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LACTASE AS A TOOL IN NEW PRODUCT DEVELOPMENT

Matti Harju, Valio Ltd

9.9.2008



GENETICS OF HYPOLACTASIA

- ~ More than half of you have the original genotype C/C -13910 in lactase gene
- ~ The rest of you are mutants with a change to C/T or T/T -13910
- ~ Only the mutants maintain their lactase activity throughout life

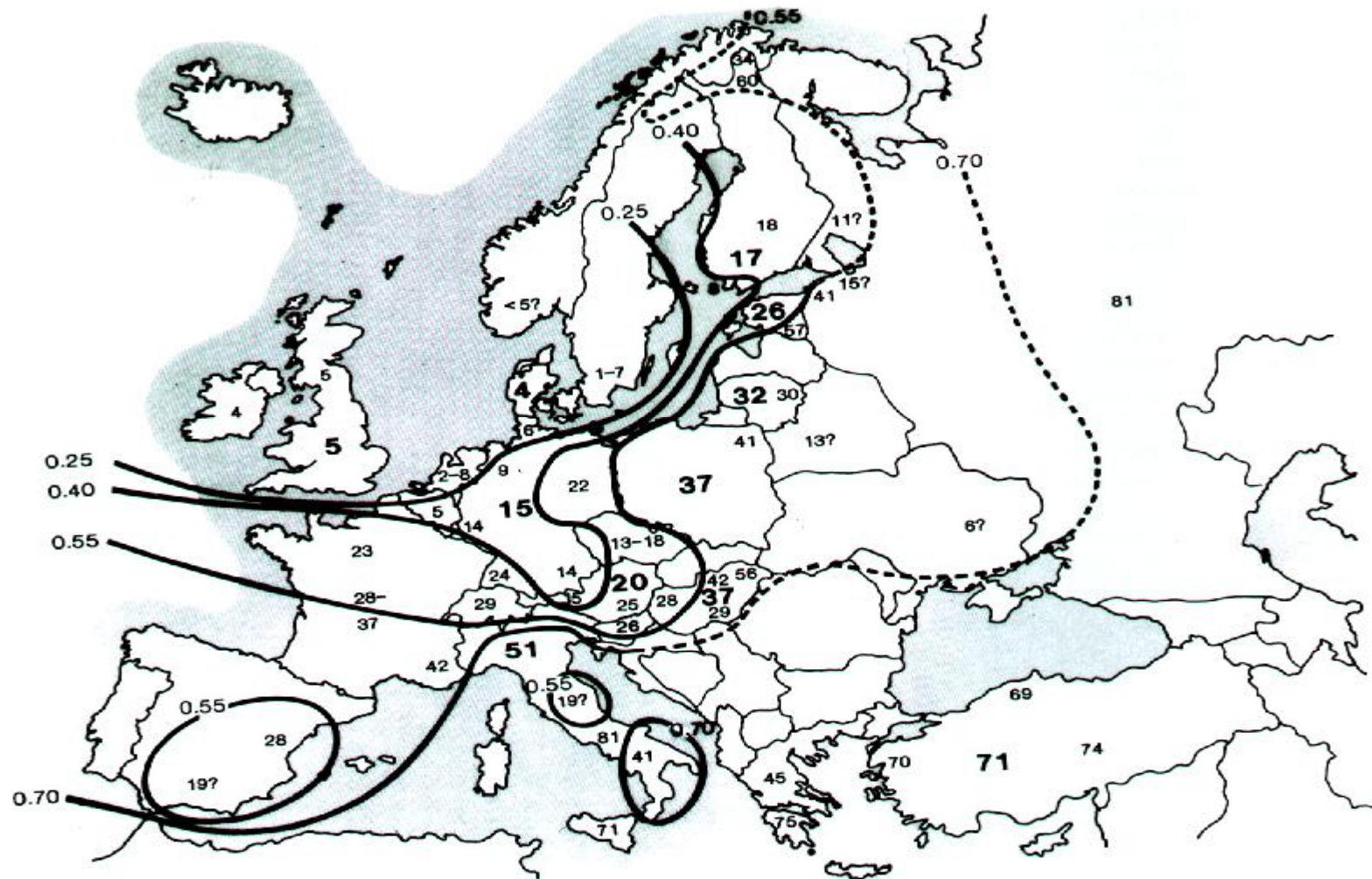
Enattah, N., Sahi T., Savilahti E., Terwilliger, J., Peltonen, L. and Järvelä, I. Nature Genetics **30**, 233-237 (2002)



