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SUMMARY – Two homogenous groups of Majorera goats were used: the DA group was fed the most commonly used feeding regime in the Canary Islands, based on concentrated foodstuffs (concentrate for milk production, maize, barley, dehydrated alfalfa and cereal straw mixture), whilst the other group (DM) was given an alternative diet with high fibre content: *Rumex lunaria, Atriplex halimus* and barley crop. All the milk parameters studied showed favourable results for the diet rich in fibre, the differences being significant ($P < 0.01$) in the quantity of milk and fat. During the control period of 105 d of lactation, the milk production was increased by 35.9 kg and fat increased by 2.22 kg. Significant differences were detected in the percentage of fat as well as in the dry matter fat content, the cheese being made from goats fed the DM diet richer in fat than those from those fed the DA diet.

Key words: Goat, diet, long fibre, milk production, cheese quality.

RESUME – *"Influence du régime (fourrage autochtone de terres arides vs aliments concentrés) sur la production de lait et de fromage de chèvres de race Majorera". Un troupeau composé de deux groupes de chèvres Majoreras a été utilisé dans cette expérience. Le groupe DA a reçu un régime alimentaire typique des Îles Canaries, c'est-à-dire du concentré (mélange de maïs, d'orge, de luzerne déshydratée) et de la paille de céréales. Le groupe DM recevait un régime expérimental riche en fibres :* Rumex lunaria*,* Atriplex halimus *et du foin d'orge. La quantité de lait et sa teneur en matière grasse ont été plus élevées chez les animaux recevant le régime riche en fibres (P < 0,01). Pendant les 105 jours de lactation contrôlée, la production laitière et la quantité de matière grasse ont augmenté, respectivement, de 35,9 kg et 2,22 kg. Les fromages du groupe DM avaient une teneur en graisse plus élevée que ceux du groupe DA.*

Mots-clés : *Chèvre, régime, fibres, production laitière, qualité du fromage.*

Introduction

One of the problems for livestock farming development at the Canary Islands is the lack of available pasture resources as well as the high cost of the imported forages. This results in a cost of feeding the livestock that can reach 86% of the total maintenance cost (Castañón and Flores, 1993), leading many livestock farmers of intensive and semi-intensive exploitations to reduce the long fibre usage. This creates many health problems in the animals (Gutiérrez *et al*., 1999), as well as reduces the life expectancy of the female milk producers (Delgado *et al*., 1995; Elejabeitia, 1997) and the percentage of fat in milk (Fresno *et al*., 1992b; Gutiérrez *et al*., 1999).

This serious problem cannot be solved simply by importing forage, due to the high cost of its transport. Even though the Canary Islands established the protection of 50% of its territory, it could produce autochthonous forages or forages that are appropriately adapted to this habitat, thereby reducing this problematic situation. Furthermore, it would support the development of a type of livestock farming which would help to the environmental conservation, recovering areas of forage production that are presently under severe deterioration.

The aim of this research is the study of the real effect of diets on the milk production and on the quality of the Majorera goat cheese, keeping in mind three stages of its preparation: fresh cheese (24

hours), semi-fresh cheese (15 days) and hard cheese (60 days). In accordance with the characteristics of the island where these cheeses are produced (Fuerteventura) and using information obtained from surveys on the exploitation and cheese characterization (Fresno *et al*., 1992a; Darmanin *et al*., 1995), two different diets have been designed: one that lacks long fibre, unbalanced, and used by the majority of the farmers in the Canary Islands, which was fed to the first group of Majorera goats, and the other, with a higher quality and fibre content, which included forage adapted to arid lands, given to a second group of females of the same breed. The forages chosen for this investigation were *Atriplex halimus*, vinagrera (*Rumex lunaria*), and barley (*Hordeum vulgare*). The first of these three is a specie which has already been tested in other similar habitats, the vinagrera is an endemic Canarian specie, traditionally used as a complement of the livestock's diet, with interesting forage potential, and barley, which has been cultivated extensively in Fuerteventura up to the 1950's.

Material and methods

A group of 40 goats belonging to the Majorera breed was divided into two homogeneous groups of 20 animals each, according to the following characteristics and in order of preference: lactation numbers, amount of milk obtained during the first milking recorded, and type of birth. One of the groups was fed the "present diet" (DA), made up of a mixture of concentrates (dehydrated alfalfa, concentrates for milk production, maize grain and barley grain) and cereal straw, while the other group was fed "Majorera diet" (DM) with the same basic nutritive complexes plus extra fibre content of *Rumex lunaria*, *Atriplex halimus* and barley hay (*Hordeum vulgare*). The feeding portions of both diets can be considered to be isoenergetic and isoproteic, fulfilling the nutritive requirements for female milk producers.

