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SUMMARY – Metabolism trials were carried out with two groups of male, weaned Wistar rats to determine the nutritional value of the goat and cow milk protein. Diets contained 15% protein and 10% fat. The protein source was skimmed milk powder goat or cow milk, and the fat source was goat or cow milk fat. The food intake, growth rates and protein efficiency ratio did not differ significantly between the two groups ($P > 0.05$). However, nitrogen digestibility and balance of diets were higher ($P < 0.05$) in the group given the goat milk protein diet. It is concluded that the nutritional value of goat milk protein is higher than that of cow milk.

Key words: Milk, goat, cow, nutritional value of the protein, rats.

RESUME – *"Valeur nutritionnelle de la protéine du lait de chèvre et de vache". Dans le but d'établir la valeur nutritive de la protéine du lait de chèvre et de vache, des essais de métabolisme ont été effectués sur deux groupes de rats Wistar, mâles et sevrés. Les régimes distribués à ces rats contenaient 15% de matières azotées et 10% de matière grasse. La poudre de lait écrémé et les matières grasses du lait de chèvre et de vache ont été utilisées, respectivement, comme source de protéines et de matière grasse. L'ingestion du régime, le gain de poids des rats et le coefficient d'efficacité des matiéres azotées n'ont pas varié avec la source de lait ($P > 0,05$). Par contre, la digestibilité du régime et le bilan azoté ont été plus élevés ($P < 0,05$) chez les animaux qui ont reçu un régime à base de protéines et de matières grasses du lait de chèvre. En conclusion, la protéine provenant du lait de chèvre est mieux utilisée que celle du lait de vache.*

Mots-clés : *Lait, chèvre, vache, valeur nutritionnelle de la protéine, rats.*

Introduction

Nowdays, the quality of any food used for human consumption is, to a considerable extent, considered by its possible contribution to the maintenance or improvement of the consumer's health (Van Es, 1991). Chandan *et al.* (1992) reported that in developed countries there is increasing interest in goat milk and its derivates, the quality of which is considered of special importance in the light of current tendencies favouring healthy eating. In particular, the composition of goat milk is said to have certain advantages over that of cow milk, and thus the former is preferable for some consumers (Haenlein, 1992; Boza and Sanz Sampelayo, 1997; Alférez *et al.*, 2001; Barrionuevo *et al.*, 2002).

This paper shows the results obtained with rats, comparing the nutritional utilisation of goat and cow milk. Two diets were prepared such that the protein and fat contents were obtained either from goat milk or from cow milk. Feed intake, diet digestibility, nitrogen balance and growth rate were measured.

Material and methods

Experimental design and procedure

Two groups of male, weaned Wistar rats, aged 21 days, with a live weight of 40 ± 1 g were held in individual metabolism cells, within an ecologic chamber, in which the temperature was maintained at 21 ± 2°C with a relative humidity of 60 ± 5%, for a period of four weeks. The first three weeks corresponded to the adaptation period, and the fourth, to the main experimental phase. Throughout the experiment, the animals were weighed twice weekly, and food and water were available *ad libitum.*

The diets had a fat content of 10% and a protein content of 15%. Each diet was prepared with skim milk powder (goat or cow milk) as the sole source of protein, and goat or cow milk fat as the sole source of fat. This fat was prepared from the butter of the corresponding milk. This was heated in a bain-marie and the fat separated by centrifugation at 37°C, 3500 r.p.m. for 15 minutes. Following the recommendations of the American Institute of Nutrition (AIN) (Reeves *et al.*, 1993) concerning the composition of a standard diet for growing rats, the quantity of lactose in the skim milk of the cow or goat milk used for each diet was taken into consideration when the total carbohydrate values of each diet were calculated. To maintain these carbohydrate values, the diets were complemented with the corresponding quantities of saccharose and wheat starch. Similarly, the mineral-vitamin mixture was prepared following AIN recommendations (Reeves *et al.*, 1993). The composition of the two diets is given in Table 1.

Table 1. Chemical composition of the diets

	Diets†	
	1	2
Dry matter (% DM)	93.59	94.02
Organic matter (% DM)	96.01	96.22
Protein (% DM)	15.00	15.00
Fat (% DM)	10.00	10.00

†Diets 1 and 2 based on goat milk and cow milk, respectively.

