These few slides were part of presentations given
at various conferences, including C&E Spring Meeting,
Montpellier 2006, World Grain Summit, San Francisco 2006,
and Nordic Cereal Congress, Helsinki, 2006.

Probiotic cereal smoothies and non-dairy yoghurts

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Dairy alternative market

- Rapid growth in the dairy alternative market
  - Annual growth 5 -15% per year
  - Most volume for soy milk, soy yogurts
  - Strong lobbying for soy, technology also developed
- → Invites competitors
  → Invites other alternatives, including cereal-based
- → *'Cereal-based **dairy alternatives'***
  → Such as 'oat milks', 'oat yoghurts'
  - Two examples:
    - Yosa®
    - Velle®

Example 1: Yosa®

- Yoghurt-type
- 1995 by Bioferme Oy (Ltd.), Finland
- www.bioferme.fi
  - **completely dairy free**
  - **low in fat: only 0,7-0,8 g/100 g**
  - **cholesterol free**
  - **100% plant-based**
  - **no artificial sweeteners**
  - **rich in fibre and betaglucan**
  - **probiotic - a functional food**

Example 2: Velle

- drink-type and yogurt-type
- by Velle Oats, St. Petersburg, Russia
- www.velleoats.com

Launched December 2005

First drinkable probiotic cereal-based ‘smoothie’

- introduced in 2004 at Hi Europe fair, Amsterdam

100 ml ’shot’

The concept: two key properties combined

1. Probiotic bacteria used in fermentation

2. The substrate (oat bran) is high in soluble beta-glucan fibre

Both properties provide health benefits and health claim potential.

Such combination is new (called synbiotic since 1995) and opens new technological challenges.

Rules applied by the FDA when approving the oatmeal health claim:

More than 0.75 g per serving of soluble beta glucan fiber

(leading to a total of 3g/d from four servings)

*"Soluble fiber from oatmeal as part of a low saturated fat, low cholesterol diet **may reduce the risk of heart disease"***

- A generic health claim

These servings contain 0.75g of beta-glucan*:

Hot oatmeal *(porridge), small portion 0.5-1.0 dl, or 20 g of oatmeal*	***Musli*** *- small portion including 0.5-1.0 dl oatmeal*	***Oat bread*** *containing 30% oat bran, 2-3 slices or 75g*	*A serving (150g) of **oat bran yogurt** containing 10 to 12 g of reg. oat bran*

*US FDA regulation (1997) for the "may reduce the risk of heart disease" health claim for oat products: 3g of beta-glucan/d and 0.75g/serving

Traditional usage of oats:

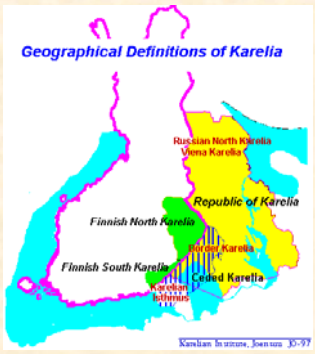
How to get rid of the hulls?

- if you only have a stone grinder

The Karelian answer:

- Mix the flour with water
  - hull particles will float, can be screened away
  - the starchy endosperm will sediment
- Add sourdough, keep in cellar
  - keeping properties improved, weeks
- Use the sediment to cook porridge, flummery (kiesukiisseli)

Traditional Karelian fermented oat flummery (‘kaurakiisseli’)



The tradition is kept alive by native Karelians

Veera Kujanpää shows how she cooks the kaurakiisseli using rolled oats (1992)

