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# Feed Intake and Digestibility of Total Mixed Ration fed Murciano-Granadina Dairy Goats

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**Abstract:** A digestibility trial was carried out in order to determine the quality of a commercial total mixed ration offered to lactating dairy goats. Three, 3 years old Murciano-Granadina goats at mid lactation were used in a Latin Square Design and, intake, apparent total tract digestibility and milk production and composition was determined in a total mixed ration offered at three levels; 2, 3 and 4 kg/d. When 2 kg/d was offered, lower dry matter intake than 3 or 4 kg/d was observed, and no significant differences were found for apparent digestibility among treatments. Significant differences were found for milk production and, greater and significant values for chemical composition (energy, protein and fat) were observed for 3 and 4 than 2 kg offered per day. No lactose difference was obtained. Although goats selected the ingredients and higher percentage of particles < 0.99 mm were found into the refusals for 2 kg/d of diet offered, the use of 4 kg/d is not of economical interest because it is necessary to permit 40% of refusals and it is not efficient because the increase in voluntary DMI and milk yield was only about 6 and 7% respectively.

**Key words:** Total mixed ration, intake, digestibility, milk composition, goats

## Introduction

In the last few years, the need to change from traditional extensive goat rearing to an intensive system has increased in semiarid Spanish lands as in other Mediterranean areas in order to increase productivity. Range goats are free to choose their diets, and in semiarid areas goats rely on browse most of the year, and when there are scarce or large variations in diets, lower milk performance may occur (Landau *et al*., 2000). Intensive system provides a more abundant and constant availability of forages, by-products and concentrates during the year, joined to a more efficient farm management. Given their selective abilities, goats adapted to intensive system would select the most nutritious mixture of feeds. It is clear that the demand for nutrients is affected by the physiological status of goats. Periods of high requirements, like lactation, needs more density of nutrients to reach optimal performance and, under extensive systems, dietary composition does not vary greatly and goats would try increase feed intake and is not always possible, specially under Spanish drought conditions. Use of total mixed ration (TMR) system may reduce this problem and moreover, concentrates are diluted with forage and over consumption of concentrates may be avoided. For this purpose use of a TMR, already widely used in cattle feeding, could be considered in order to enhance productivity of dairy goat by improving consistency of the selected diet nutrient content.

The TMR system involves the feeding of an intimate mixture of dietary ingredients on an *ad libitum* basis (Owen and Miller, 1971). This could increase the possibility of meeting nutritional requirements, facilitate management, allowing full mechanization and, taking into account that goat are selective feeders, more flexibility for inclusion of a wide range of alternative feeds (Coppock *et al*., 1981; Owen, 1984).

At the moment, the information of use TMR to fed Murciano-Granadina goats is scarce. Evaluation of a commercial TMR, used under practical conditions by farmers in the Southeast of Spain, was the main objective of the present experiment. In this trial, the response to milk productivity and composition when different amount of the same TMR was available for goats was assessed. Voluntary feed intake and particles size, apparent total tract digestibility and energy and nitrogen balance were also studied.

## Material and Methods

**Animals and Diets:** The experiment was carried out with 3 goats of the Murciano-Granadina breed, mid ($5^{th}$ month) through second lactation, with similar live weight (33.45 ± 0.07 kg), same number of births and similar previous milk production (611.53 ± 33.58 kg milk/210 days of lactation, on average). Goats were allocated at the Experimental Farm of ACRIMUR (Asociación Española de Criadores de la Raza Murciano-Granadina).

Goats were fed with the same TMR at 3 different amounts of offered (2, 3 and 4 kg per day). Feed offered and refusals were recorded and both, fresh and refusal were screening as is mentioned below, in order to

determine the particles size consumed by goats.