The milk production progress was determined following the A4 recording guidelines of the International Committee for Animal Recording (ICAR), especially modified for this experiment. The first milking record was performed 90 days after birth, so that the experimental stage coincided with the middle of the lactation period. The goats were milked once every day. The interval between two consecutive records varied between 14 and 18 days, therefore making up a total of 6 records per goat during the whole experimental period. Therefore, the results refer to the total milk production during the 105 d of lactation, and not the real production. There was also 1 record performed before this period of study and 2 records performed after. As well as obtaining the amount of milk produced individually by each female using a volumetric measurer, a 40 ml milk sample was collected, after homogenisation, and an automatic analytical test was carried out using the *Milko-Scan 133B*, to determine the percentage of fat, protein, lactose and dry extract content.

Following the Protected Origin Denomination Majorero Cheese specifications, the milk obtained from each group of goats was used to produce cheese at three stages of maturation: fresh cheese (2 days), semi-hard cheese (15 days) and hard cheese (60 days). An analytical test was repeated three times using an *Instalab 600 NIR Product Analyser* on each sample of cheese, which enabled the collection of data on the moisture, fat, protein and fat in the dry matter content. The pH was also measured using the *pHmeter inoLab ph Level 1*.

Descriptive statistical analyses were carried out to determine the quantity and quality of the daily and cumulative milk production. The cumulative milk production was carried out by using the Fleischman method (Craplet and Thibier, 1973) following the Caja *et al*. (1986) equation, being representative of days 60, 90 and 105. The variance was also analysed, using the diet as the fixed parameter, for milk production (quantity and quality) and for the three types of cheese, depending on the maturation time.

Results and discussion

The goats fed "Majorera diet" produced a larger volume of milk throughout the experimental period, than those fed the "present diet". Significant differences were found at all three measurement days. The daily average milk production after 60 days was 14% greater in the DM group than in DA one, the difference rising to 16% after 105 days. Figure 1 represents the influence of the two diets on the lactation curve. It is important to note that the steepness of the curve ascending section is greater

for the DM group, with an increase compared to the previous record (29.3%). This is almost three times greater than the one shown by the DA group, which only reached an increase of 10.4%, even though it began with a slightly higher productive level when the diets were identical.

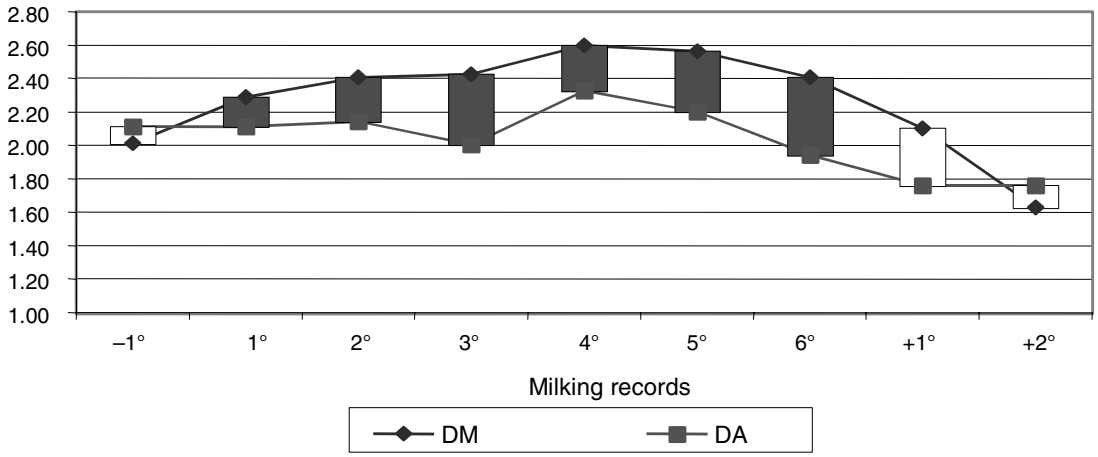

Fig. 1. Evolution of dairy milk production (l/d).

The values corresponding to the DM group were greater for all the records analysed, approximately 10% compared to the DA group. That agrees with observations made by others (Letourneau *et al*., 2000), since the production of fat in the udder is mainly due to the ingestion of sufficient long fibre forage. In this case, the difference is not just due to the physical form of the forage, but also to the fibre/concentrated (F/C) ratio in the diet received by DM animals compared to those of DA group. Concerning the cumulative production, determined by the Fleischman method for total fat (Table 1), the comparison of the values for the DM and the DA group show that the increase observed in the first group was further amplified, reaching a 22% value on the 105th day of lactation. During the period studied, this value represented about 2.22 kg more of fat.

Table 1. Cumulative productions. Fleischman method (kg)

	DM	DA
Milk production	306.09[a]	270.19[b]
Fat	12.53[a]	10.31[b]
Protein	11.02[c]	9.48[d]
Lactose	14.02[a]	12.52[b]
Total solids	39.71[a]	34.20[b]
Solids not fat	27.18[a]	23.90[b]

[a,b]$P < 0.001$; [c,d]$P < 0.01$.

