Digesting Dairy

Lactose and protein digestion in dairy avoiders

Dr Amber Milan PhD
FNCE® 2017
Affiliations: past and present

• University of Auckland – Liggins Institute
• a2 Milk Company
• Nestle
• Yashili New Zealand Dairy Company
• AgResearch
• Ministry of Business Innovation and Employment
• National Science Challenge: High Value Nutrition
• Dairy Goat Cooperative
• Palm Oil Board of Malaysia
Outline

• The spectrum of lactose and dairy intolerances

• Is there a role for dairy protein?

• The aMiGo Trial: a2 Milk™ for Gut Comfort
  Mechanisms of non-lactose dairy intolerance by studying acute digestive symptoms
The spectrum of lactose and dairy intolerances

The role of dairy in health
Lactose intolerance
The unanswered questions
What’s in a drink?

- 90 g water for thinking and avoiding tiredness
- 5 g carbohydrate for energy
- 3.5 g milk protein for growth
- 1.5 g milk fat for brain and muscle cells
- Vitamins and minerals

Dairy in human health

• Content:
  • Calcium: bone health
  • Protein: rich source
  • Essential nutrients

• Bioavailable:
  • ‘Fast’ protein
  • High quality protein
  • Calcium

Alternatives just as good?

- Alternatives available
- Quantity
- Quality

Dietary Restriction: the costs

• Quality of life
• Nutrient deficiency risks

“Many individuals with real or perceived lactose intolerance avoid dairy and ingest inadequate amounts of calcium and vitamin D, which may predispose them to decreased bone accrual, osteoporosis, and other adverse health outcomes.

In most cases, individuals do not need to eliminate dairy consumption completely.”

“Lactose intolerance is a real and important clinical syndrome, but its true prevalence is not known.”

Mechanisms of (In)tolerance

**Lactose Tolerant (has lactase)**
- Lactose
- Lactase
- Glucose
- Galactose

**Lactose Intolerant (no lactase)**
- Lactose
- Bacterial fermentation
  - Gas
  - Acids
  - Flatulence, abdominal pain

Digest dairy!
**Lactase enzyme**
120 tablets

Diagnosing Lactose Intolerance

- Biopsy – enzymatic activity
- Single nucleotide polymorphisms (SNPs)
  - C/T\textsubscript{13910}
  - G/A\textsubscript{22018}
- Lactose Challenge
  - Breath Hydrogen Test
  - Lactose Tolerance Test

One test fits all?

• False positives (SIBO)
• Variation depending on malabsorption degree
The malabsorbers among us...

“The majority of people with lactose malabsorption do not have clinical lactose intolerance.”


The ones the lactose challenge left behind

"Many individuals who think they are lactose intolerant are not lactose malabsorbers."

Summary: lactose and dairy intolerances

• NIH statement identifies gap in knowledge

• Lactose tests have limitations

• Lactose may not be the cause of symptoms for all
Is there a role for dairy protein?

Dairy protein variation & sensitivities
A2 β-casein
Links between inflammation and intolerance
Dairy proteins – more than meets the eye

β-lactoglobulin 10%
α-lactalbumin 5%
Albumin 1%
Immunoglobulins 3%
αs1-casein 33%
κ-casein 10%
β-casein 28%
αs2-casein 10%

Whey (20%)

Casein (80%)
A2 β-casein

Inflammation

BCM7 mechanisms

**Slower transit time**

![Image showing a frog on a toilet]

**Inflammation**

![Image showing histological sections with inflammatory markers]


Can you feel the difference?

Stool consistency

<table>
<thead>
<tr>
<th>Bristol Stool Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type 1</strong></td>
</tr>
<tr>
<td><strong>Type 2</strong></td>
</tr>
<tr>
<td><strong>Type 3</strong></td>
</tr>
<tr>
<td><strong>Type 4</strong></td>
</tr>
<tr>
<td><strong>Type 5</strong></td>
</tr>
<tr>
<td><strong>Type 6</strong></td>
</tr>
</tbody>
</table>

Discomfort

<table>
<thead>
<tr>
<th>Weekly total VAS score for gastrointestinal symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A1-A2</strong></td>
</tr>
<tr>
<td>Week 0</td>
</tr>
</tbody>
</table>


Summary: the role of dairy protein

• A1 β-casein breakdown to BCM7

• BCM7 localised digestive changes

• BCM7 may exacerbate lactose intolerance

• Controlled human trials are lacking
The aMiGo Trial: a2 Milk for Gut Comfort

Mechanisms of non-lactose dairy intolerance by studying acute digestive symptoms

Non-lactose dairy intolerance?
Interactions of lactose and protein intolerance?
The aMiGo Trial

• Non-Lactose Dairy Intolerance
  • Known that a proportion of self-reported lactose intolerant are not lactose malabsorbers
  
