

THE NUTRITIONAL QUALITIES OF GOAT MILK AS AN ALTERNATIVE TO COWS' MILK IN INFANT FORMULAE



Jacqui Lowden
Paediatric
Dietitian - Team
Leader Critical
Care, Therapy &
Dietetics, RMCH

During infancy, appropriate nutrition is required for normal growth and development.

There is now substantial evidence to indicate that early nutrition also has fundamental implications for long-term health, by programming aspects of ensuant cognitive function, thereby preventing obesity and anaemia, as well as reducing the risk of serious diseases such as diabetes, cardiovascular disease, osteoporosis, cancer and atopy (1, 2, 3).

To achieve these outcomes, breastfeeding is recommended (4). Where breastfeeding is not possible, or breast milk is insufficient, infant formulae are used. Traditionally, infant formulae made with cows' milk are the first line choice for formula-fed infants. Until recently, most of the conclusive studies in human infants published in the international literature have been limited to the evaluation of cows' milk or soy protein-based infant formulae. Proteins from the milk of animals other than cows, or from various plant sources, have also been considered potentially suitable for use in infant formulae (5, 6). However, the suitability and safety of goat milk has only recently been approved, despite the fact that goat milk has a history of use for human nutrition in many cultures (7, 8, 9) and that there has always been

demand for goat milk infant formulae, with reports of home-made goat formula and raw goat milk being used (10, 11, 12, 13).

The Dietetic Products, Nutrition and Allergies of European Food Safety Authority (EFSA) panel (14) concluded that protein from goat milk is suitable as a protein source for infants and for follow-on formulae (as long as the final products comply with the compositional criteria as per the EU Directive 2006/141/EC). From March 2014 goat milk infant formula has now become allowable throughout the EU. But is it any different from cows' milk formula?

Table 1 outlines the main differences between cows' milk and goat milk formulae.

COMPOSITIONAL PROPERTIES

Nucleotides

In young infants, rapid growth can increase the need for nucleotides, which are important constituents of RNA and DNA. It is well documented that nucleotide supplementation increases weight gain and head growth in formula-fed infants. Therefore, nucleotides may be conditionally essential for optimal infant growth in some formula-fed populations (19).

Presently team leader for Critical Care and Burns, Jacqueline previously specialised in gastroenterology and cystic fibrosis. Although her career to date has focused on the acute sector, Jacqueline has a great interest in paediatric public health.

Table 1: How goat milk differs from cows' milk

Goat milk is secreted by an apocrine process, similar to that of breast milk (15)
Goat milk has a lower level of alpha s1-casein and greater proportion of beta-casein compared to cows' milk and is more similar to human milk (16)
Goat milk has more medium chain fatty acids than cows' milk (17)
Goat milk has five times more nucleotides than cows' milk, similar to human milk (18)

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Protein and amino acids

Goat milk infant formula has amino acids in amounts similar to human milk reference values, when expressed on a per-energy basis (21).

The protein content of infant formula has, in the past, been set higher than human milk. This was due to concerns regarding protein quality and insufficient amounts of some amino acids. However, there now exists evidence that the protein content has been set too high, resulting in a greater than normal weight gain and stress on a young infants immature kidneys (22, 23).

With this 'growth acceleration hypothesis', suggesting that early and rapid growth during infancy programs the infant metabolic profile to be susceptible to obesity and the other components of metabolic syndrome, it is essential that any infant formulas are brought in line with human milk reference values.

Whey proteins

Infant milk formulas often have whey proteins added to improve the quality of protein available as essential and semi-essential amino acids (24, 25). Goat milk infant formula, however, has been shown to have sufficient quantities of all essential and semi-essential amino acids, without added whey proteins and so has an amino acid profile compatible with international standards for infant formula (21). It has also been demonstrated that this type of goat milk formula has amino acid digestibility and absorption properties similar to those of a cows' milk infant formula, with added whey, in an animal model (26).

NUTRITIONAL ADEQUACY

As well as meeting international compositional standards, it is also essential that the suitability and nutritional adequacy of infant formulas containing new sources of protein are established (27, 28).

Until recently, there has only been one previous randomised controlled trial using a goat milk infant formula to feed infants (29), demonstrating that the growth in 30 infants fed

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a goat milk formula was similar to that of 32 infants fed a whey-based cows' milk formula, but the study was criticised for lack of blood biochemical data and numbers (30).

Since then, however, a study published in 2014 has demonstrated that in infants, the growth and nutritional outcomes provided by the goat milk formula did not differ from those provided by a standard whey-based cows' milk formula. The study of 285 infants fed goat or cow formula or breast milk, provided the necessary evidence leading to the recent change allowing goat milk as a base in infant formula (31).

An earlier study by Zhou et al 2011 (16) highlighted an interesting aspect, in that they measured how many times an infant was offered an alternative formula or non-formula foods before the age of four months, as a measure of compliance. In the group randomised to receive the cows' milk formula, almost 40 percent of the infants were offered either another formula or a non-formula food for more than 12 days before the age of four months. The rates in the infants fed the goat milk formula were far less and more similar to the breast milk fed infants.