A commercial TMR was formulated and elaborate by Unión Agropecuaria del Guadalentin (UAG). This TMR is often used under practical conditions and UAG supply to the farmer. Most of the farmers belong to the Murciano-Granadina Breeder Association (ACRIMUR) and technical support was required for them. Chemical composition of TMR was 385.8 g NDF/kg of dry matter (DM) and 217.9 g ADF/kg of DM. The level of energy and protein were 17.05 MJ GE/kg of DM (0.86 UFL, as estimate value) and 176.9 g CP/kg of DM, respectively (AFRC, 1993). The following ingredients were pelleted; goat compound feed, alfalfa, beet pulp, orange pulp and sunflower meal. The rest of the ingredients were incorporated as raw to the pelleted and mixed; alfalfa hay, cotton seed, carob bean, gluten feed, carob bean and cane molasses. Compound feed for lactating goats (180 g/kg) was introduced into the mixed ration. The level of energy, protein and fiber of that compound feed was as follow: 0.96 UFL (6.83 MJ ENL/kg), 180 g CP/kg, 52.7 g crude fiber/kg). Diet formulation and chemical characteristics are shown in Table 1. Balance of the diet was obtained using the recommended values of INRA (1988) and AFRC (1993) for energy, protein, fiber, calcium, phosphorus, sodium and chloride. The diet was supplemented with a vitamin-mineral premix (5 g/kg) provided by TROUW Nutrition S.A. (a Nutreco Company).

Table 1: Ingredient and chemical composition of the total mixed ration (TMR)

| Ingredient, g/kg | TMR |
|---|---|
| Goats compound feed (pellets) | 180 |
| Alfalfa hay | 150 |
| Dehydrated alfalfa (pellets) | 100 |
| Dehydrated beet pulp (pellets) | 150 |
| Dehydrated orange pulp (pellets) | 50 |
| Sunflower (pellets) | 100 |
| Soybean meal | 20 |
| Gluten feed | 50 |
| Cotton seed | 100 |
| Cane molasses | 60 |
| Carob bean | 35 |
| Premix† | 5 |
| DM, g/kg | 891.0 |
| OM, g/kg of DM | 888.1 |
| Ash, g/kg of DM | 111.9 |
| CP, g/kg of DM | 176.9 |
| Ether extract, g/kg of DM | 50.6 |
| CF, g/kg of DM | 176.2 |
| NDF, g/kg of DM | 385.8 |
| ADF, g/kg of DM | 217.9 |
| ADL, g/kg of DM | 51.0 |
| GE, MJ/kg of DM | 17.05 |

† Provided by Trouw Nutrition España S.A. to give (ppm or UI per kilogram of diet) : Se. 30 ; I. 240 ; Co. 190 ; Cu. 1100 ; Fe. 4200 ; Zn. 27000 ; Mn. 13000 ; S. 69000 ; Mg. 45000 ; vitamin A. 1000000 UI ; vitamin $D_3$. 280000 ; vitamin E. 2000 ppm.

**Experimental Procedure:** Three Murciano-Granadina goats were used to determine the apparent total tract digestibility of DM, OM, energy, fiber (CF, NDF and ADF), CP, ash and ether extract of the mixed diet. Goats were housed in individual metabolism cages that allowed separation of feces and urine. After 15 d adaptation period, feed intake (*ad libitum* access), refusal and total fecal output were recorded for each goat over a 7 d period (experimental period). The experimental design consisted of a Latin square, and each experimental digestibility period consisted of 7 d separated by a 5 d change over period. Live weight was recorded with an electronic scale (Grupanor-Cercampo).

Goats were fed twice a day; 9:00 (after milking) and 15:00 with a half quantity each time. Goats were milked once a day and milk production of each goat was recorded daily at each milking during each digestibility period (portable milking machine, Flaco-J. Delgado) and free water was available all the time.

Energy and nitrogen balance was measured on the 3 goats for 7 consecutive days in a Latin square design as mentioned above and at the same time that digestibility was done. The time for the first energy and nitrogen balance period was selected to ensure that the rumen was totally adapted to experimental diets. During these periods, quantity of TMR offered and rejected was recorded. The samples were frozen and pooled at the end of the period for analysis. Milk was collected daily and its energy and protein content were calculated as described below.