PREVALENCE OF HYPO-LACTASIA IN EUROPE

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Sahi, T. Scand. J. Gastroenterol. 29 Suppl 202:7-20 (1994)



YOU CAN BUY LACTASE

- ~ Commercial lactases are available
- ~ Yeast lactases work at pH 6–7
- ~ Mould lactases work at pH 4–6
- ~ Lactases can be immobilized*
(Valio IML in industrial use)
- ~ Side activities can be a problem**

* Gänzle, M.G., Haase, G. and Jelen, P. Int. Dairy J. **18**, 685-694 (2008)

** De Swaaf, M., Van Dijk, A., Edens, L. and Dekker P. Pat. appl.
WO/2007/060247

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VALUE ADDED BY IMPROVING DIGESTIBILITY

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Some of the lactose free products available in Finland



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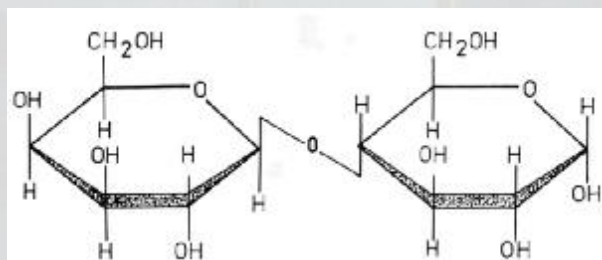
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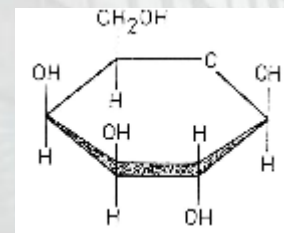
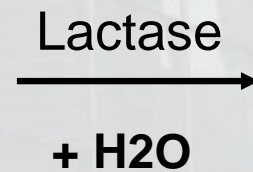
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LACTOSE PROBLEM IN WHEY AND A RESOLUTION

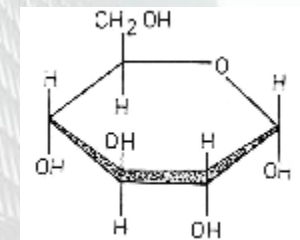
- ~ Hydrolysis solves the digestibility problem
- ~ Hydrolysis doubles sweetness
- ~ Hydrolysis doubles solubility



Lactose



Galactose



Glucose

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WHY FINALLY A DAIRY SWEETENER?

- ~ Nanofiltration has made the demineralization of permeate cheap
- ~ Calcium is easily removed through cation exchange
- ~ Lactose is economically hydrolyzed with immobilized lactase



HOW TO INCREASE SWEETNESS MORE?

- ~ Hydrolyzed lactose has only 50% of the sweetness of sucrose
- ~ Glucose and galactose can be separated by chromatography
- ~ Glucose-fructose syrup using immobilized glucose isomerase



