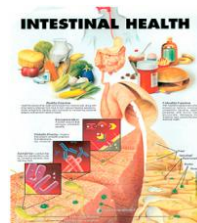
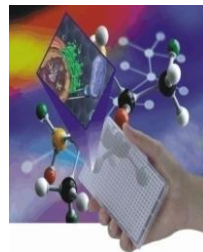
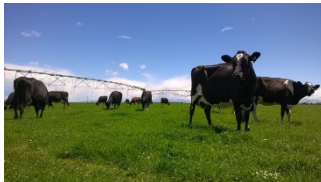


Between Ewe and Me

Composition and health benefits of sheep's milk



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AgResearch Grasslands

Objectives

- A comprehensive review of the available scientific literature regarding the composition and nutritional value of sheep milk, and what distinguishes it from cow and goat milk.
- Jointly funded by Blue River Nutrition and AgResearch



Good

vs.



Better

vs.



Best?

Overview

Literature search

- Databases and search strategy used
- Search results

Review to date

Composition

- Basic composition
- Amino acids
- Lipids and fatty acids

Nutritional value / health benefits

- Digestibility
- Allergy
- Bioactive compounds



VS.



VS.



Literature search strategy

CAB Abstracts, Biosis Previews, Food Science & Technology Abstracts, Medline, Scopus

Initial search strategy

- Keyword, title & abstract searches using combinations of the following
 - (ovine and bovine and caprine and milk) or (sheep and goat and cow and milk) or (sheep's and goat's and cow's and milk);
 - (composition or component/s or comparison or comparative);
 - (health benefit/s or nutritional quality or human nutrition or human health or nutritional study or nutritional value or health effect/s).
- Search strategy subsequently refined as follows:

COMPOSITION

NUTRITIONAL VALUE / HEALTH EFFECTS

TOTAL MILK SOLIDS

DIGESTIBILITY

Literature search results

>500 references found to date

- Composition
 - 235 English language
 - 98 not English language
- Health benefit
 - 71 English language
 - 14 not English language
- Specific to sheep (no comparison with cow or goat)
 - 139
- Allergy
 - 58

Composition

- Basic composition
- Amino acids
- Lipids and fatty acids



Basic milk composition



Component	Cow	Goat	Sheep
Total solids (g/L)	120	140	190
Protein (g/L)	35	40	60
Fat (g/L)	40	50	70
Lactose (g/L)	50	40	50
Energy (kJ/L)	2,800	2,800	4,200
Calcium (mg/100 mL)	120	130	200
Phosphorus (mg/100 g)	120	120	140

References: Claeys et al. *Food Control* 42 (2014), 188-201. Barlowska et al. *Comprehensive Reviews in Food Science and Food Safety* 10 (2011), 291-302.
Park et al. *Small Ruminant Research* 68 (2007), 88-113.

Amino acid composition



Amino acid (mg/100 g milk)	Cow	Goat	Sheep
Alanine	100	118	269
Arginine	110	118	198
Aspartic acid	260	210	328
Cysteine	20	46	35
Glutamic acid	770	626	1019
Glycine	60	50	41
Histidine*	100	98	167
Isoleucine*	140	207	338
Leucine*	290	314	587
Lysine*	270	290	513
Methionine*	60	80	155
Phenylalanine*	160	155	284
Proline	320	368	580
Serine	160	181	492
Threonine*	150	240	268
Tryptophan*	50	44	84
Tyrosine	150	179	281
Valine*	160	240	448

*Essential amino acid. Reference: Claeys et al. *Food Control* 42(2014), 188-201.

