Influence of kid rearing systems on milk yield, kid growth and cost of Florida dairy goats

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Abstract
The aim of this work was to study the effect of two different kid-rearing systems, natural or artificial, on milk yield, composition, hygiene-sanitary quality, kid growth and cost in Florida dairy goats. Two groups of animals were created, one with goats under natural suckling and the other under artificial rearing. In the suckling group, the kids were suckled up to 5 weeks of age, and had free access to goat milk 24 h a day. Dams in the milking group were separated from their kids at 48 h post-partum; then, kids were reared artificially, and the dams were milked twice daily. The number of goats used in each rearing system was 20 (all giving birth to twins). Each week, from the 2nd to the 5th post-partum, the volume of milk produced was measured, and individual samples were taken. The chemical composition, the bacteriology, and the somatic cell count of the milk were analysed. The kids, of both sexes, were assigned to two groups, natural suckling (NS, n = 40) and ad libitum artificial rearing (AR, n = 40), and birth weight and weight every week from the second to the fourth week of life were recorded. During the 5 weeks of lactation the total milk yield per goat was higher for the NS group (93.6 L vs. 71.2 L), although the total amount of marketable milk was greater for the AR group, with a difference of some 39 L. There was a significant effect of the rearing system for the contents of fat, protein, and non-fat dry extract, the goats in artificial rearing presenting the highest values. No effect of the rearing system on the somatic cell count was observed. No significant effect was observed either for the feeding system or the sex on the live weight of the kids at 28 days and the postnatal growth rate from birth to 28 days. Natural suckling costs were slightly lower than artificial rearing ($14.5/kid vs. $15.4/kid, respectively), but if the additional per-goat milk production in the NS group (22.4 L) is taken into account, the extra income per naturally suckled kid is $5.18.

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1. Introduction

The primary role of Spanish dairy goats is to yield marketable milk; in fact almost all milk obtained is destined for cheese production (Castel et al., 2003). However, meat production from kids is important in Africa, Asia, and the Far East, and is now emerging as an alternative source of meat in other parts of the World (Devendra, 2007). Early weaning of kids is important if milk is to be sold at a good price, and thereby increase farm profitability. Moreover, the use of machine milking has enabled enlargement of the herd and increased income on the farm (Castel et al., 2003; Mena-Guerrero et al., 2005).

In goat farms, artificial rearing is closely linked to their intensification and to their specialisation in milk production and in some Spanish regions, such as Murcia and...
the Canaries its use is widespread (Argüello et al., 2004). Andalusia is the Spanish region with the highest population of dairy goats, comprising essentially autochthonous breeds. However, and especially in the hilly areas, the use of artificial rearing is not habitual (Mena-Guerrero et al., 2005). There are hardly any works studying the effect of the type of rearing system on the yield and chemical composition of goat milk, although those on the growth of the kids are more numerous. Thus, Keskin (2002), making a partial separation of kids from dams or Peris et al. (1997), with complete separation from birth, found no differences in the milk yield throughout lactation, although there was a higher yield of marketable milk in the goats with machine milking. The results obtained with regard to the kids’ growth in autochthonous breeds are somewhat contradictory. Thus Sanz et al. (1987, 1990), Peña-Blanco et al. (1994) and Tejón et al. (1995) found no differences in daily gains with regard to rearing system, be it natural or artificial. There are, however, works showing that there is a higher growth rate among naturally suckled kids (Rodríguez et al., 1988; Piasentier et al., 2000; Argüello et al., 2004).

Criteria of hygienic and bacteriological quality of ewe and goat milk are outlined in the European Union (EU) Directive 92/46 (Council of the European Communities, 1992), as last amended by Directive 94/71/EC, which regulate different aspects of production and transformation of milk from various animal species. Despite this, there are very few studies on the characterisation and effect of management practices for the hygiene-sanitary quality of milk on dairy goat farms in Spain (Delgado-Pertiñez et al., 2003); and none in which the effect of the type of rearing system has been studied.