CHROMATOGRAPHIC SEPARATION OF HYDROLYZED PERMEATE

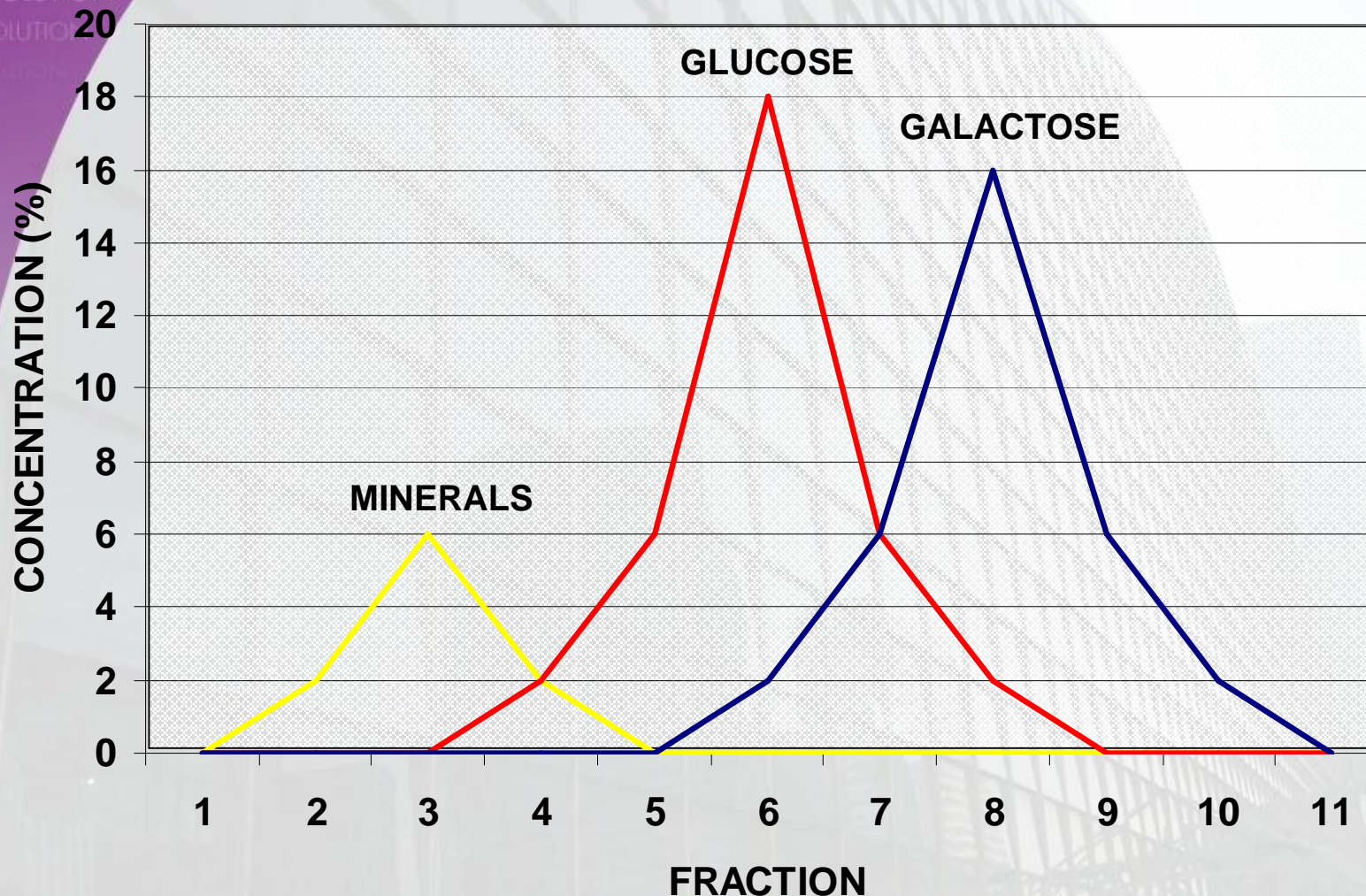
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EVEN MORE SWEETNESS AND FUNCTIONALITY

