THE EFFECT OF SUCKLING REGIME ON THE QUANTITY AND QUALITY OF MARKETABLE MILK AND THE PERFORMANCE OF LAMBS

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SUMMARY

The effect of three suckling regimes (8, 12 and 24h) on the quantity and quality of marketable milk, the rate of milk secretion, milking time and performance of lambs from 28 to 42 days (weaning), and the milk yield and fat content of milk and the performance of lambs from 43 to 63 days post partum, was investigated in Chios ewes. Total milk yield was similar until weaning, but ewes in treatment S8 had higher marketable milk yield with a lower fat content. Fat corrected milk (6%) and cheese production were also higher on treatment S8. Lambs on treatment S24 grew faster until weaning and lambs on S8 grew faster after weaning. From 28 to 63 days of age lambs had a similar growth regardless of treatment. The rate of milk secretion until weaning was not influenced from the milking interval. Milking time was inversely related to the quantity of marketable milk available in the udder. The revenue from the sale of marketable milk and total gain of lambs was higher with partial suckling of ewes.

INTRODUCTION

Many studies have been carried out aiming at increasing marketable milk from sheep, without adversely affecting lamb growth. Early weaning (35 to 42 days) associated with restricted suckling (12 or 8 h daily) gave higher marketable milk; in addition, lambs had a greater consumption of solid feed and a smaller check of growth following weaning (Louca, 1972; Lawlor, Louca and Mavrogenis, 1974; Hadjipanayiotou and Louca, 1976). Factors which affect milk yield, carcass gain and conversion of milk to lamb gain with 42 day weaning associated with restricted suckling were also studied (Economides, 1980; 1984a).
The application of any restricted suckling until weaning, depends mainly on the price of milk, labour availability and/or cost of labour to remove the surplus milk. In addition, the quality of marketable milk during the restricted suckling is lower, because of the low fat content (3.2 to 3.81%; Papachristoforou, personal communication). More information is needed on the quality of marketable milk until weaning, and few data are available on the effect of suckling interval on the milk yield and quality of marketable milk and the cost to remove marketable milk during suckling.

The objectives of this work were to examine the effect of restricted suckling on the quantity and fat content of marketable milk, the effect of unequal milking interval on the milk yield, milking time of marketable milk and cost of milking.

MATERIALS AND METHODS

Animals. Sixty six multiparous ewes and their offspring (99 lambs) were used. The mean liveweight and milk yield of ewes 24 days post-partum was 65 kg and 3.15 kg (2.8 kg for single and 3.45 kg for twin suckling ewes), respectively. They were divided into groups of three according to days in lactation, type of birth, and milk yield and liveweight at 24 days post-partum and were assigned at random to 3 suckling regimes on day 29 post-parum until weaning (42 days) as follows:

1. Continuous Suckling (S24). Lambs were kept continuously with their dams and were allowed to suck at will. Twice daily (at 06.00 and 17.00 h) surplus milk was removed by hand.

2. Twelve-hour Suckling (S12). Lambs were allowed to suck for 12h during the night. They were removed from their dams at 06.00 h and ewes were milked. The lambs rejoined their dams at about 18.00 h, immediately after the afternoon milking.

3. Eight-hour Suckling (S8). Lambs were allowed to suck for only 8h during the day. They were removed from their dams at 15.30 h and ewes were milked. The lambs rejoined their dams at about 7.30 h, immediately after the morning milking.

Diets and management

The trial had two phases; before weaning (29 to 42 days-phase one) and following weaning (until 56 days for ewes and 63 days for lambs-phase two). Lambs were allowed to suck continuously from birth to 28 days post partum. From 10 days of age until weaning they had, in addition to milk, free access to a pelleted concentrate mixture containing 16% crude protein (CP) and alfalfa hay. In the first phase ewes were housed by treatment in 6 adjacent pens of 11 ewes and were offered 2 kg of concentrates, containing 16% crude protein, 0.5 kg of alfalfa hay (20% CP and 9.3 MJ of ME/kg dry matter) and 0.4 kg of barley hay (8.5% CP and 8.3 MJ of ME/kg dry matter) daily. The bulk milk yield was recorded at each milking separately for each treatment daily. The same type and quality of feeds was offered to ewes following weaning. They were milked by hand twice daily and the bulk milk yield at each milking was recorded separately for each treatment.

