# Effect of weaning system on lamb growth and commercial milk production of Awassi dairy sheep

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**ABSTRACT**: To determine the effect of weaning system on Awassi sheep milk production and lamb growth, 68 Awassi ewes and their lambs ($n$ = 104) were assigned to one of the following treatment groups a) after 3 days from birth (MIX), ewes were separated from their lambs during the evening for 15 h and milked once daily in the morning, and their lambs were allowed to suckle for 9 h during the day or b) ewes were not milked and suckled by their lambs (DY60) during the first 60 days of lactation. Ewes and their lambs were assigned to the groups according to ewe's age, parturition date, sex of the lamb and birth type. All lambs were weaned at 60 days of age and the ewes were milked twice daily. Milk yield was recorded fortnightly and milk fat composition was recorded monthly. The birth weight of lambs was recorded in the first 2 hours and they were weighed fortnightly until 240 days of age. Average lactation lengths (including suckling and milking) in MIX and DY60 group were similar (171.21 ± 5.40 and 168.36 ± 4.87 days, respectively). Differences between MIX and DY60 group in commercial milk yield (103.25 ± 7.93 and 63.59 ± 5.41 kg, respectively) and milk fat yield (5.88 ± 0.64 and 3.62 ± 0.31 kg, respectively) were highly significant ($P < 0.001$). Growth performance of lambs was similar in both groups ($P > 0.05$), however, male lambs were heavier and grew faster than female lambs until weaning ($P < 0.05$) and 90 days of age ($P < 0.001$). The effect of birth type at 210 days of age for the female lambs in MIX group was found to be statistically significant ($P < 0.05$) and the mean weight of single born female lambs was 40.39 ± 1.27 kg, and 41.09 ± 1.22 kg for twin born female lambs. The effects of ewe's age for female lambs in MIX and DY60 group and birth type for the lambs in DY60 group were insignificant ($P > 0.05$). These results show that Awassi lambs can be successfully reared in MIX suckling system and ewes produce more commercial milk than in the traditional rearing system (DY60), which offers a potential increase in economic return for Awassi sheep producers.

**Keywords**: Awassi sheep; lamb growth; milk yield; restricted suckling

Sheep milk producers are mostly located in the Mediterranean area. In this area, a dairy sheep rearing system relies on local sheep breeds that are well adapted to such an environment with local feed resources together. Sheep in most Mediterranean countries are kept for the production of both milk and meat (Akçapinar, 2000). Therefore, most breeding programs aimed at improvement of productivity have a twofold objective. Awassi sheep is a fat-tailed breed, found extensively in southern Turkey, Iraq, Syria, Lebanon, Israel, Jordan (Akçapinar, 2000), and there is about one million Awassi sheep in Turkey. Awassi sheep production is based on a semi-intensive system characterized by low prolificacy but by high milk production (Pollot and Gootwine, 2004). Nowadays dairy ewes produce a high amount of milk which exceeds the requirement for normal lamb growth (Bocquier et al., 1999; Pollot and Gootwine, 2004). Since the late 1960s several reports have been published about the consequences of different suckling systems in industrial dairy herds (Folman et al., 1966;

Gargouri et al., 1993; Sheath et al., 1995). Several mixed systems for early lactation management of ewes allowing both suckling and milking were also reported (Papachristoforou, 1990; McKusick et al., 2001). During the first 30 days of lactation a dairy ewe produces quite an important amount of total lactation milk yield (Folman et al., 1966); it is the period when lambs are typically allowed to suckle their dams. And the peak daily milk production typically occurs during the first month of lactation (Akçapinar, 2000) when in a traditional rearing system it is not possible to get this milk because of suckling. Therefore, a dairy sheep producer has to wait until weaning for the milking of ewes, which significantly reduces the income from a dairy sheep herd because of lower milk production (Gargouri et al., 1993; McKusick et. al., 2001). It has been reported for cattle rearing that mixed systems can be superior in terms of both cow and calf performance (Ugarte and Preston, 1975; Gaya et al., 1977). Total saleable milk yield is increased, mastitis is reduced and calves grow faster with fewer diseases and lower mortality. The benefits of this mixed system have been reported for several dairy sheep breeds and used extensively throughout the world for dairy ewes and goats (Caja and Such, 1991; Sheath et al., 1995; Garcia et al., 1998).

