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Review Article

Goat Milk vs. Cow Milk vs Human Milk? A Comprehensive Comparison of Nutritional Composition in Infant Nutrition

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Abstract

There have been efforts to compare the nutritional content between goat, cow and human milk to investigate its safety as an infant formula, along with some studies testing goat's milk formula in other animals which have shown positive results. However, there have been relatively few trials in human infants.

The use of goat's milk infant formula results in normal growth. Growth, blood nutritional markers, and health status were comparable in infants who received goat's milk-based infant formula to that of infants who received cow's milk-based infant formula. Therefore, the safety and tolerability of goat's milk-based infant formula did not appear to differ from cow's milk-based formula.

There were no differences in the other blood nutritional markers, and they were in the normal ranges for both formula groups. There were no differences in the risk of a health condition or event between infants who received goat's milk formula and cow's milk formula at 6 months. There was no difference in weight, length, head circumference, and BMI between the two formula groups across the 6 months. The microbiome composition seen to develop in those fed goat's milk formula appears to be more similar to that of breast-fed infants than those fed cow's milk-based formula. Overall, goat's milk-based formulas appear to be a suitable alternative to cow's milk-based infant formula.

Keywords: Cow milk; Goat milk; Infant nutrition; Nutrition; Growth; Gut health

Introduction

Milk and dairy products are part of a healthy diet. Milk composition varies in different animal species, but in each case, it has a high priority in human nutrition. It is important to help individuals meet their dietary needs. Now, this dietary field goes beyond the study of essential nutrients. Differences between species, which are symptomatic of evolutionary adaptation to the different requirements of newborns, can be of great biological importance. Research over the past 20 years has focused on cow's milk formula [1]. Thus, goat milk remains an important attractive research subject, with the possibility of developing easily digestible dairy. Milk products for groups of consumers with the special need's category, such as aged adults, infants and athletes is growing stronger. In addition, dairy products may have specific health effects when ingested as part of their daily diet and may be appropriate compounds of the p-peptides that reduce the activity of the Angiotensin-converting enzyme, which is involved in vasoconstriction and thus blood pressure. The attendance of phosphor- casein-peptide may enhance the physiological importance of dairy products. As part of the "non-nitrogen" is capable to transfer messages such as biochemical nucleotide and polyamine and, it has also attracted special scientific interest.

Further exploration of goat milk is warranted to understand his culture and the function of milk appropriate. The cow milk formula is suitable for healthiest babies and is recommended for formulas made from soy or modified lactose. Milk formulas made from dairy products have been developed to be very close to the formula of breast milk to be given to the baby since birth. Cow's milk contains all the nutrients, especially the "iron" necessary for the growth of the infant and its development, so it is a suitable formula and safe for the infant. Goat formula contains higher levels of protein compared to cow's milk, so it is observed as generally begin at higher end of the acceptable protein range.

Table 1: Basic Nutrients, Minerals and Vitamins Concentrations (per 100 g) for cow, goat and human milk formula [25, 26].

	Constituents	Cow	Goat	Human
Basic nutrients	Protein (g)	3.3	3.5	1.2
	Fat (g)	3.6	3.8	4
	Lactose (g)	4.6	4.1	6.9
	Calories (cal)	69	70	68
	Total solids (g)	12.3	12.2	12.3
	Ash(g)	0.7	0.8	0.2
Mineral	Calcium "Ca" (mg)	122	134	33
	Magnesium "Mg" (mg)	119	141	43
	Phosphorus"P" (mg)	119	141	43
	sodium"Na" (mg)	58	41	15
	potassium"K" (mg)	152	181	55
	chlorine "Cl" (mg)	100	150	60
	Sulfur"s" (mg)	-	2.89	-
	Copper "Cu" (mg)	0.06	0.05	0.06
	Manganese"Mn" (mg)	0.02	0.032	0.07
	selenium "Se" (mg	0.96	1.33	1.52
	Iodine "I" (mg)	0.021	0.022	0.007
	Zinc "Zn" (mg)	0.53	0.56	0.38
Vitamin	Vitamin A(I.U.)	126	185	190
	Vitamin D(I.U.)	2	2.3	1.4
	Vitamin B12 (mg)	0.357	0.065	0.03
	Pantothenic acid(mg)	0.32	0.31	0.2
	Thiamine (mg)	0.045	0.068	0.017
	Riboflavin (mg)	0.16	0.21	0.02
	Niacin (mg)	0.08	0.27	0.17

Goat milk formula has a unique formula compared to cow's milk, as it is rich in nutrients. The structural uniqueness of goats 'milk lies in its high natural levels of vitamins, minerals, and many other elements found naturally in goats' milk, such as the prebiotic oligosaccharides. A large proportion of the world's population suffer from the difficulty of digesting lactose in cow's milk known as "lactose Intolerance" [2-4].