The Florida breed was founded recently, possibly starting from an imported herd of Anglonubian breed. Its area of origin is the province of Seville (Andalusia, South Spain). The importance of the autochthonous breed Florida has grown. This breed has been extended into neighbouring provinces (Sánchez, 2007). Actually there are around 150,000 Florida goats, located mainly in the Seville and Cordoba provinces. Although these animals are suitable for grazing, at present most of the flocks have an intensive management, and animals remain indoors. The average milk production is 650 kg per goat and year, with lactations of 10 months. The fat and protein content of milk is 4.97% and 3.50%, respectively. On average, 2.11 kids are produced for grazing, at present most of the flocks have an intensive management, and animals remain indoors. The average milk production is 650 kg per goat and year, with lactations of 10 months. The fat and protein content of milk is 4.97% and 3.50%, respectively. On average, 2.11 kids are produced per goat and year (Sánchez, 2007). But there is a general belief among breeders of the existence of a marked maternal–young bond so that, if the artificial rearing system is practised, the milk yield and growth of the kids would be reduced (Sánchez, unpublished data). Such a relationship has been noted by some authors in other breeds and species (Marnet and McKusick, 2001). However, information is lacking on how artificially reared in the Florida goat would affect the lactation traits in comparison with natural suckling, under identical conditions.

As well as the study on the technical factors determining the interest in artificial rearing compared with natural suckling, there are also socioeconomic factors. Therefore, due to the investment costs and the increase in labour required – a labour which must also be relatively skilled –

Table 1
Composition of milk replacer (MR) and goat milk (GM).

<table>
<thead>
<tr>
<th>Item</th>
<th>MR (%)</th>
<th>GM (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter (%)</td>
<td>96.0</td>
<td>13.7</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>23.7</td>
<td>3.4</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>20.0</td>
<td>4.83</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>0.8</td>
<td>0.53</td>
</tr>
<tr>
<td>Crude cellulose (%)</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>Vitamin A (UI/kg)</td>
<td>40,000</td>
<td></td>
</tr>
<tr>
<td>Vitamin D3 (UI/kg)</td>
<td>25,000</td>
<td></td>
</tr>
<tr>
<td>Vitamin E (mg/kg)</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Vitamin B1 (mg/kg)</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Vitamin C (mg/kg)</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Fe (mg/kg)</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Metabolizable energy (MJ/kg DM)</td>
<td>11.93</td>
<td>15.64</td>
</tr>
</tbody>
</table>

A Analysis provided by SOFIVO, Conde-sur-Vire, France.

b The metabolizable energy (ME) concentration was estimated according to the equation: MJ/kg = 1.6949 + (0.4025 × milk fat%) (Nsahlai et al., 2004).

The present study was aimed at investigating the effect of two different kid-rearing systems, natural or artificial, on milk yield, composition, hygiene-sanitary quality, kid growth in Florida dairy goats. The study was also aimed at comparing costs between both rearing systems.

2. Material and methods

2.1. Experimental farm and goats

A goat farm that bred the autochthonous Florida breed was chosen. The farm was located in Seville’s Sierra Norte (Andalusia, South Spain), where this breed predominates (Castel et al., 2003). In this area, goats gave birth once a year in October or November.

The goats chosen were in their 3rd to 5th parity and kidded in October. Two treatments were established. In one, the goats suckled their kids up to 5 weeks of age (natural suckling group, NS) and kids had free access to suckling 24 h a day. Furthermore, all NS goats were milked daily only in the morning to extract the residual milk. In the other, kids were reared on milk replacer (artificial rearing group, AR). For each treatment, the number of goats used was 20. All the goats used gave birth to twins. The goats did not graze during the rearing phase. They received 1.5–2 kg/day of a concentrate (91.5% OM, 16.5% CP, 4.7% EE, 18.9% CF), with barley straw available ad libitum.

