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EFFECTS OF THE FIBER SIZE AND PHYSICAL FORM AND PROTEIN SOURCE ON GOAT MILK PRODUCTION

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Summary

With the aim to improve the quality of goat milk of the Granadina breed for goat cheese, a serie of trials were carried out using in this kind of animals different diets according to their fiber size and physical form and their protein source. The diets were isonitrogenous (17.70% crude protein) and isoenergetic (18.17 MJ/kg gross energy). The forage fraction (50%) was for diets 1, 3, 4 and 5, from an alfalfa hay and from and alfalfa pellets for diet 2. Twenty percent of crude protein was from beans fro diets 1 and 2, and from sunflower cake, corn gluten feed or cottonseed for diets 3, 4 and 5, respectively. In all cases, dry matter intake determined milk yield and this last one the milk composition. When alfalfa was offered in the form of pellets instead of hay, fat content and casein content of the mlk resulted higher. At the same time an improving in the milk quality was infered using corn gluten feed as protein source. Together with a similar milk production it was deduced a higher milk protein content and over all, a higher casein (β-casein) content. However no positive responses were obtained using sunflower cake or cottonseed. From these results it is concluded that the use of forage fraction in the form of pellets and corn gluten feed as protein source seems to be good feeding strategies for improving both the dietetic and technological quality of goat milk of the granadina breed for goat cheese.

Key words: Fiber size, fiber physical form, protein source, goat milk.

Introduction

The possibility of using dietary intervention to modify the composition of goat milk sems to be limited. Morand-Fehr et al. (1982) reported that feeding conditions can however, modify the technological and dietetic qualities of goat milk resulting therefore very important to control goat feeding in order

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to improve the milk quality for goar cheese. In general terms feeding diest containing greater quantities of undegradable protein it is posible to influence de milk protein response (Chandler, 1993). However in the goat using isoenergetic and isonitrogenous diets, the crude protein and casein contents of the milk seem to be not very sensitive to a dietary protein source (Monard-Fehr et al., 1991). At the same time, forage particle length of forage physical form seem to affect the milk fat and/or protein content because the changing that in the rumen metabolism takes place (Fehr, 1971, Lu, 1991). With this in mind and takin into account that in Spain goat milk is very often used for cheesemakin, a study was carried out to analyse the effects of certain protein sources and fiber size and physical form on the Granadina milk goat yield and composition.

Material ad methods

Five groups of five goats of the granadina breed each one, in their second lactation were used. They were in midlactation being penned in individual boxed and paired according to bodyweight and milk production. Taken into account the protein and energy requirements for maintenance and for lactation of Granadina breed (Prieto et al., 1990, Aguilera et al., 1990), the animals received daily a diet of 1 kg forage and 1 kg concentrate, quantities enough to produce 2 kg milk per animal and per day. Treatments consisted of five differents diets according to fiber size and physical form and protein source. The forage fraction was for diets 1, 3, 4 and 5, from an alfalfa hay and, from an alfalfa ground and pelleted for diet 2. Twenty percent of total protein was form beans for diets 1 and 2 and from sunflower cake, corn gluten feed or cottoneseed, for diets 3, 4 or 5, respectively. The diets were isonitrogenous (17.70% crude protein DM) and isoenergetic (18.17 MJ/kg gross energy DM). Prior to the start of the experiment, all animals received the corresponding diet for a period of 14 days. Afterward and during four days, food intake, milk production and milk composition were recorded daily. So, dry matter intake rates (g/kg$^{0.75}$ day), milk production (g/day), dry matter (g/kg), protein (g/kg), fat (%) and energy (MJ/kg) contents of the milk were determined as well as the quantitiy of casein and whey protein (g/kg) and the casein (αs, β, and K-casein) and whey protein (sero-albumin, α-lactoalbumin and β-lactoglobulin) fractions (g/kg).

Dry matter in milk was determined by freeze-drying, crude protein by a Kjeldahl procedure (Nx6.38), fat by Gerber method and energy using an adiabatic calorimeter bomb. The different protein fractions were determined by polyacrylamide-agarose gel electrophoresis in an automatic equipe. The quantification was carried out using an image analyser. Results were analysed by the general linear models procedure. In the analysis of milk production the food intake rate was used as covariance factor. In the same way, in the analysis of milk composition the milk production was used as covariance factor. Turkey's multiple range test was used for comparison of means.