All lambs were offered the same concentrate mixture consumed until weaning ad libitum and 100g of alfalfa hay per lamb daily in separate feed troughs. Individual lamb liveweights were recorded at 29 and 42 days and weekly thereafter. Group feed intake was also recorded weekly.

Ewe milk yield during the first phase was estimated from a single individual test-day (35 day) milk yield using the suckling technique (Economides, 1984b) and from the bulk milk yield of each treatment using the daily records as individual observations (Blaxter, Wainman and Wilson, 1961). During the second phase (43 to 56 days) milk yield was estimated from weekly individual records and the daily bulk milk yields. The fat content of marketable milk was determined (Gerber method) once during the first and twice during the second
phase, from individual milk samples. In addition, it was determined from the morning and afternoon daily bulk milk yields on 8 different days in the first and on 4 days in the second phase. The protein content was determined twice from morning and afternoon samples of the bulk milk yield of each treatment using the macroKjeldahl method.

Data on ewe milk yield and milk composition, and lamb performance data were analyzed using standard statistical procedures (Steel and Torrie, 1960).

**RESULTS**

One female lamb on treatment S8 died from internal haemorrhage and three ewes (two on treatment S8 and one on treatment S12) were treated for mastitis.

Total and marketable milk yields estimated from individual records, and fat content of marketable milk determined also from individual records were similar for all three suckling regimes. Ewes suckling lambs continuously (S24) had lower marketable milk (P<0.01) than those suckling lambs for 8 or 12h daily (S8 and S12), but total milk sucked by lambs was highest (P<0.01) for the former ewes (Table 1). The fat content of marketable milk was significantly lower (P<0.01) for ewes on the S8 suckling regime, and fat yield was significantly lower (P<0.01) for ewes suckling lambs continuously (Table 1). The proportion of marketable milk produced at the morning and afternoon milkings was 56 and 44, 17 and 83 and 17% for S24, S12 and S8, respectively.

The production of marketable milk, measured from the daily bulk yields, had a similar trend with that estimated from individual records (Table 2). The protein content of marketable milk was similar in the three treatments and ranged from 5.32 to 6.01%. The fat content of milk for treatments S12 and S24 was higher in the morning and that of treatments S8 and S24 was higher in the afternoon (P<0.01). The average fat content of morning and afternoon milk

<table>
<thead>
<tr>
<th>Table 1. Production and fat content of marketable milk and fat yield of ewes on the three suckling regimes during the first phase (Individual recording)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
</tr>
<tr>
<td>Total milk yield (kg/ewe)</td>
</tr>
<tr>
<td>Milk sucked (kg/ewe)</td>
</tr>
<tr>
<td>Marketable milk (kg/ewe)</td>
</tr>
<tr>
<td>Fat (%) (marketable milk)</td>
</tr>
<tr>
<td>Fat yield (kg/ewe)</td>
</tr>
</tbody>
</table>
was lower on treatment $S_8$ (Table 2). However, the production of fat and protein was higher on treatments $S_8$ and $S_{12}$ than that on treatment $S_{24}$ (Table 2).

During the second phase, milk yield was similar for all treatments (Table 3) regardless of the method of estimation (individual or bulk). Fat content of milk was also similar (Table 3), but ewes suckling two lambs until weaning produced more milk with lower fat content (5.04 vs 5.60%). Liveweight changes from the commencement of the trial until weaning or until the end of the trial (56 days post partum) were also similar.

During the first phase (29-42 days), lambs on treatment $S_{24}$ grew faster ($P<0.01$) than those on treatments $S_8$ and $S_{12}$. The weaning weight of females on treatment $S_{24}$ was heavier ($P<0.05$) than that of females on treatments $S_8$ and $S_{12}$ (Table 4). Lambs on treatment $S_{24}$ consumed significantly more milk ($P<0.01$) than those on treatments $S_8$ and $S_{12}$ (Table 4). Solid feed intake of lambs on treatment $S_8$ was higher than that of lambs on the other two suckling regimes. During the second phase (43 to 63 days) lambs on treatment $S_8$ grew significantly faster ($P<0.01$) than other lambs. For the whole growth periods daily gain was similar for all lambs. Male lambs were heavier ($P<0.01$) than female lambs and singles heavier than twins at birth, 28, 42 (weaning) and 63 days of age. Milk consumption of single lambs was also higher ($P<0.01$) than that of twin lambs (19.7 vs 13.4 kg).