The kids of both sexes were assigned to two groups, natural suckling (NS, n = 40) and ad libitum artificial rearing (AR, n = 40). AR kids were colostrum hand fed during the first two days of life on the farm itself. After thecolostrum feeding period, the kids were taken to the Corsevilla Cooperative’s artificial rearing centre where they were accommodated in artificial rearing slatted-flored rooms providing at least 0.3 m² floor space per kid. The artificial rearing centre had central heating providing a room temperature of between 23 and 28 °C. After fasting for 12 h, the animals were trained to suckle from a teat connected to a unit for feeding liq-uid diets (Industrias J.R. automatic milk replacer machine, Valdelafuente, Spain). A commercial milk replacer (Elvior kids, SOFIVO, Conde-sur-Vire, France) was given warm (36–38 °C), reconstituted at 17% (w/w), continuously mixed (half a litre each time) and offered ad libitum on a 24-h basis. Composition of the milk replacer and average composition of goat milk used are shown in Table 1. Water was supplied ad libitum to kids. Birth weight and weight every week from week two until week four of age were recorded in kids from both groups, because the kids in the AR group were slaughtered at week four when they reached commercial slaughterweight. The kids in the NS group, however, were left with their mothers until 5 weeks of age to be able to follow the impact of suckling on milk production until this time. No mortalities were recorded during the trial.

2.2. Milk sample collection

The sampling period began 10–15 days after birth (2nd week post-partum). Samples were taken weekly until the 5th week post-partum. In
the AR group, the goats were milked twice daily (09:00 and 17:00 h) in a double 12–14 stall Casse system parallel milking parlour, and individual recording jars were used to measure the volume of milk produced. Milking was conducted at a vacuum pressure of 42–45 kPa, a pulsation rate of 90 pulses/min, and a pulsation ratio of 66%. In the NS group, to calculate the milk yield of a complete day, the night before the control day’s sampling, the kids remained isolated from their dams so that they could not suckle, and the milk yield was estimated by the weigh-suckle-weigh method twice a day (08:00 and 18:00–20:00 h). The kids were weighed before and after suckling, and the difference between the two weights gave the milk yield of the dam (Djibrilou et al., 1998). The weight of the milk (in kg) was transformed into volume (L), measuring the density of the milk (using a Quevenne lactometer) in representative samples from each group of goats. Following the daily routine, in the morning of the control day, the dams were milked at the parlour after the kids were fed and the amount of residual milk was recorded.

For each group, two aliquots of both morning and afternoon milkings were mixed to obtain a representative sample. The milk samples were collected aseptically into sterile vials with preservative (Azidiol), and immediately stored at 4 °C until laboratory analysis.

2.3. Laboratory analyses

For analysing milk composition (fat, protein, and lactose), an infrared spectrophotometer (MilkoScan 5000, Foss Electric, Hillerød, Denmark) was used; for number of bacteria/mL, a BactoScan 8000S was used (FOSS Analytical A/S, Hillerød, Denmark); and somatic cell counts/mL (SCC) were measured by flow cytometry, using a Fossmatic Electronic Cell Counter in a Combi-Foss 5000 (Delgado-Pertínez et al., 2003).

In all cases, as recommended by Zeng (1996) and Zeng et al. (1997, 1999), instruments were calibrated with goat milk standards for more reliable and accurate analyses.

2.4. Comparison of costs between rearing systems

In order to compare the costs between the two types of rearing systems, the information from an earlier study of our group (unpublished data) that compared the costs of natural and artificial rearing of kids in two different farms in Andalusia (South Spain) was also used. In this other study, the breed of kids on one farm was Malagueña while the breed on the other farm was Payoya.

Labour costs were calculated by multiplying the cost of 1 h of work (€8) by the number of hours per goat employed in the whole kid rearing process (from birth to the 4th week of age) (Table 2). This mainly consisted in assisting at births in both types of rearing and, in the case of artificial rearing, operating a milk replacer machine. Feeding costs of the kids fed on natural milk has been calculated by multiplying the consumed milk by the market cost of such milk. The kids consumed only milk (natural or artificial, according to the group). Other costs of artificial rearing were also taken into account, such as electricity consumption and the milk replacer machine’s depreciation and maintenance.