Goat Milk and Allergy

Potential health benefits from the consumption of goat milk were recently reviewed, including hypo allergenicity, and improvements in gastro-intestinal disorders, Fe and Cu absorption, growth rates, bone density, and blood levels of vitamin A, Ca, thiamine, riboflavin, niacin, and cholesterol, however, claims around human health still mostly rely on anecdotal evidence, which is also used in industry promotional material and within the media [4,5]. Given that the effect of species, breeds, husbandry practices, and season strongly influences the nutritional quality of milk [6-10], differences between cow and goat milk are expected, while their extent may also differ between and within countries. However, there is a lack of detailed nutrient profiling of retail goat milk in most countries, including the UK. The aim of this study was therefore to (i) investigate the differences in the nutritional profiles (basic solids composition, Fatty Acids (FA), minerals and phytoestrogens) between cow and goat retail milk, (ii) assess the seasonal effect on the observed differences, and (iii) quantify the potential implications on the consumers' nutrient intakes.

The discussion in the present work focuses on milk FA profiles, minerals and phytoestrogens. Milk and dairy products are the main source of saturated FA (SFA) in human nutrition, also including those deemed responsible for increased risk of cardiovascular disease (C12:0, C14:0, and C16:0) [11,12]. Total SFA consumption is currently higher than the recommended levels and nutritional recommendations ask for a reduction in their consumption (to contribute less than 10% of total energy intake [11,12]). However, milk also contains several monounsaturated FA (MUFA) and polyunsaturated FA (PUFA) which have been associated with beneficial effects on human health [13-17]. The main beneficial MUFA in milk are c9 C18:1 (oleic acid; OA) and t11 C18:1 (vaccenic acid; VA), while the main beneficial PUFA include c9t11 C18:2 (rumenic acid; RA), and the omega-3 (n-3) c9c12c15 C18:3 (α-linolenic acid; ALNA), c5c8c11c14c17 C20:5 (eicosapentaenoic acid; EPA), c7c10c13c16c19 C22:5 (docosapentaenoic acid; DPA) and c4c7c10c13c16c19 C22:6 (docosahexaenoic acid; DHA). Minerals are essential to the human body and play numerous vital roles, including (but not restricted to) enzyme co-factor activity, metallo-proteins, vitamin and bone formation, osmolarity, nutrient absorption and oxygen transport, as previously presented in multiple books and publications [18].

Milk is a good source of the macro minerals Ca, Mg, P and K as well as three micro minerals I, Se and Zn [19,20]. It also contains the macro minerals Na and S along with the micro minerals B, Co, Cu, Fe, Mn, Mo and Ni, although it is not considered a major source of these minerals in human diets [10,19,21]. Phytoestrogens (including lignans, isoflavones and coumestans), and in particular equol, have been associated with health benefits, such as reduced risk for cardiovascular disease, type-2 diabetes, certain cancers, as well as symptoms of osteoporosis, metabolic syndrome and menopause.

A prospective cohort of 976 infants from birth to 12 months of age [22] found no significant differences in weight gain between infants fed with GMF or a combination of HM and GMF compared to infants fed with CMF or a combination of HM and CMF during the first 4 months of life. However, the study did report differences in bowel motions among the infants. Infants fed with GMF had more frequent stools than CMF-fed infants, with the average number of stools per day being similar for GMF-fed and HM-fed groups. The CMF-fed group was more likely to have one–two stools per day, while the GMF-fed

group was more likely to have seven or more stools per day. The consistency of stools in the CMF-fed group was firmer than that in the HM-fed and GMF-fed groups. It is important to note, though, that this study was unblinded for outcome assessors and parents, and the allocation was chosen by the mothers.