In relation to the progress of total fat production (Fig. 2), it is worthwhile noting that in the previous record the DA group showed a total fat value considerably greater than the DM group. This quickly changed once the effect of the diets became clear. A similar trend was observed in the follow up records, in which the average values became similar once the experimental diets were no longer in use and the diets actually fed both groups were homogeneous. The results show that the effect of the diet on the protein content is low, and even though the values for the DM group are greater than those for the DA group in all the records carried out, the differences were not significant. Several authors (Hussain *et al*., 1996; Sanz Sampelayo *et al*., 1998; Schmidely *et al*., 1999; Letourneau *et al*., 2000; Morand-Fehr *et al*., 2000) have also observed a small effect of the diet on protein milk content. Furthermore, the influence of the different diets on the lactose and total solids content was not significant.

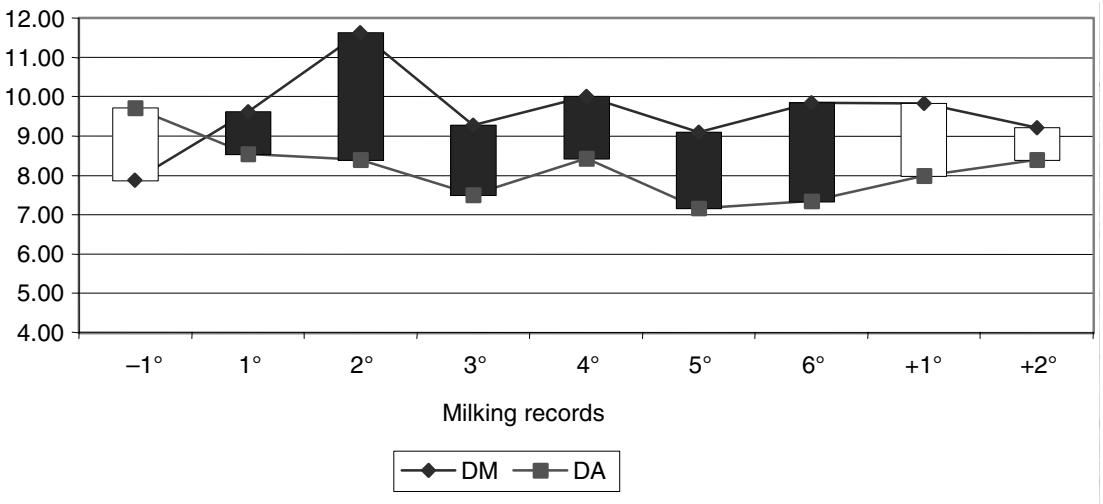

Fig. 2. Dairy fat evolution (kg).

The cheese yield values obtained for the DM group were favourable for all type of cheeses (Table 2), being statistically significant for the cheese of greater maturation time ($P < 0.01$), which leads to a saving of 63 litres of milk for every 100 kilograms of cheese produced.

Table 2. Cheese yield (means ± SD)

	DA	DM
Fresh	5.99 ± 0.30	5.90 ± 0.30
Semi-hard	7.55 ± 0.35	7.07 ± 0.30
Hard	8.72 ± 0.33[a]	8.09 ± 0.35[b]

[a,b]$P < 0.01$.

Table 3 shows the basic parameters of the cheeses being studied. For the hard cheese, the effect of the diet promoted a significant difference for all the basic parameters analysed, including the pH. These differences were not so obvious for the cheeses of less maturation time. For the 15 day maturation cheeses, significant differences with respect to fat and fat in dry matter content were appreciated, while there was no significant difference in any of the parameters for the fresh cheese, even though the cheese made from the "Majorera diet" goat's milk did not have a greater fat content.

Table 3. Cheese composition (means ± SD)

		DM	DA
pH	Fresh	6.53 ± 0.14	6.63 ± 0.21
	Semi-hard	5.02 ± 0.19	4.97 ± 0.13
	Hard	6.33 ± 0.28[a]	6.80 ± 0.38[b]
Fat (%)	Fresh	20.69 ± 1.58	18.77 ± 2.30
	Semi-hard	23.28 ± 1.18[a]	21.52 ± 1.11[b]
	Hard	29.50 ± 2.27[a]	27.17 ± 2.03[b]
Protein (%)	Fresh	19.49 ± 0.81	19.51 ± 0.49
	Semi-hard	20.65 ± 0.51	20.59 ± 0.30
	Hard	21.11 ± 0.56[a]	21.95 ± 0.92[b]
Fat in dry matter (%)	Fresh	39.08 ± 2.22	36.23 ± 3.41
	Semi-hard	45.98 ± 1.34[a]	40.24 ± 0.72[b]
	Hard	49.64 ± 2.13[a]	47.15 ± 2.11[b]

[a,b]$P < 0.05$.

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