Measurements and analyses

During the main period of the trials, and concurrently with the quantification of the food consumed and the body weight of the rats, the faeces and urine of each animal were collected and frozen at -20°C until analysed. The dry matter (DM) of the diets was determined by oven-drying at 100 ± 2°C, and that of the faeces was determined by lyophilization. The quantity of ash in the diets was established after incineration in an electric oven at 550°C. The nitrogen content of the diets, faeces and urine was determined by Kjeldahl's method. For the diet, the results obtained were converted to protein by multiplying by a factor of 6.38.

The utilisation of protein in the diets was established by means of the following parameters:

Protein efficiency ratio (PER) = BWG/PI $\times$ 100
N digestibility = NI – NH/NI $\times$ 100
N balance: NR/NI $\times$ 100 and NR/DNI $\times$ 100

where BWG = body weight gain; PI = protein intake; NI = N intake; NH = faecal N excretion; NR = N retention; NU = urinary N excretion; DNI = digestible N intake.

In addition, the N retention values were calculated and analysed in relation to the average body weight and BWG of the animals.

The model accounted for variations caused by the type of diet. The results were submitted to an ANOVA using the general linear model procedure (Steel and Torrie, 1984).

Results and discussion

Table 2 shows the values of the different parameters analysed, together with the variations caused by the type of diet. The values of DM intake, BWG and PER did not vary significantly between the diets ($P > 0.05$). In contrast, the N digestibility values and those of N retention and N balance were greater ($P < 0.05$) with the goat milk diet than with the cow milk diet.

Table 2. Intakes, body weight gain (BWG), protein efficiency ratio (PER), nitrogen digestibility of the diet and N balance data

	Diet†		RSD	Level of significance
	1	2		
Intake (g/d)	12.98	12.57	1.03	NS
BWG (g/d)	4.95	4.82	0.66	NS
PER (BWG/protein intake)	2.56	2.55	0.24	NS
N digestibility (%)	94.99	94.14	0.60	*
NR/body weight (mg/g)	1.22	1.01	0.10	**
NR/BWG (mg/g)	40.93	36.04	4.51	*
NR/NI†† (%)	66.15	58.41	3.70	**
NR/DNI††† (%)	69.74	62.10	3.94	**

†Diets 1 and 2 based on goat milk and cow milk, respectively.
††NI: N intake.
†††DNI: Digestible N intake.
*P < 0.05; **P < 0.01; NS: non significant.

Morón *et al.* (2000) made a comparative study on the composition of proteins in goat and cow milk and, specifically, of their aminoacid profile. The latter parameter was similar in both types of milk, except with respect to sulphur amino acids, which were present in a higher concentration in the goat milk protein in comparison with cows. Other differences were also found, but these concerned more the physical-chemical nature of the proteins, and in particular, the different concentrations of the casein fraction in the two types of milk. Such differences could produce a different degree of utilisation at the digestive level (Chandan *et al.*, 1992).

Additionally, one of the main differences found between goat and cow milk composition concerns fat nature; not only the small size of the micelles formed, an aspect that is doubtless responsible for its high digestibility, but also the nature of the fatty acids found in the milk (Haenlein, 1992; Boza and Sanz Sampelayo, 1997; Morón *et al.*, 2000). In this respect, goat milk normally presents 30-35% medium chain fatty acids (C_6-C_{14}), included medium chain triglycerides (MCT), while the corresponding content in cow milk is only 15-17%. Together with the efficient digestion achieved for these acids, their metabolic utilisation is characterised by a rapid oxidative catabolism, which comprises a very useful source of energy for the growing animal (Aurousseau *et al.*, 1989; Piot *et al.*, 1999). Finally, Velázquez *et al.* (1996), among numerous other studies carried out with different types of animals, reported that this metabolism produces an N-sparing effect of medium chain fatty acids. It could be deduced that the higher digestibility of the diet and, mainly the higher N balances obtained with goat milk diet could be explained not only by the different nature of their protein fractions but also by the different fat compositions of the two types of milk.

Conclusion

We concluded that the protein of goat milk presents a higher nutritional value of utilisation than that of cow milk.

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