Lipids and fatty acids

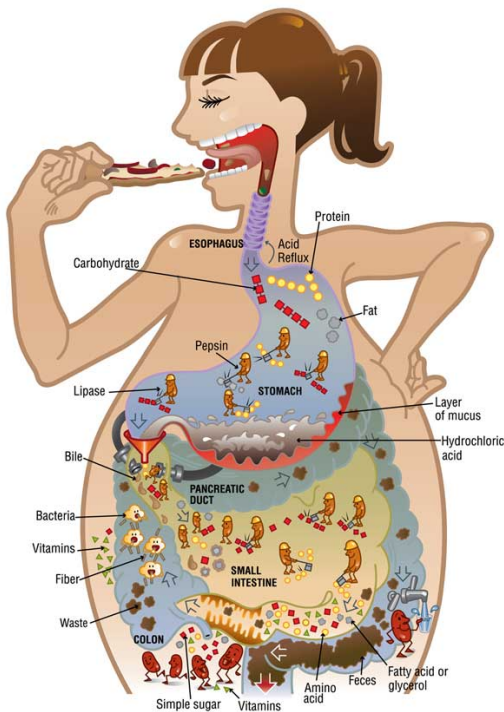


Component	Cow	Goat	Sheep
Total fat (g/L)	40	50	70
Saturated fatty acids (% of total fatty acids)	56-73	60-74	58-75
Monounsaturated fatty acids (% of total fatty acids)	23-30	23-40	22-36
Polyunsaturated acids (% of total fatty acids)	2.4-6.3	2.5-7.3	2.4-5.6
Linoleic acid (C _{18:2}) (% of total fatty acids)	1.2-3.0	1.9-4.3	1.6-3.6
Linolenic acid (C _{18:3}) (% of total fatty acids)	0.2-1.8	0.2-1.2	0.5-2.3
Conjugated linoleic acids (% of total fatty acids)	0.2-2.4	0.3-1.2	0.6-1.1
n-6:n-3 ratio	2.9	4.0	2.4
Cholesterol (mg/100 mL milk)	22	15	21
Fat globule diameter (µm)	3.7	3.1	3.4

Claeys et al. *Food Control* 42(2014), 188-201.

Nutritional value / Health benefits

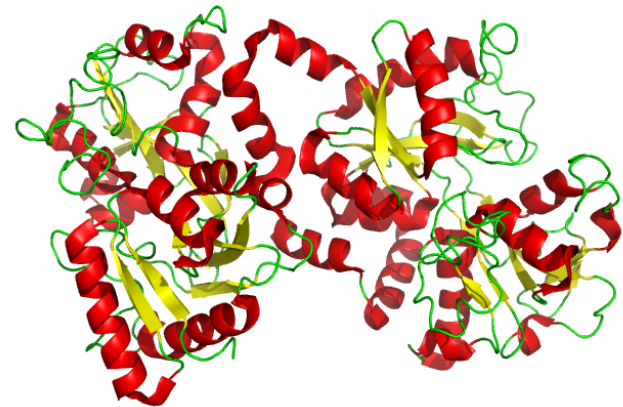
Digestibility



Allergy



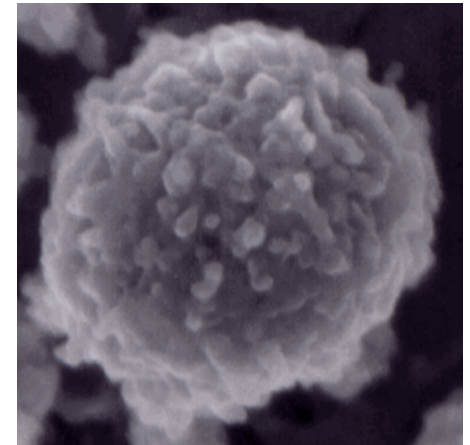
Bioactive compounds



Health benefits - digestibility

Several factors influence the digestibility of milk, including

- Curd formation in the stomach
- Differences in total protein composition
 - Casein content
 - Casein/whey protein ratio
- Micelle structure
 - Size
 - Casein distribution
 - Mineralization
- Differences in digestibility of individual proteins from different species
- Size of the milk fat globule



Casein micelle. Image from: Dalgleish, D. Get al. (2004). International Dairy Journal. 14: 1025-1031.

Health benefits - digestibility

Some differences are well established

- Goat and sheep β -lactoglobulin are more easily digestible than bovine
- Sheep and goat milk have smaller fat globules than bovine milk
- Bovine milk produces a firm and dense coagulum, while other species produce soft curds in the stomach, more like human milk, e.g.
 - Goat
 - Donkey
 - Camel

Still much that is not known about digestibility of sheep's milk

- Opportunity?