During the first phase, the apparent rate of milk secretion was similar between milking intervals within suckling regimes. It was also similar among suckling regimes ($S_{24}=0.121$ kg/h; $S_{12}=0.126$ kg/h; $S_8=0.130$ kg/h).

### Table 2. Production and fat content of marketable milk and fat and protein yields of ewes on the three suckling regimes during the first phase (Bulk recording)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>$S_{24}$</th>
<th>$S_{12}$</th>
<th>$S_8$</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marketable milk (kg/ewe)</td>
<td>8.25</td>
<td>20.60</td>
<td>25.60</td>
<td>0.43</td>
</tr>
<tr>
<td>Fat (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morning</td>
<td>5.21</td>
<td>5.57</td>
<td>3.81</td>
<td>0.16</td>
</tr>
<tr>
<td>Afternoon</td>
<td>6.16</td>
<td>4.90</td>
<td>5.97</td>
<td>0.23</td>
</tr>
<tr>
<td>Average fat (%)</td>
<td>5.63</td>
<td>5.01</td>
<td>4.17</td>
<td></td>
</tr>
<tr>
<td>Fat yield (kg/ewe)</td>
<td>0.46</td>
<td>1.03</td>
<td>1.07</td>
<td></td>
</tr>
<tr>
<td>Protein yield (kg/ewe)</td>
<td>0.47</td>
<td>1.17</td>
<td>1.45</td>
<td></td>
</tr>
</tbody>
</table>
Table 3. Production and fat content of milk and fat yield of ewes during the second phase (Individual and Bulk recording)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Individual Recording</th>
<th></th>
<th>Bulk Recording</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S&lt;sub&gt;24&lt;/sub&gt;</td>
<td>S&lt;sub&gt;12&lt;/sub&gt;</td>
<td>S&lt;sub&gt;8&lt;/sub&gt;</td>
<td>SE</td>
</tr>
<tr>
<td>Milk yield (kg/ewe)</td>
<td>35.20</td>
<td>36.85</td>
<td>34.62</td>
<td>1.97</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>5.08</td>
<td>5.41</td>
<td>5.47</td>
<td>0.15</td>
</tr>
<tr>
<td>Fat yield (kg/ewe)</td>
<td>1.77</td>
<td>1.98</td>
<td>1.85</td>
<td>0.10</td>
</tr>
<tr>
<td>Milk yield (kg/ewe)</td>
<td>34.02</td>
<td>35.42</td>
<td>34.30</td>
<td>0.58</td>
</tr>
<tr>
<td>Fat (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morning</td>
<td>4.53</td>
<td>4.75</td>
<td>4.70</td>
<td>0.13</td>
</tr>
<tr>
<td>Afternoon</td>
<td>5.68</td>
<td>6.00</td>
<td>6.00</td>
<td>0.11</td>
</tr>
<tr>
<td>Average fat (%)</td>
<td>5.05</td>
<td>5.31</td>
<td>5.23</td>
<td>-</td>
</tr>
<tr>
<td>Fat yield (kg/ewe)</td>
<td>1.72</td>
<td>1.88</td>
<td>1.79</td>
<td>-</td>
</tr>
</tbody>
</table>

S<sub>8</sub>=0.129 kg/h, SE=0.006). The apparent rate of milk secretion in ewes suckling twins (T) was higher than that of ewes suckling singles (S) (S=0.110 kg/h; T=0.140 kg/h, SE=0.05).