All goats were housed in a building in which the environment was partially controlled (temperature varied between 16 and 20 ºC). Throughout the trial, the goats were handled according to the principles for the care of animals in experimentation published by NRC (1998).

**Measurements and Analyses:** Representative samples of TMR were collected every 2 days, and representative samples of feces were collected daily. Aliquots of fecal samples taken during the digestion trial were frozen at –20 ºC until analysis. Samples of milk with azidiol (400 µL/100 mL) preservative were immediately analyzed.

Chemical analyses of the diet and feces were conducted according to methods of AOAC (1995) for DM, ash, CF and CP (Kjeldahl nitrogen from diet, refusal and feces were converted to CP by multiplying N by a factor of 6.25). DM of the TMR was determined by oven-drying at 102 ± 2 ºC for 24 h. Feces was drying at 80 ± 2 ºC in order to avoid loosing volatile compounds. Van Soest *et al.* (1991) method was used to determining ADF and those of Robertson and Van Soest 1981 for determining NDF. Different fiber fractions were determined by a

Table 2: Voluntary intake and apparent digestibility for goats fed with a total mixed ration (TMR)

| | TMR offered, kg/d | | | S.E. | contrast | |
|---|---|---|---|---|---|---|
| | 2 | 3 | 4 | | 2 vs 3,4 | 3 vs 4 |
| Refusals, g/d | 365.36 | 1241.76 | 2262.36 | 45.153 | 0.0001 | 0.0001 |
| Voluntary intake, g/d | 1634.64 | 1758.24 | 1737.64 | 45.153 | 0.046 | NS† |
| DMI, g/d | 1456.46 | 1566.59 | 1548.23 | 40.232 | 0.046 | NS |
| DMI, g/kg $^{0.75}$ d | 103.48 | 111.7 | 111.44 | 2.751 | 0.0201 | NS |
| Digestibility, % of DM | | | | | | |
| DM | 66.99 | 66.4 | 66.5 | 1.187 | NS | NS |
| Ash | 51.18 | 50.49 | 53.77 | 1.913 | NS | NS |
| OM | 68.98 | 68.41 | 68.11 | 1.149 | NS | NS |
| CF | 40.62 | 40.6 | 41.0 | 2.111 | NS | NS |
| NDF | 48.52 | 47.56 | 46.59 | 1.906 | NS | NS |
| ADF | 36.27 | 32.52 | 32.47 | 2.530 | NS | NS |
| Fat | 68.28 | 65.87 | 66.06 | 1.632 | NS | NS |
| CP | 64.13 | 62.38 | 62.2 | 1.402 | NS | NS |
| Energy | 67.06 | 65.12 | 65.87 | 1.215 | NS | NS |
| ED, MJ/kg of DM | 11.43 | 11.1 | 11.23 | 1.107 | NS | NS |

† P > 0.10

Table 3: Milk yield and milk composition for goats fed with a total mixed ration (TMR)

| | TMR offered, kg/d | | | | contrast | |
|---|---|---|---|---|---|---|
| | 2 | 3 | 4 | S.E. | 2 vs 3,4 | 3 vs 4 |
| Milk yield, g/d | 1701.14 | 1821.82 | 1836.82 | 74.343 | 0.0497 | NS† |
| Milk composition, g/kg | | | | | | |
| DM | 118.6 | 128.25 | 130.17 | 0.103 | 0.0001 | NS |
| Ash | 59.42 | 58.45 | 57.2 | 0.060 | 0.0353 | NS |
| Fat | 43.8 | 45.92 | 47.49 | 0.04 | 0.0001 | 0.106 |
| Lactose | 46.79 | 47.06 | 46.42 | 0.035 | NS | NS |
| Protein | 29.81 | 30.68 | 30.23 | 0.028 | 0.0451 | NS |
| Energy, MJ/kg | 2.41 | 2.47 | 2.72 | 0.017 | 0.0001 | 0.0001 |
| SCC, x 103 cells/mL | 168 | 110 | 225 | 67.213 | NS | NS |

† P > 0.10

Dosifiber, Selecta. Gross energy was determined using an adiabatic bomb calorimeter (Gallenkamp – CBA – 305). Ether extract was measured after acid hydrolysis to recover saponified fat with a DET-GRAS, Selecta equipment, by extraction with diethyl ether.