2.5. Statistical analysis

After testing the variables for normality, using the descriptive statistics of asymmetry and kurtosis, the logarithmically transformed somatic cell and bacterial cell counts were used to normalise the frequency distribution (Delgado-Pertínez et al., 2003). For these and the other milk yield and composition parameters, the results were analysed by repeated measures, using the general linear model (GLM) of the SPSS software statistical package (SPSS Inc., 2006), including fixed effects of treatment (NS or AR). The results of the kids’ growth were analysed using the GLM model, using birth weight as a covariable, including fixed effects of treatment (NS or AR) and sex. Weekly weight was carried out to determine the average daily gain (ADG). Pearson correlation coefficients among different variables of goat milk were also determined.

3. Results

3.1. Milk yield, composition and hygiene-sanitary quality

The changes in daily milk yield during the 5 weeks of suckling depending on the type of rearing system are shown in Fig. 1. A daily yield mean of 2.72 and 2.03 L/d was obtained (Table 3), with the highest milk yield obtained in the 5th week (2.93 and 2.26 L/d, for the NS and AR groups respectively). The total milk yield per goat was higher for the NS group (P < 0.01) (93.6 L vs. 71.2 L), although the total amount of marketable milk was greater (P < 0.001) for the AR group, with a difference of some 39 L (Table 3).

The patterns of milk composition (fat, protein, lactose, and non-fat dry extract) during rearing were affected by week for all the components (P < 0.05). There was a significant effect of the rearing system on the contents in fat (P < 0.01), protein (P < 0.05), and non-fat dry extract
(P<0.05), the goats with artificial rearing presenting the highest values (Table 3).

The pattern of hygiene-sanitary quality of the milk during rearing was affected by week only in the SCC (P<0.05). No significant effect of the rearing system was found, upon either the bacteriological values or the SCC (Table 3).

With regard to the relationship between chemical composition of the milk and the hygiene-sanitary quality for the total of samples analysed, the SCC was found to have a positive correlation with the percentages of fat (r = 0.13, P<0.05) and protein (r = 0.20, P<0.01) and a negative one with that of lactose (r = −0.40, P<0.01), while the bacterial cell count only had a negative correlation with the percentage of lactose (r = −0.24, P<0.01).

### 3.2. Kids growth

Table 4 shows the kids’ average live weight and daily weight gain as a function of the rearing system and sex. Although males were heavier than females at birth (P<0.05), no significant effect was observed either for the feeding system or the sex on the live weight of the kids at 28 days and the postnatal growth rate from birth to 28 days.

### 3.3. Comparison of costs among rearing systems

To study costs in both rearing systems, the feed efficiency ratio (FR, amount of feed required to produce 1 kg of kid growth) must be evaluated. In the case of milk replacer the FR obtained was 1300 g/kg, while the natural milk FR was 7.6 L/kg. The cost differentials of the AR and NS from birth to the 4th week of age (Table 5) were the sum of the costs of the labour employed (€5.20/kid vs. €2.64/kid, respectively), feeding costs (€9.31/kid vs. €11.83/kid, respectively) and three other costs, milk replacer machine depreciation, its maintenance and electricity which only affected the AR group (€0.31/kid, €0.15/kid, and €0.42/kid, respectively). Total costs were similar in both groups (€15.38 and €14.47 for AR and NS, respectively). On the other hand, taking into account the greater milk production per goat until the fifth week of lactation of the NS group (22.4 L per goat), and the average price of milk (€0.462 per litre), the additional income obtained per kid in the NS system compared to AR was €5.17. It should be noted that incomes correspond to a period of 35 days of lactation while costs only refer to 28 days.

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### Table 3

Mean values (±SE) of the yield, chemical composition, and hygiene-sanitary quality of the milk from birth to the 5th week of lactation, depending on rearing system (natural suckling, NS or artificial rearing, AR) in goats of Florida breed.

