

Naturally high content of nucleotides in goat milk based infant formula

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Why did we perform this study?

- Goat milk offers a solid basis for infant formula and, like cow's milk, is amended and complemented with essential nutrients to be in compliance with infant formula legislation. The natural composition of goat milk however differs from cow's milk. Insights into micronutrients such as nucleotides add valuable information to the research journey on how the natural composition of goat milk can contribute to the health and well-being of infants.
- Human milk has been shown to naturally contain nucleotides (10.5-11.0mg/100kcal⁵), suggesting they are physiologically relevant. The little data available shows goat milk to contain lower levels of nucleotides compared to human milk, but considerable amounts of nucleotides compared to cow's milk.
- Nucleotides have been added to some cow's milk or goat milk-derived infant formulas for their suspected beneficial effects on early infant growth and development.

What we learned from this study

- Skimmed goat milk powder, goat milk based infant formulas and follow-on formula contain high natural levels of nucleotides. Formulas based on goat milk have 4-5 times higher naturally occurring levels of total nucleotides than cow milk based formulas, with levels at least 25% of maximal levels previously reported in mature human milk⁵.
- Differences in analysis and quantification methods, as well as differences in nucleotides terminology used in literature can explain some of the apparent discrepancy with previously published results.



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Breast milk is the best source of nutrition.

Naturally high content of nucleotides in goat milk based infant formula

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Abstract

Background

Nucleotides from dietary sources have been suggested to have important physiological roles in gastrointestinal development and immune function of infants¹. Goat milk contains considerable amounts of nucleotides but little data is available on nucleotide content in goat milk infant formula (IF) and follow-up formula (FOF)². Furthermore, free nucleotide concentrations in bovine and human milk decrease with advancing lactation but it is unknown whether seasonal variation also occurs in goat milk³⁻⁴.

Objectives

The major objective of this study was to quantify the level of total nucleotides in goat milk IF and FOF versus cow milk formulas. The second objective was to study seasonal variation in levels of individual monophosphate nucleotides in skimmed goat milk powder, the basis for goat milk formula.

Methods

Total nucleotide levels were measured in goat and cow milk IF and FOF, using liquid chromatography combined with UV detection conform the GB 5413.40 standard. Nucleotides in excess of supplemented amounts were assumed to be naturally occurring nucleotides. In addition, individual monophosphate nucleotide levels were determined in skimmed goat and cow milk powder at several time points throughout the year.

Results

Formulas based on goat milk have 4-5 times higher naturally occurring levels of total nucleotides than cow milk based formulas, with levels at least 25% of maximal levels previously reported in mature human milk⁵. Uridine 5'-monophosphate (UMP) was the major nucleotide in skimmed goat milk powder. Levels of individual free nucleotides were stable throughout the year.

Conclusion

Skimmed goat milk powder, goat milk based infant formula and follow-up formula contain high levels of nucleotides. No seasonal variation was observed in the levels of individual free nucleotides. Differences in analysis and quantification methods can explain some of the apparent discrepancy with previously published results. Future research should focus on 'total potentially available nucleotides' (TPAN), defined as the sum of free nucleosides, free nucleotides, nucleotide-containing adducts and nucleotide polymers, as the physiological relevance of nucleotides might not be limited to free nucleotides alone.

References: 1. Hess JR, Greenberg NA. *The Role of nucleotides in the immune and gastrointestinal systems potential clinical applications*. Nutrition in Clinical Practice. 2012;27(2):281-94 ; 2. Prosser CG, McLaren RD, Frost D, Agnew M, Lowry DJ. *Composition of the non-protein nitrogen fraction of goat whole milk powder and goat milk-based infant and follow-on formulae*. International journal of food sciences and nutrition. 2008;59(2):123-33 ; 3. Schlimme E, Martin D, Meisel H. *Nucleosides and nucleotides: natural bioactive substances in milk and colostrum*. British Journal of Nutrition. 2000;84(S1):59-68 ; 4. Schlimme E, Schneehagen K. *Ribonucleosides in human milk. Concentration profiles of these minor constituents as a function of the nursing time*. Z Naturforsch C. 1995;50(1-2):105-13 ; 5. European Food Safety Authority (EFSA). *Scientific opinion on the essential composition of infant and follow-on formulae*. EFSA Journal 2014;12(7).

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Nucleotide concentrations in goat milk based formulas are higher than in cow's milk based formulas

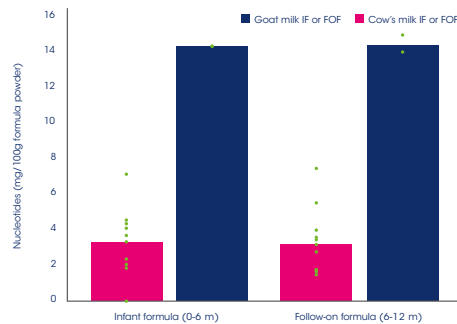


Figure 1. Nucleotide concentrations in excess of supplemented amounts. Data are presented as means (mg / 100 gram formula powder) with green bullet points indicating the nucleotide levels of the individual products (n = 10-11 for cow's milk based formulas, n = 2 for goat milk based formulas). Pink bars indicate cow's milk based formulas, blue bars indicate goat milk based formulas.

UMP is the major nucleotide in skimmed goat milk powder

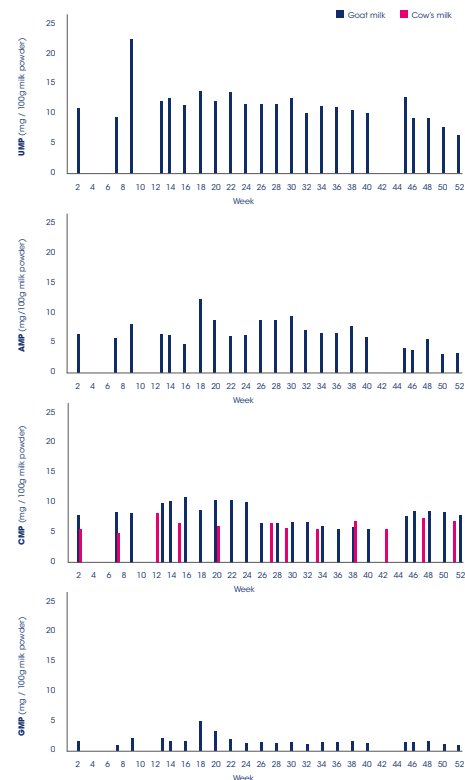


Figure 2. Nucleotide concentrations in skimmed goat (color blue) or cow's (color pink) milk powder (expressed as mg / 100 gram powder). Weeknumbers start January 1, 2017. UMP: Uridine 5'-monophosphate; AMP: Adenine 5'-monophosphate; CMP: Cytosine 5'-monophosphate; GMP: Guanine 5'-monophosphate. No inosine 5'-monophosphate was detected. In skimmed cow's milk powder, only CMP was detected.

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- Hess JR, Greenberg NA. The Role of nucleotides in the immune and gastrointestinal systems potential clinical applications. Nutrition in Clinical Practice. 2012;27(2):281-94.
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- Schimme E, Martin D, Meisel H. Nucleotides and nucleotides: natural bioactive substances in milk and colostrum. British Journal of Nutrition. 2003;94(3):39-68.
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