Key Differences Between Cow and Goat Milk for Babies

The main differences of goat milk vs cow milk include lactose levels, fat composition, and casein content. Goat milk has slightly lower lactose levels and smaller fat globules, making it easier to digest for some infants. Also, goat milk contains less alpha-S1 casein, which can be helpful for babies with cow milk protein allergies.

Lactose Content: Goat milk contains a bit less lactose compared to cow milk, which is beneficial for little ones who have lactose intolerance or sensitivity. Goat milk is typically easier on their digestion.

Fat Content: While goat milk's fat content is similar to cow milk's, the fat globules are smaller. This makes it easier for babies to digest and reduces the likelihood of an upset tummy.

Casein Content: Cow milk has lower levels of alpha-S1 casein, a protein that causes allergies in some children. As a result, goat milk can be a fitting alternative for little ones with a cow milk protein allergy.

Composition of the Milks

Compositions of human, goat and cow milk formula are different as shown in Table 1; they vary with diet, breed, individuals, parity, season, feeding, management, environmental conditions, locality, stage of lactation, and health status of the udder. The advantage of goat's milk formula for cow's milk formula compared to human milk is that it is easier to be digested and its more portability and ability to cache and alkalinity, as well as in the therapeutic values on human nutrition and medicine. The formula for the composition of goat's milk is not significantly different from the formula of cow's milk. But goat milk formula has some characteristics that give it technological advantages compared to cow's milk formula as the size of fat globules is smaller, which provides a smoother texture in derived products, lower amounts of as1-casein, resulting in softer gel products, and a higher water content [22-24].

Conclusion

Milk composition is different depending on the species of mammals; cow and goat formula varies widely with human breast milk. Human breast milk is less than goat and cow milk in protein content (1.2 vs 3.3, 3.5). The fat content of human milk is close to goat and cow (4 vs 3.8, 3.6). Human milk contains significantly higher lactose content and calories than goat and cow.

The nutritional value of goat milk and cow's milk is not significantly different, but the volume of fat globules is smaller for goats' milk, which increases digestion of goat's milk, and the protein of goat milk presents a higher nutritional value of utilization than that of cow milk.

Goat milk and cow's milk may contain higher mineral content than breast milk, but still cannot replace human milk in young children but could complement it. [27,28].

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References

1. Soliman GZ. Comparison of chemical and mineral content of milk from human, cow, buffalo, camel and goat in Egypt. Egypt J. Hosp. Med, 2005; 21: 116-130.
2. EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA). Scientific Opinion on the suitability of goat milk protein as a source of protein in infant formulae and in follow-on formulae. EFSA Journal, 2012; 10(3): 2603.
3. Igwegbe AO, Maina FJ, Kassum AL, Agbara GI, Chibuzo EC, Badau MH. Evaluation and acceptability of yo-ghurt drink processed from goat milk and a combination of goat and cow milks. Intl. J. Biotechnol. Sci, 2015; 3(4): 41-48.
4. Haenlein GFW. Goat milk in human nutrition. Small Rumin. Res, 2004; 51: 155–163. doi: 10.1016/j.smallrumres.2003.08.010.
5. Haenlein GFW. Nutritional value of dairy products of ewe and goat milk; Proceedings of the IDF/Greek Na-tional Commission IDF/Cerval Seminars; Crete, Greece. Brussels, Belgium: International Dairy Federation, 1996; pp. 159–178. IDF Special Issue 9603.
6. Chilliard Y, Glasser F, Ferlay A, Bernard L, Rouel J, Doreau M. Diet, rumen biohydrogenation and nutritional quality of cow and goat milk fat. Eur. J. Lipid Sci. Technol, 2007; 109: 828–855. doi: 10.1002/ejlt.200700080.
7. Stergiadis S, Berlitz CB, Hunt B, Garg S, Ian Givens D, Kliem KE. An update to the fatty acid profiles of bo-vine retail milk in the United Kingdom: Implications for nutrition in different age and gender groups. Food Chem, 2019; 276: 218–230. doi: 10.1016/j.foodchem.2018.09.165.
8. Stergiadis S, Leifert C, Seal CJ, Eyre MD, Nielsen JH, Larsen MK, et al. Effect of feeding intensity and milking system on nutritionally relevant milk components in dairy farming systems in the north east of England. J. Agric. Food Chem, 2012; 60: 7270–7281. doi: 10.1021/jf301053b.
9. Stergiadis S, Seal CJ, Leifert C, Eyre MD, Larsen MK, Butler G. Variation in nutritionally relevant compo-nents in retail Jersey and Guernsey whole milk. Food Chem, 2013; 139: 540–548. doi: 10.1016/j.foodchem.2013.01.078.
10. Currò S, De Marchi M, Claps S, Salzano A, De Palo P, Manuelian CL, et al. Differences in the Detailed Milk Mineral Composition of Italian Local and Saanen Goat Breeds. Animals (Basel), 2019; 9: 412. doi: 10.3390/ani9070412.
11. EFSA Scientific Opinion on Dietary Reference Values for fats, including saturated fatty acids, polyunsaturated fatty acids, monounsaturated fatty acids, trans fatty acids, and cholesterol. EFSA J, 2010; 8: 1461.
12. FAO. Fats and Fatty Acids in Human Nutrition-Report of an Expert Consultation. Food and Agriculture Organ-ization of the United Nations; Rome, Italy, 2010.
13. Barcelo-Goblijn G, Murphy EJ. Alpha-linolenic acid and its conversion to longer chain n-3 fatty acids: Bene-fits for human health and a role in maintaining tissue n-3 fatty acid levels. Prog. Lipid Res, 2009; 48: 355–374. doi: 10.1016/j.plipres.2009.07.002.
14. Dilzer A, Park Y. Implication of Conjugated Linoleic Acid (CLA) in Human Health. Crit. Rev. Food Sci. Nutr, 2012; 52: 488–513. doi: 10.1080/10408398.2010.501409.
15. Field CJ, Blewett HH, Proctor S, Vine D. Human health benefits of vaccenic acid. Appl. Physiol. Nutr. Metab, 2009; 34: 979–991. doi: 10.1139/H09-079.
16. Haug A, Hostmark AT, Harstad OM. Bovine milk in human nutrition. Lipids Health Dis, 2007; 6: 25. doi: 10.1186/1476-511X-6-25.
17. Swanson D, Block R, Mousa S. Omega-3 fatty acids EPA