<table>
<thead>
<tr>
<th>Item</th>
<th>Rearing systems (RS)</th>
<th>p&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NS</td>
<td>AR</td>
</tr>
<tr>
<td>Number of goats</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Milk yield (L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily milk yield</td>
<td>2.72 ± 0.08</td>
<td>2.03 ± 0.08</td>
</tr>
<tr>
<td>Total yield</td>
<td>93.6 ± 4.8</td>
<td>71.2 ± 5.3</td>
</tr>
<tr>
<td>Daily marketable milk</td>
<td>1.03 ± 0.08</td>
<td>2.03 ± 0.08</td>
</tr>
<tr>
<td>Total marketable milk</td>
<td>31.9 ± 4.5</td>
<td>71.2 ± 5.3</td>
</tr>
<tr>
<td>Milk composition (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fat</td>
<td>4.83 ± 0.19</td>
<td>5.68 ± 0.09</td>
</tr>
<tr>
<td>Protein</td>
<td>3.14 ± 0.03</td>
<td>3.36 ± 0.04</td>
</tr>
<tr>
<td>Lactose</td>
<td>4.95 ± 0.02</td>
<td>4.98 ± 0.03</td>
</tr>
<tr>
<td>Non-fat dry extract</td>
<td>8.89 ± 0.04</td>
<td>9.14 ± 0.05</td>
</tr>
<tr>
<td>Hygiene-sanitary quality (×10³ [mL])</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacteria&lt;sup&gt;b&lt;/sup&gt;</td>
<td>165 ± 17</td>
<td>201 ± 55</td>
</tr>
<tr>
<td>Somatic cells&lt;sup&gt;b&lt;/sup&gt;</td>
<td>974 ± 318</td>
<td>834 ± 334</td>
</tr>
</tbody>
</table>

<sup>a</sup> P<0.05; <sup>b</sup> For the statistical analysis, the values were transformed to logarithmic scale, base 10.

### Table 4

Mean values (±SE; coefficient of variation in parentheses) of the live weight and average daily gain (ADG) for growth of Florida breed kids depending on rearing system (natural suckling, NS or artificial rearing, AR) and sex (male, M or female, F) (from birth to the 4th week of age).

<table>
<thead>
<tr>
<th>Item</th>
<th>Rearing systems (RS)</th>
<th>Sex (S)</th>
<th>p&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NS</td>
<td>AR</td>
<td>M</td>
</tr>
<tr>
<td>Number of kids live weight (g)</td>
<td>40</td>
<td>40</td>
<td>45</td>
</tr>
<tr>
<td>Birth</td>
<td>3287 ± 77 (15)</td>
<td>3450 ± 96 (17)</td>
<td>3465 ± 77 (16)</td>
</tr>
<tr>
<td>14 d</td>
<td>4863 ± 135 (17)</td>
<td>5040 ± 137 (16)</td>
<td>5102 ± 115 (16)</td>
</tr>
<tr>
<td>21 d</td>
<td>5890 ± 171 (18)</td>
<td>6121 ± 173 (17)</td>
<td>6225 ± 142 (16)</td>
</tr>
<tr>
<td>28 d</td>
<td>6769 ± 199 (18)</td>
<td>7405 ± 178 (14)</td>
<td>7379 ± 155 (15)</td>
</tr>
<tr>
<td>ADG (g/d) Birth–28 d</td>
<td>116 ± 5.4</td>
<td>136 ± 4.5</td>
<td>133 ± 4.1</td>
</tr>
</tbody>
</table>

<sup>a</sup> P<0.05; NS: not significant, P>0.10.

### Table 5

Differential costs (€) per goat in the use of artificial rearing (AR) compared to natural suckling (NS) (from birth to the 4th week of age).