There is a lack of information on the effect of mixed suckling system on the lactation performance of Awassi ewes and growth traits of lambs in comparison with the traditional 60-day weaning system. Therefore, the objectives of this study were to compare commercial milk and fat yield during lactation and lamb growth traits under two different weaning systems for Awassi dairy sheep.

## MATERIAL AND METHODS

The experiment was conducted at the research farm of University of Uludag located in Bursa. After birth, according to ewes' age, birth type and sex of the lamb, a ewe and her lambs were assigned to one of the following treatments: (a) at 3 days of lamb age, ewes were separated from their lambs for 15 h during the evening and milked once daily in the morning and their lambs were allowed to suckle for 9 h during the day (MIX, $n$ = 34 ewes and their 52 lambs) or (b) ewes were not milked and they were only suckled by their lambs during the first 60 days of lactation (DY60, $n$ = 34 ewes and their 52 lambs). After the weaning period, MIX and DY60 lambs were weaned, and all ewes in the two groups were milked twice daily. Birth type, age of ewes and male to female ratio were similar in the treatment groups (Table 1). During the experiment only one lamb from MIX group died before weaning and two lambs died from DY60 group (at 90 and 150 days of age). Lambs in MIX and DY60 group were housed in straw bedded pens during the suckling period. During the lactation, all ewes were fed lucerne hay and a concentrate ration of 18% crude protein (CP) and 10.87 MJ/kg metabolizable energy (ME).

Lambs in MIX system were allowed to suckle colostrum for the first 3 days after birth. After receiving colostrum, lambs in MIX group were allowed to suckle their dams during the daytime hours from 08.00 to 17.00, afterwards they were separated for the evening in a nearby pen. MIX and DY60 lambs were weaned at 60 days of age. Birth weights in the two groups were similar (Table 2). All lambs had an *ad libitum* access to concentrate feed con-

Table 1. Lamb survival and data structure in MIX and DY60 group

| | MIX | | | | DY60 | | | |
|---|---|---|---|---|---|---|---|---|
| **Sex** | | | | | | | | |
| Male | 27 | | | | 26 | | | |
| Female | 25 | | | | 26 | | | |
| **Age of dam** | | | | | | | | |
| 2 years | 15 | | | | 15 | | | |
| 4 years | 19 | | | | 19 | | | |
| **Birth type** | | | | | | | | |
| Single | 16 | | | | 16 | | | |
| Twin | 36 | | | | 36 | | | |
| | weaning | 120 | 180 | 240 | weaning | 120 | 180 | 240 |
| Lamb survival (%) | 98.08 | 98.08 | 98.08 | 98.08 | 100 | 98.08 | 96.16 | 96.16 |

Table 2. Least-squares means ± SEM for lamb growth until 90 days of age according to the weaning system

| | MIX | | | | | | DY60 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BW | | WW | | day 90 | | BW | | WW | | day 90 | |
| | *n* | mean (kg) | *n* | mean (kg) | *n* | mean (kg) | *n* | mean (kg) | *n* | mean (kg) | *n* | mean (kg) |
| **Sex** | | | | | | | | | | | | |
| Male | 27 | 4.26 ± 0.13 | 25 | 20.21 ± 0.76 | 25 | 28.77 ± 1.04 | 26 | 4.56 ± 0.13$^{b}$ns | 24 | 21.35 ± 0.57$^{b}$ns | 24 | 30.42 ± 0.64$^{b}$ns |
| Female | 25 | 4.11 ± 0.87 | 24 | 18.41 ± 0.43 | 24 | 24.71 ± 0.56 | 26 | 4.01 ± 0.09$^{b}$ns | 26 | 18.26 ± 0.40$^{b}$ns | 26 | 24.92 ± 0.60$^{b}$ns |
| | $^{a}$ | ns | | * | | *** | | ns | | * | | *** |
| **Birth type** | | | | | | | | | | | | |
| Single | 16 | 4.62 ± 0.14 | 15 | 19.94 ± 0.79 | 15 | 27.53 ± 1.28 | 16 | 4.57 ± 0.21$^{b}$ns | 16 | 19.91 ± 0.73$^{b}$ns | 16 | 27.33 ± 0.86$^{b}$ns |
| Twin | 36 | 3.97 ± 0.71 | 34 | 19.02 ± 0.56 | 34 | 26.41 ± 0.75 | 36 | 4.19 ± 0.08$^{*b}$ | 34 | 19.94 ± 0.50$^{b}$ns | 34 | 28.15 ± 0.72$^{b}$ns |
| | $^{a}$ | *** | | ns | | ns | | *** | | ns | | ns |
| **Mother's age** | | | | | | | | | | | | |
| 2 years | 15 | 4.14 ± 0.15 | 15 | 18.58 ± 0.74 | 15 | 25.40 ± 0.84 | 15 | 4.11 ± 0.19$^{b}$ns | 15 | 19.0 ± 0.78$^{b}$ns | 15 | 26.37 ± 1.04$^{b}$ns |
| 4 years | 19 | 4.21 ± 0.90 | 19 | 19.77 ± 0.58 | 19 | 27.59 ± 0.89 | 19 | 4.39 ± 0.10$^{b}$ns | 19 | 20.29 ± 0.47$^{b}$ns | 19 | 28.49 ± 0.66$^{b}$ns |
| | $^{a}$ | ns | | ns | | $P = 0.10$ | | ns | | ns | | $P = 0.10$ |
| Total | 52 | 4.18 ± 0.07 | 49 | 19.33 ± 0.46 | 49 | 26.78 ± 0.65 | 52 | 4.31 ± 0.07$^{b}$ns | 50 | 19.93 ± 0.40$^{b}$ns | 50 | 27.89 ± 0.56$^{b}$ns |