Results

The results obtained according to the statistical analysis carried out are shown on Tables 1. The highest dry mater intake rate was that for diet 1, statistically different ($P<0.05$) thatn that for diet 3. Milk production resulted affected by the covariance factor ($P<0.001$) and independently of this, by the type of diet ($P<0.05$). The first variation source explained 93% of the total variance and the second one only 5.4%. Maximum milk production was that achieved for diet 2, which was statistically different ($P<0.05$) than that for diet 4. Dry matter, protein, fat and energy contents of milk were affected by the considered covariance factor ($P<0.001$), which explained in general terms, about 80% of the total variance. At the same time these values resulted diffe ent according to the type of diet ($P<0.05$) explaining this about 20% of the total variance. According to this, milk dry matter content for diet 2 was statistically higher ($P<0.05$) than that for diet 1. In respect to milk total protein contents, those for diets 2, 4 and 1 resulted higher ($P<0.05$) than that for diet 3. Milk fat and energy content for diet 2 resulted the highest, statistically different ($P<0.05$) than that for diet 1.

Milk casein content resulted statistically ($P<0.001$) affected by the covariance factor and by the type of diet ($P<0.001$). In this case covariance factor explained 37% of the total variance and type of diet 54% of that. The highest milk casein contents were those for diets 2 and 4, different of those for diets 1 and 3 ($P<0.05$). Milk whey protein content was also affected by the covariance factor ($P<0.01$) and by the type of diet ($P<0.05$). The proportion of total variance explained by these variation sources, were 70 and 23%, respectively. Diet 1 showed the highest milk whey protein content, which was different than that for diet 4 ($P<0.05$).

In relation to the values for milk whey protein fractions (sero-albumin, α-lactoalbumin and β-lactoglobulin; g/kg) first it is necessary to indicate is that milk sero-albumin and milk β-lactoglobulin values, resulted affected by the covariance factor ($P<0.001$ and $P<0.01$, respectively), which explained 66 and 84% of the total variance, respectively. However, the covariance factor did not determine significantly ($P<0.05$) the milk α-lactoalbumin contents. According to type of diet, β-lactoglobulin values were not different ($P<0.05$). Milk sero-albumin contents was highets for diet 1, statistically different ($P<0.05$) than that for diet 4 and, milk α-lactoalbumin values were for diets 1 and 3 higher ($P<0.05$) than that for diet 4.

In respect to the milk α-, β- and K-casein values, it was deduced a significant effect ($P<0.05$) of covariance factor only on K-casein contents which explained 50% of the total variance. Type fo diet also resulted statistically significant ($P<0.001$). The highest milk K-casein value showed by the diet 2 was different ($P<0.05$) than those for diets 1, 3 and 5 and in the same way, that for diet 4 resulted higher ($P<0.05$) than that achieved for diet 3. Milk α_s - casein values were no affected ($P<0.05$) by type of diet. Finally, milk β-casein contents resulted strongly ($P<0.001$) affected by type of diet, being the values for diets 4 and 2 higher ($P<0.05$) than those for diets 1 and 3.

Discussion

General considerations

The experimental results of this study were statistically analysed with the aim to infer in the best manner, the effect of type of diet. By this it was first determined the differences in dry matter intake rate and afterwards and considering these values as covariance factor, the differences in milk production. Finally, the different milk compositon values were statistically analysed using milk productions as covariance factor. According to this it was infered that food intake determines essentially, the milk production and this generally, the milk composition. At the same time type of diet was detected showing a variable effect on the different analysed parameters. Only for α-lactoalbumin, α_s- and β- casein contents, the covariance factor resulted not significant. These results together with the detected differences according to type of diet show the possibilities of changing goat milk composition by means of the here considered nutritive manipulations.