The DM and N contents of the milk samples, as well as milk fat, were analyzed in fresh samples. All other analyses (lactose, ash and energy) were performed on dried samples. The N content of milk was measured using the Kjeldahl method (FIL,1993) with a Kjeltec 2300 analyzer unit (Fosstecator). The results were converted to CP by multiplying N by a factor of 6.38 for milk (Ribadeau-Dumas and Grappin, 1989). The fat content of the milk was measured by the Gerber method (FIL, 1981) with a DET-GRAS, Selecta equipment. Milk lactose was calculated by the official method of chloramine T (FIL, 1974). Gross energy of milk was determined using an adiabatic bomb calorimeter (Gallenkamp – CBA – 305).

Somatic cell count (SCC) was determined in each goat at the beginning of the adaptation period. Later, was determined again at the beginning and the end of the experimental trial. Analyze for SCC was obtained by staining milk cells with ethidium bromide (Fossomatic-90).

The ash content of diet, feces, and milk was determined by incineration in an electric muffle furnace at 550 ºC.

A screen was used in order to determine the particles size in both, TMR offered and refusals. Diameter of the screen was 30 cm and after homogenization, an aliquot of about 10% of the total feed sample was screening with the next hole size; >3.5 mm; 3.5-1.2 mm; 1.2-1.7 mm; 1.7-0.99 mm; <0.99 mm.

**Statistical Analysis:** The effect of the quantity of TMR offered to goats on intake, digestibility and milk production and composition were analyzed using the GLM procedure of Statistical Analysis System 1997. The individual goat was the experimental unit and the experimental design was a Latin square. The

comparative analyses between means were carried out using orthogonal contrasts. The contrasts used were 2 vs 3 and 4 kg offered per day; and 3 vs 4 kg offered per day.

## Results and Discussion

**Dry Matter Intake:** Intake data of the 3 quantities offered are showed in Table 2. We observed that with unlike amount of food offered, goats responses different and, the voluntary feed intake changed from 1635 to 1758 and 1738 g/d (average values for 2, 3 and 4 kg/d of food offered, respectively). Those differences were significant ($P < 0.05$) between 2 kg offered and 3 and 4 kg, while no significant differences were found when we offer 3 and 4 kg of the TMR.

The voluntary dry matter intake (DMI) for 2 kg of food offered was 1455 g DM/d, and an average value of 1557 g DM/d was found for 3 and 4 kg offered per day ($P < 0.05$). Similar value (1454 g DM/d) was obtained by Aguilera *et al.* (1990) in lactating Granadina goats at mid first through second lactation, although the experimental diet was a traditional diet made by alfalfa hay and barley. Seem that DMI at the level of 3 kg of food offered per day, reach a plateau (Table 2) and did not increase DMI further. So, when refusals were studied, goats offered more feed more refusals were obtained as well. The percentage of refusal was 18% for 2 kg/d offered whilst that at higher levels, 3 and 4 kg/d, the percentages were 41 and 57% respectively, and significant differences ($P < 0.0001$) were found. Wahed and Owen (1986), under stall-feeding conditions observed that goats are selective feeding. In that study the experiment involved feeding alfalfa hay or ammonia-treated barley straw *ad libitum* and with allowance of 20% feed refusals. Goat fed untreated barley straw showed intakes to increase by a third when animals were allowed to refuse 50% of the amount offered instead of 20%. The intake response was judged to be due to goats being able to select more leaf and less stem with the higher rate of straw offered. The INRA standards (Morand-Fehr and Sauvant, 1988) also drew attention of the ability of the goat to feed selectively and the consequent implications for deriving feed intake standards, particularly for forage feeds. In our experiment an increase of 50% in food offered (from 2 to 4 kg/d) increased only a 6% the voluntary DMI.