MIX = lambs suckled their mothers for 9 hours a day until weaning; DY60 = lambs exclusively suckled their mothers until weaning, BW = birth weight, WW = weaning weight, Day 90 = live weight at 90 days of age, ADG = average daily gain

$^{a}$means within a trait in the same treatment groups, significance given below

$^{b}$means within a trait in different treatment groups, significance given in the same row

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$; ns = non-significant

taining 18% CP and 12.13 MJ/kg ME beginning at 15 days of age. After weaning, lambs were grouped in one drylot and started to consume 17% CP and 11.71 MJ/kg ME concentrate feed. When they were 3 months of age, male lambs were transferred into a fattening group. Female lambs were switched to a 15% CP and 10.04 MJ/kg ME concentrate ration in a group-feeding system until they were 240 days of age. Growth performances of ewe lambs were recorded until 240 days of age.

Individual ewe milk was sampled and production was recorded bi-weekly during the study. Milk fat composition analyses were conducted monthly. No attempt was made to sample or to measure suckled milk. Ewes were dried off when their total milk production from the a.m. and p.m. milking on a test day fell below 200 ml, in accordance with the international regulations for milk recording in sheep (ICAR, 1992). Total commercial milk production and total fat yield were estimated according to Thomas et al. (2000). The overall lactation percentage of milk fat was calculated by dividing total fat yield by total milk yield. Lambs were weighed at birth and fortnightly until weaning, and from 60 days of age to 240 days lambs were weighed monthly, from these measurements the age adjusted 90 to 240 day weights were calculated.

Least-squares means analyses of variance for ewe and lamb traits were conducted by the GLM procedure of JMP 5.1 (Desktop Statistical Discovery Software) (SAS, 2001). The following fixed effects were included in the models for lamb growth traits and lactation milk yield of weaning system (MIX, or DY60), birth type (single or twin) and age of ewe.

The following model was fitted to the data:

$$Yijk = \mu + WSi + BTj + agek + eijk$$

where:

*Yijk* = the milk yield for ewe in weaning system *i*, birth type *j* and age *k*
μ = the mean milk yield
*WS* = the effect of weaning system *i*
*BT* = the effect of birth type *j*
age = the effect of ewe's age (year) *k*
*eijk* = the random residual associated with each record

The fixed effect of sex (male or female) was additionally included in the models for lamb growth traits. All two- and three-way interactions were found not to be significant ($P > 0.05$) and they were excluded from the model. Lamb mortality data were analyzed by chi-square analysis using Fisher's exact test.

## RESULTS AND DISCUSSION

### Milk and fat yield

All ewes in MIX and DY60 weaning system lactated for a similar number of days (171.21 ± 5.40 and 168.36 ± 4.87 days, respectively), however the ewes in DY60 group had a shorter milking period than the ewes in MIX group ($P < 0.001$). It was so because the ewes in DY60 group were not milked during the first 60 days of lactation (Table 3). The ewes in MIX system produced higher total commercial milk yield ($P < 0.001$) and had higher average daily milk yield than the ewes in DY60 system ($P < 0.001$).