When parents change their baby's formulas or introduce solids earlier than the recommendation, a common reason given is because they feel that the baby is not satisfied. This does need to be investigated further, but could possibly suggest that they were more satisfied on the goat milk formula.

WHAT ABOUT COWS' MILK PROTEIN ALLERGY?

The World Allergy Organisation estimates that 1.9% to 4.9% of children suffer from cows'

milk protein allergy (32). It has previously been suggested that goat milk could be used as a possible nutritional alternative to cow's milk for these infants. However, clinical studies have demonstrated a risk of cross-reactivity between the proteins in cows' milk and in goat milk (33, 34). There have also been reported cases of infants with cows' milk allergy developing anaphylaxis after the ingestion of goat milk (35).

In the 2012 EFSA publication, it was concluded that, 'There is insufficient data on the allergenicity of goat milk protein, with no convincing data to support the conclusion that the incidence of allergic reactions is lower when feeding goat milk-based infant formula when compared with cows' milk-based infant formula.' It also concluded that, 'Substituting goat milk protein for cows' milk protein in infant formula intended for cows' milk allergic infants cannot be considered safe, unless proven to be so in clinical and in vitro studies.' (36)

Government advice at present is, therefore, that, 'Goat milk infant formula and follow-on formula is not suitable for infants with a cows' milk protein allergy unless directed by a healthcare professional.'

SUMMARY

Optimum nutrition during infancy is not only important for normal growth and development, but also for long-term health. Where breast milk is not available, it is essential that infant formulas can provide, as close as possible, the equivalent nutritional and health outcomes for babies as for those infants who are breastfed. ▶

Until recently, most of the conclusive studies in human infants published in the international literature have been limited to the evaluation of cows' milk or soy protein-based infant formulae. However, there is now published evidence that goat milk infant formula is a safe and suitable alternative to cows' and soy-based formulas and is approved for use.

Goat milk has several features that have greater similarity to human breast milk than cows' milk. There is no evidence to suggest that there is any advantage to including extra whey proteins in goat infant formula.

Goat milk infant formula, however, is not suitable for infants with a cows' milk protein allergy, unless directed by a healthcare professional.