  • Protein-mediated effects of milk intolerance may be independent of lactose malabsorption
  
  • Symptoms and identification of protein-mediated milk intolerance are undescribed

• Digestive tolerance of a2 Milk
Aims

• To characterise subjects with dairy intolerance (lactose or other)

• To characterise symptoms of dairy intolerance

• To investigate acute digestive response differences between conventional, lactose-free and a2 Milk™
Subjects, Design & Hypothesis

Design

Hypothesis

Self-report VAS

Dairy Intolerant

Dairy Tolerant

Conventional milk

a2 milk®

Lactose Free

Lactose

Randomisation
Lactose Challenge: Defining Lactose Intolerance

<table>
<thead>
<tr>
<th>Method</th>
<th>Criteria</th>
<th>LI</th>
<th>DI</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactose Tolerance Test</td>
<td>Blood glucose increase &gt;1.11mmol/L</td>
<td>✔️</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Hydrogen Breath Test</td>
<td>Δ25ppm</td>
<td>✔️</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Symptom Scores</td>
<td>VAS SUM &gt;7/50 (Diarrhoea, abdominal cramping, vomiting, audible bowel sounds, flatulence)</td>
<td>✔️</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Lactase SNP</td>
<td>LCT-13910, LCT-22018</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urinary Galactose</td>
<td>Ratio creatinine/galactose &lt;0.1 mg/mg</td>
<td></td>
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</tr>
</tbody>
</table>
aMiGo Milk Challenge

Conventional milk  a2 milk®  Lactose Free

Plasma  Breath  VAS  Urine  MRI

Start  

3 h
Assessed for eligibility (n=101)

- Excluded (n=42)
  - Ineligible
  - No longer required (8)

Lactose Challenge Enrolment (n=59)

Lactose Intolerant (LI) (n=26)

Lactose Intolerant (LI) (n=10)

Tolerant (n=10)

Dairy Intolerant (DI) (n=23)

Dairy Intolerant (DI) (n=20)

Milk Challenge Enrolment (40)

Randomized

Conventional
a2 Milk
Lactose-free
Participant Characteristics

**Malabsorption**

Breath Hydrogen

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Dairy Intolerant</th>
<th>Lactose Intolerant</th>
<th>Tolerant</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
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<td>60</td>
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<tr>
<td>120</td>
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**Symptoms (Flatulence, Bloating, etc.)**

Glucose

- Dairy Intolerant
- Dairy Tolerant
- Lactose Intolerant

Symptoms at 3 hrs

- Dairy Intolerant
- Lactose Intolerant
- Tolerant
Ethnic Distribution

No non-Caucasians in Dairy Intolerant group
Fewer non-Caucasian absorbers

G/A-22018- Digestion with Hhal
Dairy avoidance in dairy avoiders?

**Increasing milk consumption**

- **Count (n)**
  - Once a day
  - 2-4 per week
  - Once a week
  - 1-3 per month
  - Less than one a month
  - Never
  - I avoid eating this

**Count (n)**

- Dairy Intolerant
- Lactose Intolerant
- Tolerant

**Increasing cheese consumption**

- **Count (n)**
  - Once a day
  - 5-6 per week
  - Once a week
  - 2-4 per week
  - 1-3 per month
  - Less than one a month
  - Never
  - I avoid eating this

Fluid milk low, but products like cheese relatively high
Lactose intolerant subjects experience greater symptoms with conventional milk.

Nausea and faecal urgency reduced with lactose-free and a2 Milk.

Symptoms such as cramps, rumbling: no different.
Malabsorption reduced with a2 Milk

Breath hydrogen decreased after a2 Milk compared to conventional
Urinary galactose not different
Dairy Intolerant experience different symptoms

Poor digestive comfort
Early symptoms
(flatulence, rumbling)
Summary: The aMiGo Trial

• In Lactose Intolerant individuals, a2 Milk
  • Reduced nausea and faecal urgency than conventional milk, similar to lactose-free
  • Breath hydrogen increased later and less after a2 Milk than conventional in lactose intolerant subjects

• Non-Lactose Dairy Intolerance
  • Early symptoms of abdominal distension, bloating, and abdominal rumbling which resolved
  • a2 Milk elicited similar symptoms to conventional and lactose-free milk, while increasing flatulence
Take-home messages

• Lactose malabsorption affects majority
• Dairy intolerance not limited to lactose
• Malabsorption/intolerance not static
  • Diet
  • Inflammation
• Links to other functional digestive disorders unknown
• Diagnosis and treatment limited by unknown mechanisms
Acknowledgments

Research Team

Prof David Cameron-Smith
Dr Matthew Barnett
Aahana Shrestha, Clara Han, Utpal Prodhan, Sarah Mitchell, Jimmy Nilsson, Josefin Karlström, Jakob Martinsson

Funding

Institutional Affiliations