When DMI is expressed as percentage of body weight (BW), different values were obtained in the literature. The level of DMI for a 30 kg doe producing 1 kg milk daily, testing 4% fat and having minimal activity, is 3.2% of the BW (NRC, 1981). For Murciano-Granadina goats in this trial, weighing 33.5 kg, producing 1.9 kg milk/d (as average of 3 and 4 kg of TMR offered daily), 4.7% of fat and having minimal activity, the DMI was 4.7% of the BW (Table 3). This value is the same that NRC (1981) recommended for Angora goats of 30 kg, having high body activity, nursing at the rate of 1 kg of milk production of 4% fat per day, and producing mohair at a rate of 4 kg per year. AFRC (1993) predicted DMI of lactating goats at zero BW change using the same equations of INRA (1988) and for a dairy goat of 50 kg BW producing 2 kg milk per day containing 3.5% fat the DMI estimate is 1.81 kg/d. So, DMI is 3.6% of the BW, indicating substantial differences in goats of different breeds. The NRC recommendations are based mainly on work on goats from tropical and desert countries, whereas French studies were exclusively performed on goats in temperate regions. Systematic investigation of the requirements of goats would be desirable to asses if there are important differences in maintenance and milk production requirements between different types of goats.

The value obtained at the present work (1557 g DMI/d, as average of 3 and 4 kg of TMR offered) is different (1292 g DMI/d) that the value of DMI estimated when the equation of INRA (1988) was used. This equation is based in typical French diets, based on maize silage and alfalfa hay with some concentrate supplement. It seems, therefore, that there is little that is specific to goats in the revised UEL system (Fill Unit for Milk). Indeed, Morand-Fehr *et al.* (1987) stressed that the UEL system should be applied to goats with extreme caution. Therefore, application of French standards to Spanish dairy goats would also depend on assuming that both Spanish diet system and goats have similar fill values and intake capacities, respectively, to French ones. Climate conditions and semiarid areas environment will affect DMI, so, corroboration of the INRA (1988) standards under Spanish conditions and with more typical Spanish feeds needs to be undertaken.

Literature from both developed regions (Morand-Fehr and Sauvant, 1988) and developing ones (Kearl, 1982) were reviewed, and a mean DMI value of 119.6 g/kg$^{0.75}$ daily for lactation was obtained. Using the French UEL system, the value is 0.97. The result obtained at the present study was 111.6 g DMI/kg$^{0.75}$ daily (as average of 3 and 4 kg of TMR offered) that is in agreement with the previous value (0.91 UEL).

**Digestive Utilization of the Diets:** Total tract apparent digestibility of nutrients by Murciano-Granadina dairy goats are shown in Table 2. No significant differences among different quantities of food offered were found for DM and OM digestibility (66.63 and 68.50% as average, respectively). When digestibility coefficient of different fiber fractions was analyzed, we did not find significant differences either. Not significant differences were observed for CP and ether extract as well. For all of these chemical components, digestibility was numerically greater for 2 kg than 3 and 4 kg of TMR offered. Higher voluntary DMI was associated with lower digestibility coefficient, indicating that 2 kg/d of TMR offered is numerically slightly better digested than 3 or 4 kg/d.

Table 4: Energy and N balance for goats fed with a total mixed ration (TMR)