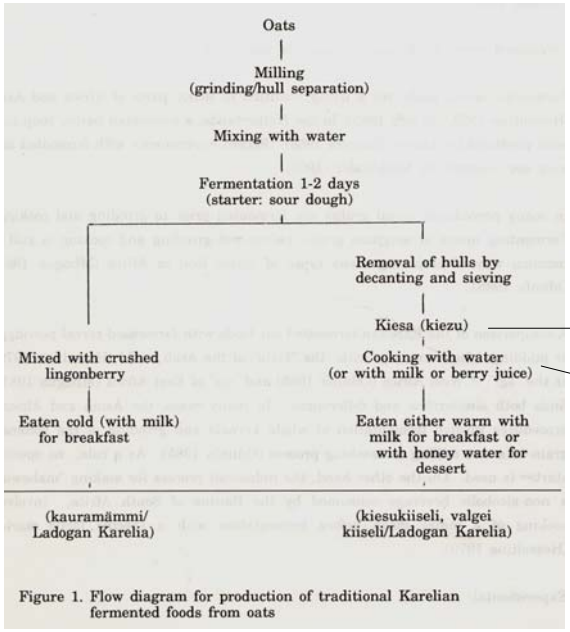


Figure 1. Flow diagram for production of traditional Karelian fermented foods from oats

The traditional Karelian fermented oat flummery revisited

Salovaara, H., Bäckström, K. & Mantere-Alhonen, S. 1990. Pages 77-83 in "Proceedings from 24. Nordic Cereal Congress", May 20-23, 1990, Stockholm 1992.

Kept in cellar

The bacteria were killed, eliminating potential probiotic effects

Not only in Karelia but also at least in Scotland and Wales, probably also elsewhere:

Not only European:

Examples of cereal-based and cereal-related foods containing live probiotic bacteria

Product	Preparation method and type of product	Bacteria used and levels	Purported physiological benefit(s)
Togwa (Tansania)	Sorghum or maize cooked in water, cooled, addition of starter, fermentation. Traditional weaning food, beverage after dilution	Dominated by *Lactobacillus plantarum*, also *L. brevis*, *L. fermentum*, *Pediococcus pentosaceus*, 10^9 CFU/g, Strains from local starters.	Reduces enteropathogen occurence in rectal swabs of children, **improves intestinal mucosa barrier function in children with acute diarrhoea.**
Fermented oatmeal soup for enteral feeding (Sweden)	Oatmeal cooked with malted barley flour, cooled, addition of starter, fermentation. Designed for enteral feeding	Probiotic Lactobacillus strains, development made with *L. plantarum* 299v, *L. reuteri*, and other strains. Strains protected.	Maintains intestinal function and structure after surgical operations, diarrhoea, etc., strains able to colonize human intestinal mucosa, reduction of sulphite reducing clostridia, Enterobacteria and other undesirable bacteria.
Fermented fruit drink with oatmeal (Sweden)	Cooked oatmeal fermented, and 5% mixed into flavoured fruit drink. Snack-type or soup-type non-dairy beverage (Proviva®)	*Lactobacillus plantarum* 299v, $5x10^7$ CFU/g Strain protected.	Strain able to colonise in the intestinal mucosa and has been associated with a reduction in harmful bacteria. Lead to increase in SCFAs which are an energy source for mucosal cells.
Oat bran velli (Finland)	Oat bran and water cooked, cooled, fermented, cooled and flavoured with fruit, berries. Yoghurt-type non-dairy snack (Yosa®)	*Lactobacillus acidophilus* La-5, *Bifidobacterium bifidum* Bb-12, and other strains, $5x10^7$ CFU/g. Only cereal based product with bifidobacteria. Strains commercially available.	Potential synbiotic effects with probiotic and prebiotic components combined. Up to 0.5% viscous beta-glucan soluble fibre, which may contribute to cholesterol lowering and blood glucose attenuation.

Slightly modified from: Salovaara, H. & Simonson, L. 2004. Fermented cereal-based functional foods. Pages 721-727 in *Handbook of Food and Beverage Fermentation Technology*, YH Hui, LM Goddik, AS Hansen, J Josephsen, WK Nip, PS Stanfield & F Toldra (eds.). Marcel Dekker Inc.,New York.