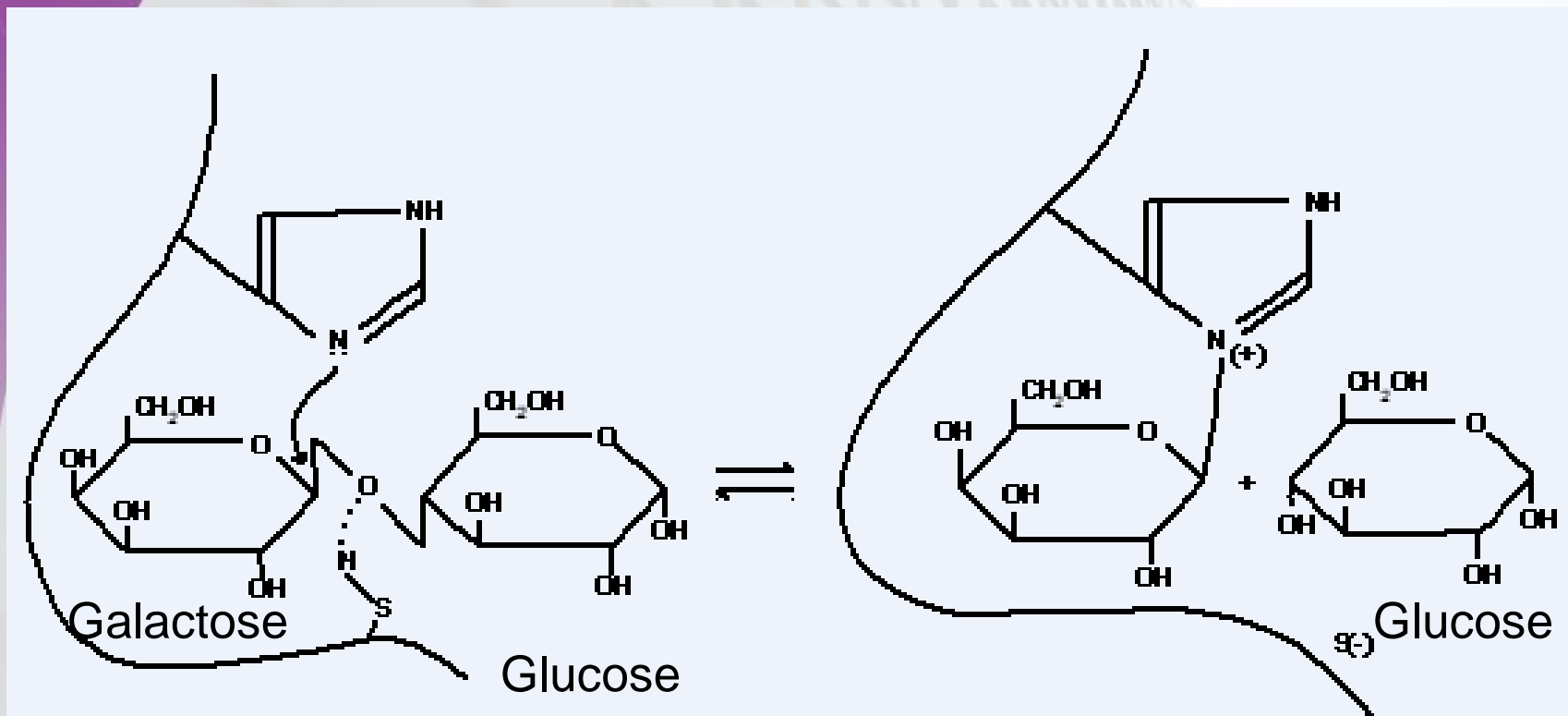
- ~ Galactose can be isomerized to tagatose using immobilized arabinose isomerase*
- ~ Tagatose has 92% of the sweetness of sucrose but only 38% of the calories

* Ryu, S-A., Kim C.S., Kim, H-J., Baek, D.H., Oh, D-K.
Biotechnol. Prog. **19** 1643-1647 (2003)