| | TMR offered, kg/d | | | S.E. | contrast | |
|---|---|---|---|---|---|---|
| | 2 | 3 | 4 | | 2 vs 3,4 | 3 vs 4 |
| DMI intake, g/kg$^{0.75}$ d | 103.48 | 111.7 | 111.44 | 2.751 | 0.0201 | NS† |
| GE intake, kJ/kg$^{0.75}$ d | 1764.4 | 1904.47 | 1900.05 | 46.911 | 0.0201 | NS |
| DE intake, kJ/kg$^{0.75}$ d | 1183.21 | 1240.19 | 1251.56 | 40.964 | NS | NS |
| 1 ME intake, kJ/kg$^{0.75}$ d | 1017.56 | 1066.56 | 1076.34 | 35.228 | NS | NS |
| 2 MEP, kJ/kg$^{0.75}$ d | 616.56 | 665.56 | 675.34 | 35.228 | NS | NS |
| Milk E, kJ/kg$^{0.75}$ d | 294.75 | 327.6 | 359.2 | 14.032 | 0.0066 | NS |
| milk E / ME intake, % | 28.97 | 30.72 | 33.37 | 1.270 | 0.0402 | NS |
| milk E / MEP, % | 47.81 | 49.22 | 53.19 | 18.949 | NS | NS |
| N intake, g/kg$^{0.75}$ d | 2.93 | 3.16 | 3.15 | 0.078 | 0.0201 | NS |
| 3 NP, g/kg$^{0.75}$ d | 2.45 | 2.68 | 2.67 | 0.078 | 0.0201 | NS |
| Milk N, g/kg$^{0.75}$ d | 0.57 | 0.63 | 0.62 | 0.024 | 0.0698 | NS |
| milk N / N intake, % | 19.45 | 19.94 | 19.68 | 0.463 | NS | NS |
| milk N / NP, % | 23.25 | 23.49 | 23.2 | 0.528 | NS | NS |

† P > 0.10, [1]ME intake: calculated assuming ME/DE=0.86 (Aguilera *et al.*, 1990), [2]MEP: calculated as ME intake-ME for maintenance (ME m), where ME m=401 kJ/kg $^{0.75}$ per d (Aguilera *et al.*, 1990), [3]NP: calculated as N intake-N for maintenance, assuming a maintenance requirements for N of 478 mg total N/kg 0.75 per d (Aguilera *et al.*, 1990)

Table 5: Percentage of particles size from the refusals obtained during the trial

| Diameter of matrix and percentage of particles size | Refusal | | | | | |
|---|---|---|---|---|---|---|
| | TMR offered, kg/d a | | | | contrast | |
| | 2 | 3 | 4 | S.E. | 2 vs 3,4 | 3 vs 4 |
| > 3.5 mm, % | 11.78 | 23.91 | 25.42 | 0.804 | 0.0001 | NS† |
| 3.5 - 1.2 mm, % | 14.96 | 20.37 | 27.21 | 1.217 | 0.0001 | 0.0002 |
| 1.2 - 1.17 mm, % | 6.39 | 7.78 | 7.17 | 0.200 | 0.0001 | 0.035 |
| 1.17 - 0.99 mm, % | 10.66 | 10.53 | 9.03 | 0.383 | 0.0662 | 0.0073 |
| < 0.99 mm, % | 55.73 | 37.49 | 31.32 | 1.464 | 0.0001 | 0.0041 |

† P > 0.10, a Original TMR (%): 46.82 (>3.5mm); 27.48 (3.5-1.2 mm); 4.76 (1.2-1.17mm); 4.68 (1.17-0.99); 16.17 (<0.99mm),

Same tendency was observed for apparent energy digestibility, and again no significant differences were found among TMR offered. From these results, the net energy value of this TMR was estimated. Digestible energy (DE) of this TMR was calculate and next value, as average, was obtained; 11.25 MJ/kg of DM. Aguilera *et al.* (1990) estimated ME as 0.86 of DE, for Grenadine goats, and using the same coefficient in our experiment we obtain the value of 9.68 MJ ME/kg DM. The efficiency of utilization of ME for milk production (kl = 0.63) recommended by AFRC (1997) was used to estimated NEL. UFL (1UFL = 7.11MJ NEL) of the TMR was estimated and a value of 0.86 was obtained. This value is in agreement with 0.83 UFL recommended by INRA (1988) for dairy goats at 5$^{th}$ month of lactation.