<table>
<thead>
<tr>
<th>Item</th>
<th>Labour</th>
<th>Milk replacer machine depreciation</th>
<th>Milk replacer machine maintenance</th>
<th>Electricity</th>
<th>Feed&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Total costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR</td>
<td>5.20</td>
<td>0.31</td>
<td>0.15</td>
<td>0.42</td>
<td>9.31</td>
<td>15.38</td>
</tr>
<tr>
<td>NS</td>
<td>2.64</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>11.83</td>
<td>14.47</td>
</tr>
</tbody>
</table>

<sup>a</sup> In the case of the AR: 1300 g milk replacer/kg weight increase, €1.86/kg milk replacer; in the case of NS the cost of the milk that was not sold due to its being suckled by the kid: 7.6 L/kg weight increase, €0.462/L. During the first days of life and consumption of colostrum on the farm itself before beginning the experiment comparing the AR and NS kids, in both cases the kids gained 0.11 kg in weight.
4. Discussion

4.1. Milk yield, composition and hygiene-sanitary quality

The milk yield values of this herd of Florida goats in the lactation phase were similar to those obtained in this same breed by Peña-Blanco et al. (1999) (with a range of estimated peak values between 2.4 and 3.0L) and higher than in other Spanish goat breeds (Peris et al., 1997). These authors, in goats of the Murciano-Granadina breed, found no significant differences in milk yield between the groups of natural and artificial rearing for either the entire lactation or the rearing phase. These results agree with those obtained by other authors in foreign breeds (Zygoyiannis, 1994; Keskin, 2002). However, in a work with French goats (Masson and Decaen, 1978), the goats with natural suckling produced some 19% more milk during the rearing period than those with artificial rearing. This could be because in that work, the goats suckled two kids, whereas in the work of Peris et al. (1997), only one. In this sense, the comparison of our results in the Florida breed is more consistent with those of Masson and Decaen (1978), with higher yield during the rearing phase in the goats with natural suckling, and rearing twins (31.5% more milk).

The results of Peris et al. (1996, 1997) show that the milk ejection reflex in Murciano-Granadina goats can be stimulated by milking nearly as effectively as by suckling. In fact, according to some works the neuroendocrine milk ejection reflex is less important in the goat than in the dairy cow (Marnet and McKusick, 2001), because small ruminants have proportionally larger cisterns (40–80% of the total volume), and this plays an important role in the storage of milk between milkings (Bruckmaier et al., 1994; Peris et al., 1996). However, our study obtained a greater amount of milk with suckling. This could be due to a more-effective milk storage between milkings, in that a greater proportion of the total milk could be stored away from the alveoli (Marnet and McKusick, 2001), thereby reducing the effect of the feedback inhibitor of lactation, which decreases milk secretion rate as milk accumulates in the udder (Knight and Peaker, 1984). Other researchers have suggested that suckling plus frequent milking during early lactation enhances mammary development, increasing both proliferation and differentiation of mammary cells (Bar-Peled et al., 1995).

The mean values of milk constituents measured were similar to the composition observed by other researchers for the same breed (Sánchez et al., 2005). The highest values for these components were found in the AR group, which present lower milk yield during the period of rearing, and could be explained by the effect of concentration–dilution of these components induced by variations of milk production (Falgán and Mateos, 1996; Morand-Fehr et al., 2007). Peris et al. (1997). In Murciano-Granadina goats, both for the entire lactation and in the rearing phase, found no significant differences in either the yield or the composition of the milk between the groups of natural and artificial rearing.

The limit for SCC in ewe and goat milk has not yet been definitely established (Boyazoglu and Morand-Fehr, 2001). Nevertheless, for Europe and for fresh milk Barbosa et al. (1994) have advised a threshold of 1,500,000 cells/mL. In the case of number of bacteria, Spanish legislation (Real Decreto 402/96, modifying 1679/94), set the limit at 500,000 bacteria/mL for fresh milk. Our results show an SCC and bacterial cell count below the recommended limits, and no significant effect was obtained for the rearing system. Similarly, in sheep the rearing system (natural suckling until three months and mixed natural suckling with accompanying machine milking until three months) did not affect the hygiene quality of the milk (Wazna et al., 2001). No studies analysing these factors and parameters jointly in goat are known, but Delgado-Pertiñez et al. (2003), with the same breed used in this work, and throughout the entire lactation, obtained similar values in bacteriology and SCC, indicating the important effect of hygiene-sanitary management on the farm, besides that of other factors (physiological, production system, etc.).