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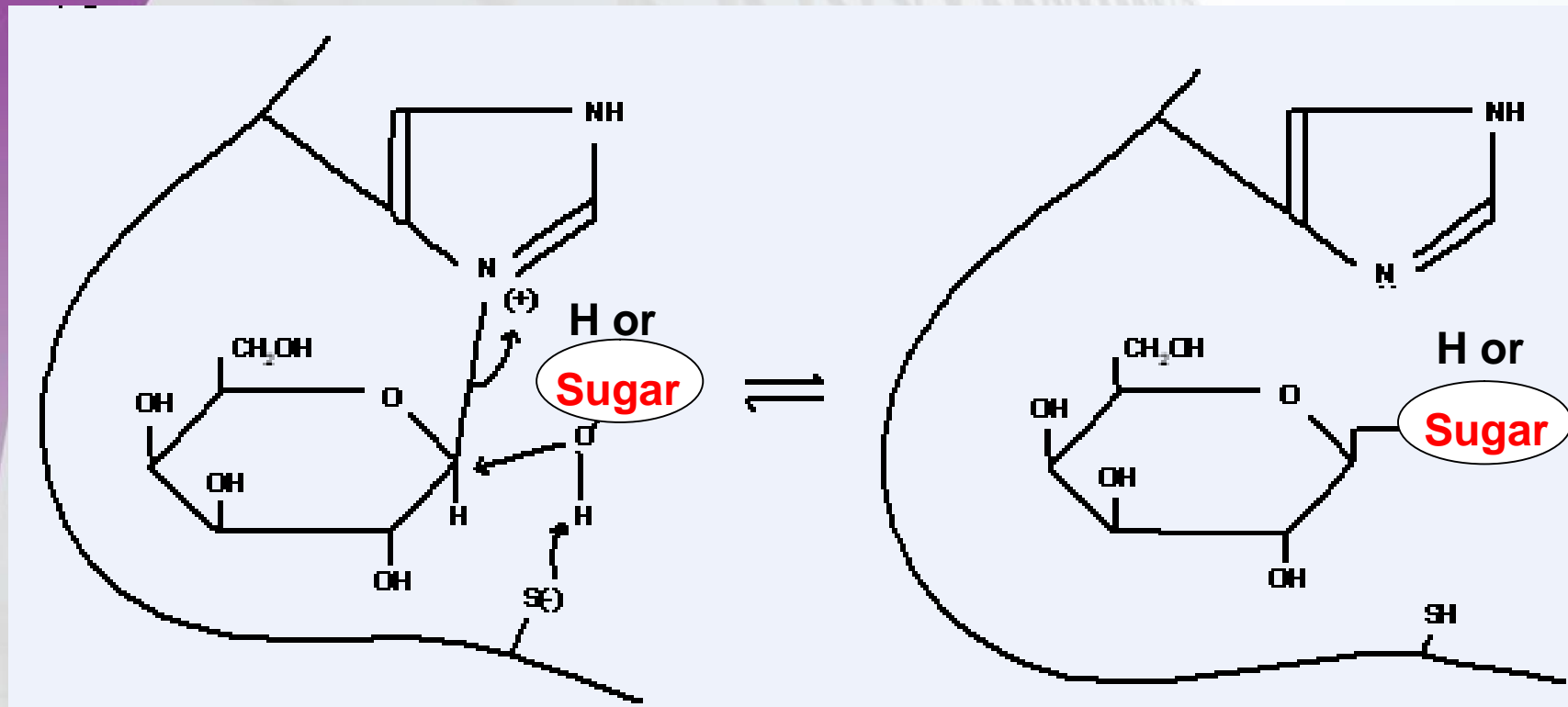
VALUE ADDED BY DECREASING DIGESTIBILITY



The reaction mechanism of lactase



TRANSFERASE REACTION



Galactosyl residue is connected to a sugar molecule instead of water



GALACTO-OLIGOSACCHARIDES

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- ~ A high concentration of lactose is needed in the reaction
- ~ Bacterial lactases give high yields
- ~ Used as prebiotics in baby foods





GALACTO-OLIGOSACCHARIDES ACCELERATE DIGESTION

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- ~ GOS are fermented in the large intestine, softening the stool
- ~ They can be produced directly into milk or whey*



* Sibakov, T., Kajander, K. and Harju, M. Pat. appl. WO/2008/ 037839

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A SOLUTION FOR PERMEATE MOTHER LIQUOR PROBLEM

- ~ Hydrolysis improves solubility and digestibility for animals
- ~ Prebiotics (GOS) are produced at the same time
- ~ It can be stored for months like beet molasses

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THE LACTOSE/LACTASE PARADOX

- ~ Lactase treatment can both increase and decrease the digestibility of lactose
- ~ Both cases create value added