In summary, when TMR was offered at the level of 2 kg/d, the voluntary feed intake (1455 g DM/d) was lower than 3 or 4 kg/d. At 2 kg/d, digestibility was numerically greater probably due to slower ruminal flow rate and longer period of time for food particles at the gastrointestinal tract (Giger *et al.*, 1987; Molina-Alcaide *et al.*, 1997) but again, not significant differences were found.

**Milk Yield and Composition:** Data of milk yield are shown in Table 3. Milk production was significantly different (P < 0.05) between 2 kg/d and others amounts of feed offered, and values of 1701 and 1829 g/d, as average, were obtained. When we analyze chemical composition of milk, significant differences were observed and greater values where found for 3 and 4 kg/d of TMR offered than 2 kg/d, except for lactose. So, fat content was greater for diet 3 and 4 than diet 2 (P < 0.0001; 46.71 vs 43.8 g/kg, as average for 3 and 4 vs 2). Same tendency across treatments was observed for protein (P < 0.05) and the values obtained were 29.81 for diet 2 and 30.46 g/kg as average for diets 3 and 4. Milk energy was different (P < 0.0001) across each quantity of TMR offered, and greater value was obtained for 4 (2.72 MJ/kg) followed by 3 (2.47 MJ/kg) and then 2 kg/d of TMR offered (2.41 MJ/kg). Although greater values of milk energy were found for 4 kg/d of TMR offered than

others, this higher value did not increase significantly the chemical composition of milk.

With 2 kg/d offered, goats did not attain higher performance in milk production and composition. When more food is available and more chance has goats to select food, energy intake increase (Table 4). Although no significant differences in digestibility was found, higher milk production and composition was obtained for higher levels of food offered, meaning goats has more chance to select ingredients and the efficiency of conversion of nutrients for production increase, and therefore, greater quantities of fat, protein and energy were found in milk, although no differences between 3 and 4 kg offered per day was obtained.

SCC in milk is widely accepted as indicator of health status of the lactating mammary gland in lactation (Smith and Roguinsky, 1977). No significant differences for SCC were observed among goats and a value of 167.667 cell/mL was obtained as average, being this value lower than both 750.000 (Cremoux *et al.*, 1996) for Saanen and 500.000 (Contreras *et al.*, 1996) for Murciana–Grenadine goats, indicating animals used at the present trial were free of mammary infection.

**Energy and Nitrogen Balance:** Balance of energy and nitrogen was study in order to evaluate the utilization of this TMR for milk production. Table 4 shows data regarding energy and N utilization.

As we mentioned above, when goats has the opportunity to have more available food, the DMI increase and gross energy intake was greater ($P < 0.05$). Digestible energy intake was calculated and the intake of ME was estimated at 0.86 times the intake of digestible energy (Aguilera *et al.*, 1990). Table 4 shows as well ME intake and the ME available for production (MEP). The MEP was calculated by the difference between the ME ingested and that necessary for maintenance. The ME required for maintenance was estimated (Aguilera *et al.*, 1990). All of this values are expressed as kilojoules per kilogram of body weight (BW) elevated to 0.75 ($kg^{0.75}$) per day. The milk energy yield ($kJ/kg^{0.75}$ per day) and the ratios between the energy content of milk and the ME ingested or available for production are presented (Table 4). Neither intakes of ME nor the values of MEP were different among goats fed at three levels of feed offered. Significant differences ($P < 0.01$) were found for milk energy between TMR offered at level of 2 and the average of 3 and 4 kg/d (294.75 vs 343.4 $kJ/kg^{0.75}$, respectively). Finally, the ratios between the energy in the milk and the ME ingested were higher ($P < 0.05$) for goats offered 3 and 4 kg per day than 2 kg (32.05 vs 28.97%). Similar value (30.4%) was obtained by Sanz-Sampelayo *et al.* (1998) with lactating Grenadine goats (midway though second lactation) fed with 1 kg of long alfalfa hay and 1 kg of concentrate. No significant differences were found between 3 and 4 kg of TMR offered for energy balance, and these results are in agreement with the results shown at Table 3 where not significant differences between 3 and 4 kg/d were found for milk production and composition.