Effect of the size and physical form of the forage fraction. Use of alfalfa pellets vs. alfalfa hay

When in lactating goats fed on isoenergetic diets hay is offered in the form of pellts instead of normal long hay, milk fat content tends to dicrease and milk protein content to increase (Fehr, 1971). Morand-Fehr et al (1982) reported that this effects may be explained by the fact that pelleted forages tend to direct rumen fermentation toward production of propionate at the expense of acetate. Together with this Lu (1987) informed that feeding forage with longer particle to lactating goats resulted in higher total chewing and rumination times, slightly higher milk fat content. According to the result here obtained, the use of an alfalfa pelleted instead of an alfalfa hay given rise to similar feed intake and milk production, showing the produced milk a higher content of dry matter, fat, energy and casein (β- and K-casein), resulting also higher the total protein content at P<0.01. According to the above commentaries the results here obtained agree with that reported and indicated by Fehr (1971) and Morand-Fehr et al. (1982) with regard to what protein content refers. However, different is that result obtained about fat content. In this sense perhaps it is necessary to remember the particular goat feeding behaviour. Under hay intake, diet selection could take place changing the forage fraction quality and so, the milk composition. In any way, our results seem to be very important in respect to milk dietetic and technological quality refers.

Table 1. - DRY MATTER INTAKE, MILK YIELD AND MILK COMPOSITON FOR GRANADINA GOATS FED ON DIFFERENT DIETS ACCORDING TO FIBER SIZE AND PHYSICAL FORM AND PROTEIN SOURCE. (VALUES ARE ADJUSTED MEANS)

Diet	1	2	3	4	5	SE	Significance of effect of	
							Covariate	Diet
DMI (g/kg$^{0.75}$ day)	74.0^{a}	64.1^{a,b}	57.5^{vb}	60.6^{a,b}	64.8^{a,b}	15.5	-	*
Milk yield (g/day)	1093^{a,b}	1232^{a}	1141^{a,b}	961^{b}	1092^{a,b}	237.4	***	*
Milk composition								
Dry matter (g/kg)	152.5^{a}	168.2^{b}	154.5^{a,b}	162.9^{a,b}	162.8^{a,b}	1.32	***	*
Protein (g/kg)	32.6^{a}	34.8^{a}	28.5^{b}	34.7^{a}	32.0^{a,b}	2.97	***	***
Fat (%)	6.1^{a}	7.3^{b}	6.5^{a,b}	6.2^{a,b}	6.6^{a,b}	1.02	***	*
Energy (MJ/kg)	3.65^{a}	4.27^{b}	4.05^{a,b}	4.20^{a,b}	4.15^{a,b}	0.22	***	**
Casein (g/kg)	23.1^{a}	27.7^{b}	20.1^{a}	27.0^{b}	23.5^{a,b}	3.70	***	***
Whey protein (g/kg)	9.5^{a}	7.1^{a,b}	8.4^{a,b}	6.8^{b}	8.5^{a,b}	2.06	***	*
SA (g/kg)	1.44^{a}	0.85^{a,b}	1.13^{a,b}	0.73^{b}	0.91^{a,b}	0.36	***	***
α-La (g/kg)	2.59^{a}	1.87^{a,b}	2.58^{a}	1.58^{b}	2.15^{a,b}	0.82	NS	*
β-Lg (g/kg)	5.55	4.32	4.64	4.38	5.05	1.39	**	NS
α_s-Cn (g/kg)	8.12	7.10	7.53	7.32	6.83	1.25	NS	NS
β-Cn (g/kg)	13.03^{a}	17.86^{b}	11.38^{a}	18.43^{b}	14.95^{a,b}	3.53	NS	***
K-CN (g/kg)	1.99^{a,b}	2.77^{c}	1.18^{a}	2.19^{b,c}	1.76^{a,b}	0.51	**	***

DMI: Dry matter intake; SA: sero-albumin; α-La: α-lactoalbumin; β-LG: β-lactoglobulin; α_s-casein; β-Cn: β-casein; K-Cn: K-casein ***, P<0.001; **, P<0.01; *, P<0.05; NS: No significant

Forage fraction: from an alfalfa hay for diets, 1, 3, 4 and 5, and, from an alfalfa ground and pelleted for diets 2.