The time required to separate the dams from their lambs in order to take them in the milking parlour was 8 minutes daily with ewes suckling lambs continuously (S<sub>24</sub>) and 4 minutes daily with ewes on treatments S<sub>8</sub> and S<sub>12</sub>. The time required to milk the surplus (marketable) milk (min/kg) was similar for the morning and afternoon milking for treatment S<sub>24</sub>, lower for the morning milking for treatment S<sub>8</sub>, and higher for the morning milking for treatment S<sub>12</sub> (Table 5). The relationship between production of marketable milk and milking time (min/kg) was high and negative (R<sup>2</sup>=0.91).
Table 4. Liveweight, daily gain, feed intake and feed to gain ratio of lambs on the three suckling regimes.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>S24 M</th>
<th>S24 F</th>
<th>S12 M</th>
<th>S12 F</th>
<th>S3 M</th>
<th>S3 F</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lambs</td>
<td>17</td>
<td>16</td>
<td>15</td>
<td>18</td>
<td>17</td>
<td>15</td>
<td>-</td>
</tr>
</tbody>
</table>

**Phase One**

- **Liveweight (kg)**
  - 28 day: 12.93, 12.18
  - 42 day: 16.79, 15.71

- **Weight gain (g/day)**
  - 29-42: 276, 252

- **Feed intake (kg)**
  - Milk sucked: 20.69, 19.34
  - Lucerne hay: 0.25, 0.86
  - Concentrates: 0.43, 1.54

**Phase Two**

- **Liveweight (kg)**
  - 42 day: 16.79, 15.71
  - 63 day: 23.04, 21.66

- **Weight gain (g/day)**
  - 43-63 day: 297, 284

- **Feed intake (kg)**
  - Lucerne hay: 2.10, 2.10
  - Concentrates: 16.15, 16.44

**Phase One and Two**

- **Weight gain (g/day)**
  - 29-63 day: 289, 271

- **Feed to gain**
  - Milk: 2.04, 1.63
  - Lucerne hay: 1.69, 1.99
  - Concentrates: 0.24, 0.33
Table 5. Time required to milk and cost of marketable milk during phase one.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>S24</th>
<th>S12</th>
<th>S8</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milking time (min/kg milk)</td>
<td>2.67</td>
<td>2.96</td>
<td>2.94</td>
<td>1.68</td>
</tr>
<tr>
<td>Average milking time (min/kg milk)</td>
<td>2.80</td>
<td>1.89</td>
<td>1.56</td>
<td></td>
</tr>
<tr>
<td>Marketable milk* (kg/ewe)</td>
<td>8.25</td>
<td>20.60</td>
<td>25.60</td>
<td></td>
</tr>
<tr>
<td>Milking time (min/ewe)</td>
<td>23.10</td>
<td>38.90</td>
<td>40.00</td>
<td></td>
</tr>
<tr>
<td>Cost of milking (cent/kg)</td>
<td>10.00</td>
<td>6.75</td>
<td>5.55</td>
<td></td>
</tr>
</tbody>
</table>

* See Table 2

DISCUSSION

Two methods were employed to estimate the marketable milk during the first phase (29 to 42 days), in an attempt to increase the accuracy of estimation of its quantity and quality. Marketable milk yield, fat content and fat yield were identical with both methods for treatments S12 and S8 (Tables 1 and 2) but marketable yield was higher and fat content was lower for treatment S24 from individual records. This was because during the recording day lambs consumed less milk and therefore more marketable milk was available containing less fat. It is reasonable to assume that marketable milk and its fat content for treatment S24 were more accurate when measured from the daily bulk milk yield obtained from undisturbed animals.

Milk consumption by lambs was inversely related to marketable yield. Similar relationships between marketable milk yield and milk consumption with different suckling regimes were reported also by Louca (1972) and Lawlor et al. (1974). The fat content of marketable milk was highest on treatment S24 and lowest on treatment S8. Differences in fat content of marketable milk were related to the suckling regime and the milking interval and ranged from 3.81 to 6.16%. Ling (1963) stated that, following a long milking interval, there is a greater yield of milk containing a smaller percentage of fat, whereas milk drawn after a shorter interval is richer in fat, but smaller in quantity.

Although it is well documented that twin suckling Chios ewes produce a higher milk yield than single suckling ewes until weaning (Economides, 1980; Hadjianayiotou and Economides, 1986), the continued higher milk yield of twin suckling ewes after weaning is at variance with the data of
Hadjipanayiotou and Economides (1986) obtained with Chios ewes. This disagreement may be attributed to the different length of time for which milk yield was recorded after weaning in the two studies. Indeed, the rate of decline of milk yield of ewes suckling two lambs was slower after weaning and milk production continued to be higher for two to three weeks only (Economides, 1980) after the suckling stimulus was discontinued. The fat content of marketable milk of twin suckling ewes was lower during phase one (4.49 vs 5.03%) and phase two (5.0 vs 5.60%) than that of ewes suckling one lamb until weaning.