The N available for production (NP) was calculated as the difference between the N ingested and the N necessary for maintenance. The N required for maintenance was estimated (Aguilera *et al.*, 1990). From these values, the ratios between the N in milk and that ingested or available for production were calculated (Table 4). The amount of N ingested, as well as NP, was higher for goats offered 3 and 4 kg than 2 kg per day ($P < 0.05$) and a tendency was found for milk N ($P = 0.07$). However, the ratio between milk N and N ingested or NP were not significant. Moreover, the efficiency of urea retention in the kidneys and recycling to the gut is higher in goats than other ruminants (sheep or cattle), which leads to decrease N losses in urine and improving N balance and, when the requirements of goats were already met, further increases in dietary N concentration did not affect milk production and composition (Landau *et al.*, 2000).

The result obtained from this research is in agreement with the observation of others authors working in goats (Giger *et al.*, 1987; Sanz-Sampelayo *et al.*, 1998; Schmidely *et al.*, 1999; Morand-Fehr *et al.*, 2000) indicating that energy balance is the factor that is most significant in the determination of milk fat and protein content.

**Particles Size of the TMR :** Goats have different behavior to select food than others domestic ruminants like sheep and cattle, and select the most nutritious mixture of feeds (Landau *et al.*, 2000; Morand-Fehr *et al.*, 1991). Table 5 shows different size of particles from refusals. The percentage of particles higher than 3.5 mm decreased when the amount of food offered was smaller. Thus, this percentage was 25.42% (for 4 kg/d of food offered), 23.91% (for 3 kg/d) and 11.78% (for 2 kg/d). These differences were significant ($P < 0.01$) between 2 kg/d and 3, 4 kg/d of food offered. With 3 or 4 kg/d of food, goats have the availability of select food and higher milk performance was found. By other hand, the particle percentage (at 2 kg/d) smaller than 0.99 mm were 55.73%, significantly different ($P < 0.001$) than 37.49% for 3 kg/d and 31.32% for 4 kg/d. This indicate the peculiar behavior of goats trying to select the best ingredients and avoid dust particles. Seems, they do not eat more food if they do not find the ingredient they like, in spite to be a stage of lactation of high requirements (as we observed with 2 kg/d offered). When food is abundant (3 or 4 kg/d), animals have a luxury of variety and what is palatable depend of animal nutritional state (Landau *et al.*, 2000).

This TMR has a high quantity of pelleted ingredients and we observed that with 2 kg/d offered, less particles

higher than 3.5mm and, greater particles less than 0.99mm were found (Table 5). The bottom of the Table 5 shown the particles size from the original TMR, 46.82% of particles >3.5mm and 16.17% of particles <0.99mm, indicating more proportion of fine particles when less quantity is offered and when more of the ingredients are pelleted as happen with this commercial TMR. The intake response was judged to be due to goats being able to select bigger particles (grain, pellets and forage) and less small particles. When most of the ingredients are pelleted, is easier broken down and goats reject to eat them. According to these results, special attention to physical form of particles, quantity and quality of forage, and stage of lactation is necessary to paid.

**Conclusion:** TMR of the present study had good acceptance by Murciano-Grenadine goats and milk production and composition is affected by DMI. Thereafter, the amount of food offered, variety of ingredients and quality are essential to achieve optimal performance. Given the selective behavior of goats permit refusals are an interesting tool to increase the intake, but 40% of refusals is not efficient with this commercial TMR because the increase in voluntary DMI and milk yield was only about 6 and 7% respectively. Special attention to the quality of the ingredients (tendency to form dust and particles of small size) are important points especially because fiber is not effective anymore (moreover, allowing great percentage of refusals could be of doubtful economical importance). Besides of nutritional characteristics of the ingredients, their size, shape and physical form can lead to changes in milk composition and ruminal disorders. So, under practical conditions is recommended that farmer fed goats with a TMR with more forage and less pelleted ingredients at mid lactation periods.

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