Not all Proteins are Equal

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Introduction

Dairy products are a feasible means to help meet the demands of a growing world market as well as the nutritional needs of the global population.

The demand: Nutrition-related non-communicable diseases are responsible for unacceptable high rates of morbidity mortality in South Africa justifying efforts to improve the dietary intake of the population.

FBDG: Have milk, maas and yoghurt everyday can play an important role in meeting this objective.

Introduction

Where does milk fit into the diet:

• Milk is the first food for all mammals and provides the necessary energy and nutrients to ensure proper growth and development
• Epidemiologic studies confirm the importance of milk in the human diet
• Evidence is emerging to reinforce the role of milk consumption in preventing several chronic diseases
• Only lactose intolerance and cow milk protein allergy are considered adverse reactions to milk consumption

Assessing protein quality

Why is milk protein different:

• Methods to assess the quality of protein are traditionally related to the ability of a protein to meet the demand for amino acids and nitrogen.

• Methods used to determine protein quality ranged from nitrogen balance, biological value profile, protein efficiency ratio, net protein utilisation and amino acid scores.

• It is now realised that factors such as digestibility and bioavailability are also important aspects of protein quality.

Assessing protein quality

• Methods to assess the quality of protein are traditionally related to the ability of a protein to meet the demand for

Protein digestibility → proteolytic processing of proteins to release amino acids throughout the digestive system

Bioavailability of amino acid → the proportion of consumed protein that is absorbed in a chemical form for it to be used by the human body

(DIAAS) has been developed and has confirmed the high quality of milk protein

Assessing protein quality

Amino acid score methods:

• The essential amino acid score and protein digestibility corrected amino acid score (PDCAAs) classified milk proteins to be the best protein source

• The PDCAAs score had some limitations:
  – The biological value of a protein could not exceed 100%
  – This means that proteins with essential amino acids beyond those in the reference protein – as with milk – do not get due credit
  – It also did not take into account amino acid availability, anti-nutritional factors of plant protein and gastointestinal factors

• Therefore more recently the digestible indispensable amino acid score (DIAAS) has been developed and has confirmed the high quality of milk protein

Milk typically contains **33g protein** per liter.

Milk proteins can be divided into soluble whey (20%) and insoluble casein (80%).

Both are high quality proteins in terms of:
- amino acid requirements
- digestibility and
- Bioavailability

Additionally **Bio active Peptides**
Bioactive Peptides

- Bioactive peptides in dairy have distinctive functions resulting in milk and dairy being classified as functional foods.
- **Functional foods** can be defined as "foods containing significant levels of biologically active components that provide specific health benefits beyond the traditional nutrients they contain."
- Enzymatic hydrolysis of milk proteins yields bioactive peptides that have multiple biological roles that can benefit human health.
- Dairy proteins possess antimicrobial, antioxidant, anticarcinogenic, and immunostimulatory activities.

The biologically active components of dairy make it a functional food.

Whey

- Whey is especially rich in branched chain amino acids: leucine, isoleucine, valine as well as lysine.

- Functional roles:

<table>
<thead>
<tr>
<th>Whey proteins</th>
<th>Functional roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>β-Lactoglobulin</td>
<td>Retinol and fatty acids binding</td>
</tr>
<tr>
<td></td>
<td>Possible antioxidant</td>
</tr>
<tr>
<td>α-Lactoalbumin</td>
<td>Lactose production, calcium transport, immunomodulator,</td>
</tr>
<tr>
<td></td>
<td>anticarcinogen</td>
</tr>
<tr>
<td>Immunoglobulins</td>
<td>Immune protection</td>
</tr>
<tr>
<td>Lactoferrin</td>
<td>Antimicrobial, antioxidant, immunomodulator, iron</td>
</tr>
<tr>
<td></td>
<td>absorption, anticarcinogen</td>
</tr>
<tr>
<td>Lactoperoxidase</td>
<td>Antimicrobial</td>
</tr>
<tr>
<td>Lysozyme</td>
<td>Antimicrobial, synergy actions with Immunoglobulins</td>
</tr>
<tr>
<td></td>
<td>and Lactoferrin</td>
</tr>
</tbody>
</table>
Casein

- Casein has a higher proportion of histidine, methionine and phenylalanine
- Functional roles:

<table>
<thead>
<tr>
<th>Casein proteins</th>
<th>Mineral binding and transport (Ca, PO4, Fe, Zn, Cu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>α-Casein</td>
<td></td>
</tr>
<tr>
<td>β-Casein</td>
<td></td>
</tr>
<tr>
<td>k-Casein</td>
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</tbody>
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- Other bioactive peptides yielded after hydrolysis of casein have cardiovascular, nervous, immune and digestive system benefits through their antioxidant, cytomodulatory, immunomodulatory, antihypertensive, antithrombotic and analgesic actions
**Fast vs Slow Proteins**

- Whey and casein proteins are **absorbed at different rates** in the digestive system.
- **Whey** proteins, also termed “fast proteins,” remain in a liquid state in the stomach, thus increasing amino acid availability and absorption.
- **Caseins**, or “slow proteins” clot in the low pH of the stomach, resulting in a slower postprandial availability of amino acids.
- These different digestion and absorption rates impact on the postprandial amino acid responses.