and DHA: Health benefits throughout life. Adv. Nutr, 2012; 3: 1–7. doi: 10.3945/an.111.000893.
18. Strain JJ, Cashman KD. Minerals and trace elements. In: Gibney MJ, Lanham-New SA, Cassidy A, Vorster HH, editors. Introduction to Human Nutrition. 2nd ed. Wiley-Blackwell; Chichester, UK. 2009; pp. 188–237.
19. Gaucheron F. The minerals of milk. Reprod. Nutr. Dev, 2005; 45: 473–483. doi: 10.1051/rnd:2005030.
20. Dunshea F, Walker G, Williams R, Doyle P. Mineral and citrate concentrations in milk are affected by seasons, stage of lactation and management practices. Agriculture, 2019; 9: 25. doi: 10.3390/agriculture9020025.
21. Park YW, Juárez M, Ramos M, Haenlein GFW. Physico-chemical characteristics of goat and sheep milk. Small Rumin. Res, 2007; 68: 88–113. doi: 10.1016/j.smallrumres.2006.09.013.
22. Han Y, Chang E-Y, Kim J, Ahn K, Kim H-Y, Hwang E-M, et al. Association of infant feeding practices in the general population with infant growth and stool characteristics. Nutr. Res. Pract, 2011; 5: 308–312. doi: 10.4162/nrp.2011.5.4.308.
23. Young W Park. Goat Milk: Composition, Characteristics. Encyclopedia of Animal Science. In book: Encyclo-pedia of Animal Science, Edition: 2nd Chapter: Goat Milk: Composition, Characteristics. Publisher: CRC Press, 2010.
24. Harden CJ, Hepburn NJ. The benefits of consuming goat's milk, 2011.
25. Haenlein GFW, Caccese R. Goat Milk versus Cow Milk. Extension Goat Handbook; USDA Publ.: Washington, DC, 1984; p.1-E.1.
26. Jenness, R. Composition and characteristics of goat milk: Review 1968− 19791. Journal of Dairy Science, 1980; 63(10): 1605-1630.
27. Journal of Food and Nutrition Research, 2013; 1(4): 68-81.
28. Rashmi Arora, Bhojak N, Rajani Joshi. Comparative Aspects of Goat and Cow Milk, International Journal of Engineering Science Invention ISSN (Online), 2319–6734.