In agreement with the data of Owen, Davies and Ridgman (1967) and Economides (1988) the growth rate of lambs suckling continuously was the highest until weaning, because of higher milk consumption and hence higher energy intake from milk compared to solid feed. During this period, solid feed intake was inversely related to milk consumption. The supply of energy from increased solid feed intake, however, was not adequate to balance nutrients reduced from the lower milk energy intake. Following weaning, lambs on treatment S8 grew faster. Considering the whole period, however, growth rate was similar for all treatments.

Daily milk yield was not influenced by differences in the milking interval among suckling regimes. Similar results were reported by Morag and Fox (1967) with machine milked ewes producing about 0.6 kg of milk daily and milked at the same milking interval, as in this study i.e. (8-16, 12-12 and 11-13).

However, Morag and Fox (1967) reported that the apparent rate of milk secretion progressed when milking interval increased, whereas, in the present study the apparent rate of milk secretion was not influenced from the length of milking interval.

More time was spent daily to separate the lambs from their dams on treatment S24, since they were continuously mixed and had to be separated twice daily, whereas partially suckled lambs had to be separated once daily from their dams. Milking time was inversely related to the quantity of milk available in the udder. More time was required to remove the milk, from ewes on treatment S24 (2.80 min/kg milk), compared to those on treatment S8 (1.56 min/kg). The high labour cost for milking should be considered when a suckling regime is applied. In the present study the cost of marketable milk was 10.0, 6.75 and 5.55 cents per kg for treatments S24, S12 and S8, respectively.

Marketable milk, produced during the partial suckling period, was converted to fat corrected milk (6% fat; Mavrogenis and Papachristoforou, 1988), or to halloumi cheese using appropriate equations (Economides, Georgiades and Mavrogenis, 1987) to standardize quality and make comparisons on actual price value. Fat corrected milk (6%) was 167 and yield of halloumi cheese was 182% higher on treatment S8 than the corresponding values for milk on treatment S24. Assuming a price per unit fat corrected milk of 30 cents/kg and a cost of milking of 3.56 cents/min (actual labour cost at the ARI farm), the revenue per ewe during the partial suckling period was £3.41 higher for treatment S8 than that of treatment S24 (Table 6). Moreover feeding cost of lambs from 28 to 63 days was £2.22 higher for lambs on treatment S24 and realised revenue from the liveweight gain during the same period was £1.86 higher for lambs on treatment S8 (Table 6).

It may be concluded that the income from the sale of milk and lamb output until 63 days was higher in the partial suckling regimes. Moreover, reducing suckling time to only 8h daily shortens the working day of sheep dairy farmers without detrimental effects on the rate of milk secretion and the performance of lambs. However, the implementation of partial suckling in practice depends on the availability of labour for milking and facilities for the separation of lambs from their dams.
Table 6. Production of Fat corrected milk (6%), and halloumi cheese and income from the sale of milk and meat.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>$S_{24}$</th>
<th>$S_{12}$</th>
<th>$S_{8}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat corrected milk 6% (kg)</td>
<td>7.98</td>
<td>18.75</td>
<td>21.32</td>
</tr>
<tr>
<td>Halloumi cheese (kg)</td>
<td>1.52</td>
<td>3.64</td>
<td>4.30</td>
</tr>
<tr>
<td>Income from milk (£)</td>
<td>1.57</td>
<td>4.23</td>
<td>4.98</td>
</tr>
<tr>
<td>(Revenue from milk minus cost of milking)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income from meat (£)</td>
<td>7.27</td>
<td>7.55</td>
<td>9.13</td>
</tr>
<tr>
<td>(Revenue from liveweight gain minus feeding cost)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ACKNOWLEDGEMENTS

The authors wish to thank Mrs. M. Theodoridou, Mrs. N. Parouti and Mrs. M. Karavia for technical assistance.

REFERENCES