Protein source: Twenty percent from beans for diets 1 and 2 and, from sunflower cake, corn gluten feed or cottonseed for diets 3, 4, or 5 respectively

Effect of protein source

The use of more or less undegradable protein in the diets is pointed out as a successful means of improving milk protein content and/or its composition. studies on the effect of this on the goat milk composition have given contradictory results. Rousselot (1995) reported that these studies refer over all, to the replacement of soya protein by others richer in rumen undegradable protein. According to this Masson (1981) reported that the replacement of soya meal by protein rich seeds in isoenergetic and isonitrogenous diets did not lead to any changes in the protein content of the milk. In the same way Morand-Fehr et al. (1987) to replace soys meal by meat meal in Alpine goats in mid-lactation in a diet also isoenergetic and isonitrogenous, did not significantly alter the true milk protein content. However, Hadjipanayiotou et al. (1987) by means of a partial replacement of soya meal by fish meal, improved the protein content of the milk of Damascus goats. According to these all results Morand-Fehr et al. (1991) concluded that in the most cases using isoenergetic and isonitrogenous diets, the crude protein and casein contents of goat milk are not very sensitive to changes in the type of protein source in the diet.

In our experiment this aspect of the effect of protein source on the Granadina goat milk composition way carried out using four different isoenergetic and inonitrogenous diets in which twenty percent of the total crude protein was form beans (basel diet) or from sunflower cake, corn gluten feed or cottonseed (more undegradable proteins). The best results were those obtained using corn gluten feed. Together with similar feed intake and milk production, it was infered a higher milk protein content and especially, a higher casein (β-casein) content. These results agree with those reported for cows by Kellner and Belyea (1992) and by Poland and Fisher (1993). According to this it is possible to say that using in the goat of the granadina breed corn gluten feed instead of beans as a protein source, a milk with a better both dietetic and technological qualities is obtained. However, using sunflower cake, feed intake was lower than that obtained under beans use, resulting similar the milk production and the milk fat and casein content. Besides this, milk crude protein content was infered as lower. Finally, values for feed intake, milk production and milk composition detected using cottonseed were ot different than those obtained under basal diet use. In respect to the lack of positive responses using sunflower cake as well as cottonseed, we think that it is necessary to remember that reported by Chandler (1993) that feeding diets containing greater quantities of bypass protein may or may not influence the milk protein response. If the alteration in undigestible intake protein acomplished a greater quantity of absorbed essential amino acids, then a positive response would be anticipated.

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DJELOVANJE KOLIČINE VLAKANA, FIZIČKOG OBLIKA I IZVORA BJELANČEVINA NA KOZJE MLIJEKO

Sažetak

Da bi poboljšali kakvoću mlijeka koza pasmine Granadina, za proizvodnju kozjeg sira obavljeno je niz pokusa. Primjenom različite prehrane po količini vlakna i fizičkom obliku te izvoru bjelančevina. Prehrana je bila izonitrogena (17.70 % sirovih bjelančevina) i izoenergetska (18.17 MJ/kg bruto energije). Dio krme (50%) u hrani 1, 3, 4 i 5 sastojao se od sijena lucerne a u hrani 2 od peletirane lucerne. Dvadeset posto sirovih bjelančevina bilo je od graha u hani 1 i 2, odnosno sačme suncokreta, glutena kukuruza i sjemenki pamuka u hrani 3, 4 i 5. U svim slučajevima uzimanje suhe tvari odredilo je prinos mlijeka a potonje sastav mlijeka. Kod davanja lucerne u obliku peletirane sačme umjesto sijena, sadržaj masti i kazeina u mlijeku bio je viši. Istodobno je postignuta bolja kvaliteat mlijeka upotrebom kukuruznog glutena kao izbora bjelančevina. Uz sličnu proizvodnju mlijeka postignut je viši sadržaj bjelančevina u mlijeku i iznad svega veći sadržaj kazeina (β-casein).Međutim nije bilo pozitivne reakcije na upotrebu sačme suncokreta ili sjemenki pamuka. Prema tim se rezultatima zaključuje da primjena dijela krme u obliku sačme i kukuruznog glutena kao izvora blejačnevina izgleda dobar način hranjenja za poboljšanje hranidbene i tehnološke kvalitete mlijeka koza pasmine Granadina, za proizvodnju kozjeg sira.

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