Health benefits - allergy

- ~60 references relating to allergy
- Wide range of opinion expressed
 - “The milk of goat and sheep harbor an allergic potential and is **not suitable** for the nutrition of milk-allergic patients.”
 - “Goat's milk has a guaranteed space in the market, due of it is high biological value and **low allergenicity**.”
- In cases of severe cow's milk allergy (CMA), very unlikely that sheep's (or any other) milk would be suitable
 - High degree of cross-reactivity between different ruminant milks
- There are clearly cases of low-level CMA where goat's or sheep's milk can be tolerated
 - The cause of intolerance is a factor, e.g., sensitization due to childhood exposure
- Digestion may play a role – how different milks are digested influences how allergens are presented

Health benefits - allergy

- Caution must be exercised when making any claims around allergy, because it can have serious consequences



- **MORE RESEARCH IS NEEDED**
 - The level of data currently available is not sufficient
 - This may represent an opportunity for differentiation of sheep's milk

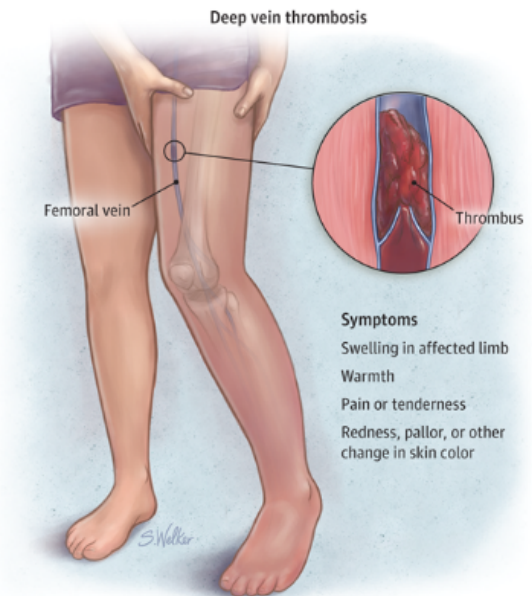
Health benefits - bioactives

- 12 references relating to bioactive compounds
- Example: lactadherin
 - A major protein of the milk fat globule membrane
 - May act as a potent anti-viral agent in rotavirus-induced gastroenteritis
 - Lactadherin structure is species dependent
 - Potential functional differences in the biological function of lactadherin due to different isoforms
- Example: lactoferrin
 - Lactoferrin is a non-immunoglobulin defence protein found in milk
 - Peptides derived from lactoferrin have antibacterial properties
 - Lactoferrin level in sheep milk 4-fold higher than goat, 8-fold higher than cow



Health benefits - bioactives

- Example: Angiotensin converting enzyme (ACE) inhibitory peptides
 - ACE regulates several systems that affect blood pressure
 - ACE inhibitory peptides are of potential benefit for treating hypertension
 - Most research has been in bovine milk, but sheep (and goat) milk proteins are recognised as a potential source of ACE inhibitory peptides
- Example: Antithrombotic peptides
 - Cardiovascular diseases (e.g., thrombosis, or clotting) are important causes of adult mortality
 - Peptides derived from κ -casein have antithrombotic properties
 - Some evidence that ovine-derived peptide have a stronger effect than those from other species



Thompson AE (2015). *JAMA*. 2015;313(20):2090. doi:10.1001/jama.2015.4761.

Summary

Composition

- Appear to be clear differences in composition of sheep's milk (total solids, amino acids, lipid profile) compared with other milk
- Many factors influence this, so a better picture of NZ sheep milk composition is needed to capitalize on these differences

Nutritional value / health benefits

- Early research suggests that sheep milk has many potential benefits (e.g., digestibility, allergy, bioactives)
- MORE RESEARCH IS NEEDED & WARRANTED



VS.



VS.



Acknowledgements

- Blue River Nutrition
- AgResearch
- Joy Dick