Milk fat yield was higher in the ewes in MIX group than in the ewes in DY60 group during the lactation period ($P < 0.001$), however no significant difference was found between the weaning system treatments in percentage of milk fat over the lactation period. Milk fat percentage was 3.83% in the ewes in MIX group during the first 60 days of

Table 3. Least-squares means (±SEM) of ewe lactation traits for MIX and DY60 group

| | Weaning system | |
|---|---|---|
| | MIX | DY60 |
| Lactation length (day) | 171.21 ± 5.40 | 168.36 ± 4.87 |
| Milking period (day) | 168.27 ± 2.73[a] | 110.18 ± 3.75[b] |
| Commercial milk yield (kg) | 103.25 ± 7.93[a] | 63.59 ± 5.41[b] |
| 60-day milk fat (%) | 3.83 ± 0.20 | – |
| 60-day milk yield (kg) | 33.10 ± 2.76 | – |
| Average milk yield (kg/day) | 0.634 ± 0.04[a] | 0.568 ± 0.04[b] |
| Milk fat (%) | 5.66 ± 0.10 | 5.72 ± 0.11 |
| Milk fat (kg) | 5.88 ± 0.64[a] | 3.62 ± 0.31[b] |

[a,b]Means within a row, and of an independent trait, are significantly different ($P < 0.001$)

lactation, which is the period before the weaning of ewes in MIX group (once daily milked). Before weaning, the ewes in MIX group produced about 52.05% more saleable milk than DY60 ewes (twice daily suckled) produced during the lactation.

Milking Awassi ewes once a day during the first 60 days of lactation rather than waiting to start milking until lambs are weaned at 60 days of age will result in a further 52.05% increase in saleable milk yield. This increase in milk yield is consistent with the results reported by Folman et al. (1966), Garguri et al. (1993), Peris et al. (1997) and Thomas et al. (2001). These findings demonstrate that the early lactation management of Awassi ewes has a great impact on overall lactation performance. The results showed that more commercial milk could be produced when Awassi ewes were milked once daily in addition to suckling during the first 60 days of age compared to ewes that were only suckled during this period. Commercial milk yield of Awassi sheep can be increased by the application of mixed management system.

Normal ewe milk contains a high milk fat percentage during early lactation (Noble et al., 1970). The ewe milk fat globule is larger than that of cow's milk fat (Muir et al., 1993) and it was reported that only 25% of fat was present in the cisternal milk fraction, while the largest amount (75%) remained in the alveolar milk fraction (Labussičre, 1969). Therefore, it was concluded that the cisternal milk fraction (with low milk fat) is available during milking and the alveolar milk fraction may need an active myoepithelial contraction (Linzell, 1955; Bruckmaier et al., 1994) to take out. But this alveolar milk is available to lambs during suckling (Marnet and Negrao, 2000) and it assists to lamb growth in MIX management system (McKusick et al., 2001), which is an important attribution of MIX management system. In this study, the percentage of milk fat during the first 60 days of milking period was low in ewes in MIX group (3.83%). Low commercial milk fat was reported in mixed management systems by several researchers in ewes (Fuertes et al., 1998; McKusick et al., 2001), in cows (Bar-Peled et al., 1995) and also in goats (Eik et al., 1999). The low milk fat content may be a result of some physiological mechanisms like milk ejection (Marnet and Negrao, 2000) and the lack of milk fat transfer from alveoli to the cistern (Bruckmaier et al., 1994) which was reported previously. Partial daily contacts of ewes with their lambs in MIX group should increase the stress associated effects and might result in the lack of milk fat transfer to the cistern.