Milk and Health
Health benefits of Milk and Dairy

- Obesity and weight loss
- Inflammation diseases
- Sarcopenia
- Hypertension
- Cardiovascular disease
- Diabetes
- Metabolic Syndrome
Obesity and Weight loss

• Loss of skeletal muscle during weight loss is undesirable because skeletal muscle:
  – is important for mobility and activities of daily living
  – plays a major role in tissue glucose uptake and thus glycaemic control

• Including dairy products in weight loss diets has been shown to decrease adiposity, while preserving lean mass

• In two meta-analyses of randomised controlled trials high-dairy energy-restricted diets led to a significantly
  – greater reduction in body weight
  – waist circumference, and
  – fat mass
  while preserving/ increasing lean mass significantly more than conventional weight loss diets

Obesity and Weight loss

• **Whey proteins** can affect **levels of satiety**
  - due to the fast appearance of amino acids in plasma which may help to decrease excessive food intake and prevent weight gain

• **Dairy BCAAs** enhance **muscle protein** synthesis and muscle mass and protect against loss of lean mass during weight loss

• **Milk proteins** may also influence gut hormones by stimulating anorexigenic hormones involved in satiety

• May ↓ ghrelin and

• ↑ thermogenesis, thus increasing REE


Chronic low-grade inflammation is present in obesity
Serum levels of pro-inflammatory cytokines are elevated

These cytokines can increase insulin resistance
inhibit glucose uptake
and increase skeletal protein catabolism

Dairy consumption has beneficial effects on markers of low-grade inflammation (C-reactive protein and adiponectin) in obese subjects

In-vitro evidence shows that dairy proteins have immuno-modulatory effects
  – Whey protein may inhibit the proliferation of lymphocytes
  – Lactoferrin and lactoperoxidase can suppress interferon

Muscle mass and sarcopenia

- Sarcopenia is defined as Age-related loss of skeletal muscle mass and strength

- Resistance exercise has the ability to increase muscle protein mass and strength

- There is a growing body of evidence that has highlighted the potential of milk-based proteins to enhance the benefits of exercise in maintaining and enhancing muscle mass in older adults

Muscle mass and sarcopenia

- **Whey protein** support rapid increases in muscle protein synthesis
- **Casein** support sustained increases in muscle protein synthesis and decreases in muscle protein breakdown

- Milk is a very good source of **leucine** which is especially important in stimulating muscle protein synthesis
- The anabolic effect of milk may be an effective way for maintenance of muscle mass and strength in the healthy elderly and fast recovery in the frail elderly

Hypertension is a major cardiovascular risk factor

Several studies have reported a significant association between low fat dairy consumption and hypertension

A dose-response meta-analysis of prospective cohort studies in almost 60,000 subjects showed that total dairy, low fat dairy, and milk were all linearly associated with a lower risk of hypertension

DASH advises daily consumption of low fat milk and other dairy products

Bazzano LA et al. 2013. Dietary Approaches to Prevent Hypertension. *Current Hypertension Reports*
Hypertension

- **Bioactive peptides** in milk have a direct inhibitory action of angiotensin converting enzyme → reducing blood pressure

- These include peptides from both whey and casein

Cardiovascular Disease

- Dyslipidemia is one of the main metabolic risk factors associated with CVD risk
- Milk protein has been shown to improve the lipid profile and reduce cardiovascular risk factors
- Arterial stiffness is an independent risk factor for CVD and is higher in those with hypercholesterolemia

consumption of whey protein seems to reduce arterial stiffness


**Cardiovascular Disease**

- **Protective effects** of dairy on LDL and HDL cholesterol and blood pressure are related to both **calcium** and **biopeptides** in milk

- Exact mechanisms explaining the effect of dairy on postprandial lipidaemia is not yet well understood

- Dairy proteins may suppress postprandial lipidaemia due to their insulinotropic effects


Various studies have shown that a higher versus lower dairy intake significantly reduced the risk of T2D.

A dose-response analysis showed a decrease of 6% in T2D risk per each additional daily serving of total dairy and a 10% risk reduction per additional serving of low-fat dairy.

In a meta-analysis of cohort studies, the highest vs. lowest dairy intake (3–5 vs. 1.5 servings per day) was associated with a lower risk of T2D.

The Dietary Guidelines Advisory Committee concluded that moderate evidence indicates that dairy products are associated with a reduced risk of T2D.
Elevated fasting glucose is a key metabolic risk factor.

Insulin is sensitive to both the composition and concentration of plasma AAs and thus both whey and casein stimulate increased insulin secretion.

Whey proteins are digested quickly and result in a rapid secretion of insulin that decreases the postprandial glucose response.

The high content of BCAA in whey protein may also play a role in the higher insulin response and improved insulin sensitivity due to their effect on pancreatic β-cells.


There is increasing evidence indicating that dairy products may reduce the risk of metabolic syndrome. The mechanism appears to be via the effects of different dairy components on specific risk factors:

- blood glucose level
- insulin metabolism
- body weight and adipose distribution
- blood pressure


Conclusion

“Consumption of dairy products is associated with decreased prevalence of metabolic related disorders...
Dairy protein may indirectly improve metabolic health by aiding loss of body weight and fat mass through enhanced satiety, whilst promoting skeletal muscle growth and function through anabolic effects of dairy protein-derived BCAAs.
BCAAs enhance muscle protein synthesis, lean body mass and skeletal muscle metabolic function....
Specific protein components in milk may provide a way to maximise benefits for metabolic health.”

Thank you for your attention
Maretha Vermaak
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