Basic processing steps

1 Cooking

2 Fermentation

3 Flavouring

4 Packaging

Cereal material (oat bran) supports growth of probiotics, cf. sourdough

Generalized compositional data of whole dehulled cereal grains

Constituent	Content (%, dry matter basis)
Ash (minerals)	1.5-3
Protein	8-15
Lipids	2-6
Starch	45-77
Dietary fibre (as NSP + lignin)	9-12
Low-molecular weight carbohydrates (total):	2-5
- Fructose	0.1-0.4
- Glucose	0.1-0.5
- Sucrose	0.5-2
- Raffinose	0.2-0.7

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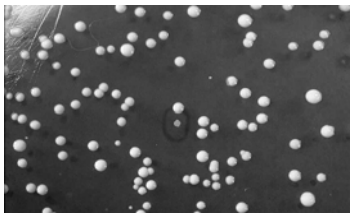
Fermentation:

Which starter?



Starter strains available from various suppliers

- *Lactobacillus acidophilus*
- *Lactobacillus sp.*
- *Lactobacillus plantarum*

- *Bifidobacterium lactis*
- *Bifidobacterium bifidus*
- *Bifidobacterium sp.*

Oat bran diet supports growth of lactic acid bacteria and bifidobacteria in rat gut: A prebiotic effect, probably by beta-glucan.

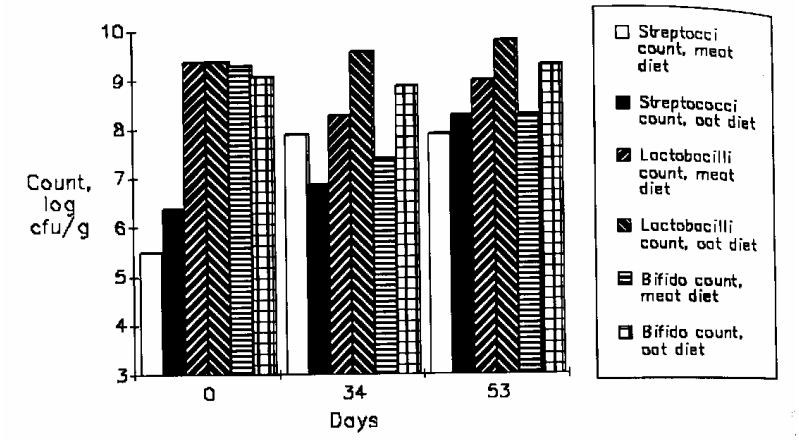


Figure 1. Counts of various groups of bacteria in faeces of rats on oat bran and meat diets

Ryhänen et al. (1993)

Some strains benefit from some additional sugar (1% glucose, fructose or sucrose)

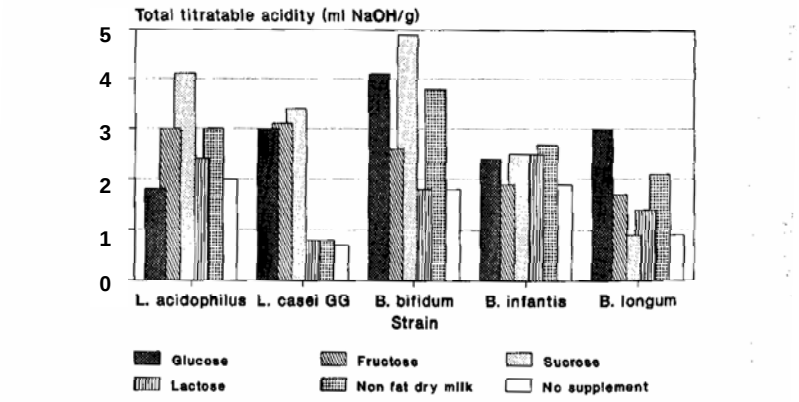


Figure 1. Effect of sugar and non fat dry milk supplementation on values of total titratable acidity of oat bran substrate fermented with five selected strains

Kontula et al. (1993)

Some bifidobacteria grow slightly better in the presence of beta-glucan (whereas lactobacilli are slightly retarded).

Proper selection of starter strains needed.
Beta-glucan to remain unaffected.