References

- 1 Lucas A. Programming by early nutrition: an experimental approach. *J Nutr* 1998;128 (suppl 2):401-6S
- 2 WHO Diet, Nutrition, and the Prevention of Chronic Disease. Report of a joint WHO/FAO Expert consultation. 2003
- 3 SACN (2011 a). The influence of maternal, fetal and child nutrition on the development of chronic disease in later life (online). London SACN. Available at www.sacn.gov.uk/pdfs/sacn_early_nutrition_final_report_20_6_11.pdf (accessed July 2014)
- 4 AAP (2012). Breastfeeding and the use of human milk. *Pediatrics* 129, e827-e841
- 5 Global Standard for the Composition of Infant Formula: Recommendations of an ESPGHAN Coordinated International Expert Group. *Journal of Pediatric Gastroenterology and Nutrition* 41:584-599, November 2005. ESPGHAN Committee on Nutrition
- 6 Codex Alimentarius Commission (2007). Standard for infant formula and formulas for special medical purposes intended for infants CODEX STAN 72-1981 (amended 2007)
- 7 Silanikove N, Leitner G, Merin U et al (2010). Recent advances in exploiting goat milk: quality, safety and production aspects. *Small Rum Res* 89, 110-124
- 8 Haenlein GFW (2004). Goat milk in human nutrition. *Small Rum Res* 51, 155-163
- 9 Razafindrakoto O, Ravelomanana N, Rasolofo A et al (1994). Goat milk as a substitute for cows' milk in undernourished children: a randomised double-blind clinical trial. *Pediatrics* 94, 65-69
- 10 Ziegler DS, Russell SJ, Rozenberg G et al (2005). Goat milk quackery. *J Pediatr Child Health* 41, 569-571
- 11 Basnet S, Schneider M, Gazit A et al (2010). Fresh goat milk for infants: myths and realities - a review. *Pediatrics* 125, e973-e977
- 12 Taitz LS and Armitage BL (1984). Goat milk for infants and children. *Br Med J (Clin Res Ed)* 288, 428-429
- 13 Baur LA and Allen JR (2005). Goat milk for infants: yes or no? *J Paediatr Child Health* 41, 543
- 14 European Food Safety Authority (2012). Opinion of the Scientific Panel on Dietetic Products, Nutrition and Allergies on a request from the Commission relating to the suitability of goat milk protein as a source of protein in infant formula and in follow-on formula. *The EFSA Journal* 10 (3):2603
- 15 Wooding FB, Peaker M, Linzell JL (1970). Theories of milk secretion: evidence from electron microscopic examination of milk. *Nature*, 226, 762-4
- 16 Zhou SJ, Sullivan T, Bibson RA, Makrides M (2011). How does goat milk infant formula compare to cow milk formula? A randomised controlled trial. *Journal of Pediatric Gastroenterology and Nutrition*, 52, E208
- 17 Lindquist S and Hernell O (2010). Lipid digestion and absorption in early life: an update. *Curr Opin Clin Nutr Metab Care*, 13, 314-20
- 18 Prosser CG, McLaren RD, Frost D, Agnew M, Lowry DJ (2008). Composition of the non-protein nitrogen fraction of goat whole milk powder and goat milk-based infant and follow-on formulae. *Int J Food Sci Nutr*, 59, 123-33
- 19 Singhal A et al (2013). Dietary Nucleotides and Early Growth in Formula-Fed Infants: A Randomised Controlled Trial. Published online September 13, 2010 *Pediatrics* Vol 126 No 4 October 1, 2010 pp e946 -e953 (doi: 10.1542/peds.2009-2609)
- 20 Prosser CG, McLaren RD, Frost D, Agnew M, Lowry DJ et al (2008). Composition of the non-protein nitrogen fraction of goat whole milk powder and goat milk-based infant and follow-on formulae. *Int J Food Sci Nutr*, 59, 123-33
- 21 Rutherford S, Moughan P, Lowry D et al (2008). Amino acid composition determined using multiple hydrolysis times for three goat milk formulations. *Int J Food Sci Nutr* 59, 6709-690
- 22 Koletzko B, von Kries R, Closa R, Escobedo J, Scaglioni S, Giovannini M, Beyer J, Demmelmair H, Gruszfeld D, Dobrzanska A et al. Lower protein in infant formula is associated with lower weight up to age two: a randomised clinical trial. *Am J Clin Nutr* 2009;89:1836-45
- 23 Escobedo J, Luque V, Ferre N, Mendez-Riera G, Koletzko B, Grote V, Demmelmair H, Bluck L, Wright A, Closa-Monasterolo R. Effect of protein intake and weight gain velocity on body fat mass at six months of age: The EU Childhood Obesity Programme. *Int J Obes (Lond)* 2012; 36:548-53
- 24 Janas LM, Picciano MF and Hatch TF (1987). Indices of protein metabolism in term infants fed either human milk or formulas with reduced protein concentration and various whey casein ratios. *J pediatr* 110, 838-848
- 25 Janas LM, Picciano MF and Hatch TF (1985). Indices of protein metabolism in term infants fed human milk, whey predominant formula or cows' milk formula. *Pediatrics* 75, 775-784
- 26 Rutherford SM, Darragh AJ, Hendriks WH et al (2006). True ileal amino acid digestibility of goat and cows' milk infant formulas. *J Dairy Sci* 89, 2408-2413
- 27 Global Standard for the Composition of Infant Formula: Recommendations of an ESPGHAN Coordinated International Expert Group. *Journal of Pediatric Gastroenterology and Nutrition* 41:584-599, November 2005. ESPGHAN Committee on Nutrition
- 28 Koletzko B, Ashwell M, Beck B et al (2002). Characterisation of infant food modifications in the European Union. *Ann Nutr Metab* 46, 231-242
- 29 Grant C, Rotherham B, Sharpe S et al (2005). Randomised double blind comparison of growth in infants receiving goat milk formula versus cows' milk infant formula. *J Paediatr Child Health* 41, 564-568
- 30 EFSA Panel on Dietetic Products Nutrition and Allergies (2004). Scientific opinion on the suitability of goat milk protein as a source of protein in infant formulae and in follow-on formula. *EFSA J* 30, 1-15
- 31 Zhou SJ et al (2014). Nutritional adequacy of goat milk infant formulas for term infants: a double-blind randomised controlled trial. *British Journal of Nutrition* 111, 1641-1651
- 32 Fiocchi A, Brozek J, Schunemann H, Bahna SL, von BA, Beyer K et al. World Allergy organisation (WAO) diagnosis and rationale for action against cows' milk allergy (DRACMA) guidelines. *World Allergy Organ J*, 2010, 3(4):57-161
- 33 Ballabio C, Chessa S, Rignanese D, Gigliotti C, Pagnacco G, Terracciano L, Fiocchi A, Restani P and Caroli AM (2011). Goat milk allergenicity as a function of alphas-casein genetic polymorphism. *Journal of Dairy Science*, 94, 998-1004
- 34 Infante Pina D, Tormo Carnice R and Conde Zandueña M (2003). Use of goat's milk in patients with cows' milk allergy. *Anales de Pediatría*, 59, 138-142.
- 35 Pessler F, Nejat M. Anaphylactic reaction to goat's milk in a cows' milk-allergic infant. *Pediatr Allergy Immuno*, 2004, 15(2):183-5
- 36 EFSA Journal (2012) 10(3):2603. Scientific Opinion on the suitability of goat milk protein as a source of protein in infant formulae and in follow-on formulae