In the relationship of the chemical composition with the parameters of hygiene-sanitary quality, other authors also observed significant correlation between SCC and fat and protein (Park and Humphrey, 1986; Zeng and Escobar, 1996; Zeng et al., 1997; Sung et al., 1999; Delgado-Pertiñez et al., 2003). The absence of correlation was observed between the bacterial cell count and the SCC, as also was reported by Park and Humphrey (1986).

4.2. Kids growth

The kids’ birth weight was similar to that described by Peña-Blanco et al. (1994) in kids of the same breed. However, at 28 days it was lower than that found by the above authors due to the lower ADG shown by the kids in our study. In fact, in these authors’ studies the kids grew around 181 g/day until day 28 while in our study the ADG did not exceed 136 g/day (Table 4). This may be due to the different climatic, feeding, and management conditions in the herds studied (Verdejo et al., 1995).

Although the AR group kids presented a greater ADG during the studied period when compared to NS kids (Table 4), there were no significant differences in weight at the fourth week of life. Due to the fact that growth essentially depends on the ingested energy, our results can be explained because the ingestion and the estimated ingested metabolizable energy were similar in both rearing systems (in the case of milk replacer the FR obtained was 1300 g/kg and 14.9 MJ ME/kg, while the natural milk FR was 7.6 L/kg and 16.7 MJ ME/kg). Several authors (Sanz et al., 1987, 1990; Tejón et al., 1995; specifically, Peña-Blanco et al., 1994, in kids of the same breed and even of the same age as those in our study) found no differences in ADG according to the type of rearing—natural or artificial. Other authors, however (Rodríguez et al., 1988; Piasentier et al., 2000; Argüello et al., 2004), have found higher growth with natural suckling, which might be attributable to the influence of other factors, as the higher digestibility in goat milk that in milk replacer (Sanz et al., 1990) and the growth promoter in the dams’ milk, that is not present in milk replacers (Baumrucker and Blum, 1993). According to Peña-Blanco et al. (1994), differences for weight at 28 days and for ADG, were not found. Nevertheless, both variables were slightly higher for males than for females.
4.3. Comparison of costs between rearing systems

The results obtained for FR of milk replacer were similar with that observed by Argüello et al. (2004) in Canary breed males and females. Considering the feeding costs and the rest of the costs in this study, no differences have been observed between the two rearing systems. However, as consequence of a greater per-goat milk production in the NS group until the kids are weaned, incomes per kid are greater. In spite of the numerous advantages of artificial rearing, according to Mantecón et al. (2000), the price of powdered milk, together with the price assigned to the milk that is not sold due to its consumption by the naturally suckled kids, are the factors that determine the interest of one type of rearing or another. Furthermore, artificial rearing frequently raises problems for breeders in terms of finding additional labour. Notwithstanding the above, the situation might be very different for those breeders who participate in the added value generated by transforming milk into cheese, since in this case the natural milk acquires a much higher value than that paid to the producer who sells it to the cheese making industry (Mena-Guerrero et al., 2005).

5. Conclusions

The rearing system has affected the total milk yield during the suckling phase (from birth to the 5th week of lactation), with higher yields being obtained in the natural suckling system; however, the number of litres of marketable milk per goat was greater in an artificial rearing system. The results indicate that the milk yield in the autochthonous Florida goats cannot be stimulated by machine milking as effectively as by suckling.

Most of the chemical components of the milk studied have been affected by the type of rearing system, with the highest values presented by the milk from the goats with machine milking. The milk’s hygienic and health qualities were not affected by the rearing system.

In comparison with natural suckling, artificial rearing produced kids of similar weight at 28 days of age, without difference between sexes. The economic profitability of using artificial rearing depends essentially upon the evolution in the cost of milk replacer, upon the quantity and price of milk produced by the goats before the kids are weaned – in both artificial and natural suckling – and the availability of specialised labour.

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References