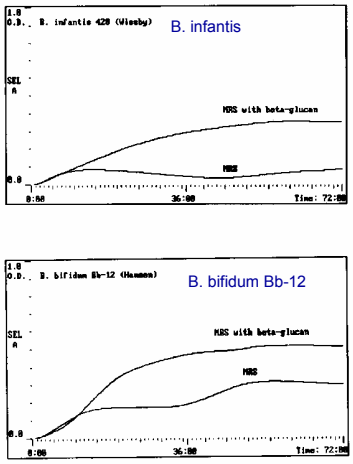


Figure 1. Growth of *B. infantis 420 (Wiesby)* and *B. bifidum Bb-12* (Hansen) in MRS broth without and with β-glucan (2 % w/v) during incubation at 37 C.

Jaskari et al. (1993)

Oat bran, possibly beta-glucan may protect probiotic strains against high acid concentrations, as shown here:
Viable count of *L. rhamnosus* LGG remains high in *in vitro* conditions;
HCl concentration up to 10 mM.
→ Improvement of probiotic effect

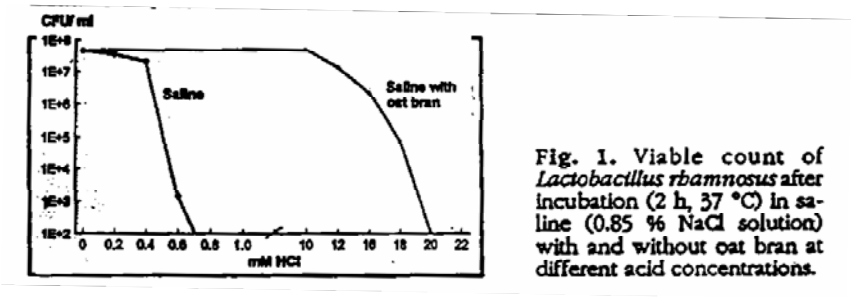
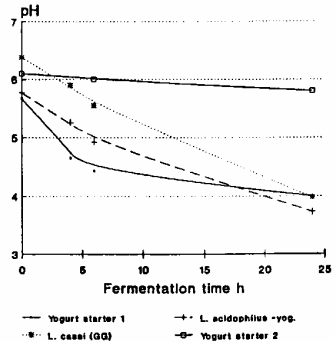
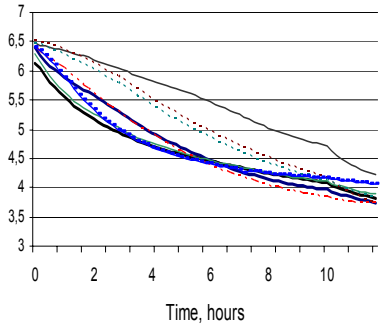


Fig. 1. Viable count of *Lactobacillus rhamnosus* after incubation (2 h, 37 °C) in saline (0.85 % NaCl solution) with and without oat bran at different acid concentrations.

Jaskari et al. (1995)

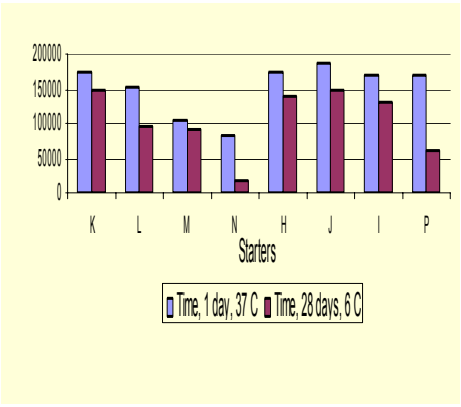
There are differences between starters: pH-drop





Gyran et al. (2004)

The suspension is highly sensitive to hydrolytic enzyme activities
a_w 0.98-0.99



Viscosity of oat suspensions fermented with various starters and stored for 28 d at 6 °C

- Day 1
- Day 28

Gyran et al. (2004)

Thanks to all co-workers and co-operating bodies!

For some more information please visit the Avenly web-page