatose	n.d.	90	20%	1.5 cal/g

\*Note that 70% allulose is absorbed in the intestines but excreted in the urine.

\*\*These values are a rough estimate.

# THANK YOU



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