## Lamb growth

There was no significant difference in birth weight (Table 2) between MIX and DY60 group. There was a tendency of lambs in DY60 group to have higher live weight (19.93 ± 0.40 and 27.89 ± 0.56 kg, respectively) than the lambs in MIX group (19.33 ± 0.46 and 26.48 ± 0.65 kg, respectively) at 60 to 90 days of age ($P > 0.05$). Growth and live weights of lambs up to 90 days of age were similar in the treatment groups. Birth weights of male and female lambs were similar ($P > 0.05$) but male lambs grew faster and were heavier than female lambs at weaning ($P < 0.05$) and at 90 days of age in both MIX and DY60 group ($P < 0.001$; Table 2). The lamb mortality rate from birth to 60 days of age was higher although insignificantly ($P > 0.05$) in MIX group (1.92%) compared with DY60 (0%) but the lamb survival rate (Table 1) was similar at 240 days of age in MIX and DY60 lambs (98.08 and 96.16%, respectively). During the suckling period and after weaning, live weights of lambs in MIX group were similar to those of lambs in DY60 group, which is consistent with Louca (1972) and Gargouri et al. (1993). Female lamb weights in MIX and DY60 group (Table 4) were similar at 120 days of age (30.48 ± 0.71 and 30.46 ± 0.72 kg, respectively) and 240 days of age (41.55 ± 0.91 and 40.30 ± 1.92 kg, respectively). The effect of birth type at 210 days of age in female lambs in MIX group was found to be statistically significant ($P < 0.05$) and the mean weight of single born female lambs was 40.39 ± 1.27 kg, and 41.09 ± 1.22 kg for twin born female lambs. The effects of ewe's age in female lambs in MIX and DY60 group and birth type in the lambs in DY60 group were insignificant ($P > 0.05$). These results show that MIX suckling system has no detrimental effect either on growth until weaning age or on female lamb growth up to 240 days of age. The application of MIX management system did not affect the long-term growth of female lambs ($P > 0.05$). Similar results were also reported for calves by Msanga and Bryant (2004). The ability of lambs to achieve high growth rates depends upon an adequate supply of milk and availability of high quality forage (Geenty and Sykes, 1983). Ewes that are milked once a day during the first 60 days of lactation also rear their lambs with no retardation of growth performance. This might

Table 4. Least-squares means ± SEM for female lamb growth from 120 to 240 days of age according to the weaning system (kg)

| | Day 120 | Day 150 | Day 180 | Day 210 | Day 240 |
|---|---|---|---|---|---|
| **Weaning system** | | | | | |
| MIX | 30.48 ± 0.71 | 32.75 ± 1.23 | 37.48 ± 0.89 | 40.85 ± 0.91 | 41.55 ± 0.91 |
| DY60 | 30.46 ± 0.72 | 33.40 ± 0.71 | 37.00 ± 0.81 | 39.12 ± 1.71 | 40.30 ± 1.92 |
| | | | **MIX** | | |
| **Birth type** | | | | | |
| Single | 30.43 ± 0.82 | 33.37 ± 1.01 | 36.85 ± 1.09 | 40.39 ± 1.27[a] | 41.89 ± 1.32 |
| Twin | 30.51 ± 1.01 | 32.45 ± 1.79 | 37.80 ± 1.25 | 41.09 ± 1.22[b] | 41.39 ± 1.23 |
| **Mother's age** | | | | | |
| 2 years | 29.82 ± 1.15 | 30.53 ± 2.80 | 37.60 ± 1.23 | 40.14 ± 1.11 | 41.30 ± 1.23 |
| 4 years | 30.87 ± 0.93 | 34.09 ± 0.96 | 37.42 ± 1.27 | 41.28 ± 1.30 | 41.71 ± 1.29 |
| | | | **DY60** | | |
| **Birth type** | | | | | |
| Single | 29.68 ± 1.56 | 33.47 ± 1.47 | 36.97 ± 1.62 | 40.08 ± 3.84 | 41.23 ± 6.06 |
| Twin | 30.88 ± 0.75 | 33.37 ± 0.80 | 37.03 ± 0.94 | 38.80 ± 2.38 | 39.54 ± 2.7 |
| **Mother's age** | | | | | |
| 2 years | 30.16 ± 1.19 | 32.80 ± 1.16 | 36.62 ± 1.42 | 40.32 ± 1.73 | 41.09 ± 1.80 |
| 4 years | 30.57 ± 0.90 | 33.63 ± 0.89 | 37.15 ± 1.01 | 38.95 ± 2.68 | 39.98 ± 3.66 |

[a,b]Means within a column are significantly different ($P < 0.05$)

be a result of creep feeding of all lambs and excellent rearing conditions available on the research farm. The 'dual purpose' attribution of MIX systems might also have an affect on the growth performance of lambs, which has been mentioned previously (McKusick et al., 2002).

In conclusion of this study, the application of MIX suckling system to Awassi sheep breeding had no detrimental effect on lamb growth performance either before weaning or until 240 days of age for female lambs. MIX suckling system can improve the profitability of dairy sheep enterprises (Thomas et al., 2001) by an increase in commercial milk yield (McKusick et al., 2001) for sale. Breeders should consider MIX suckling system as a means to get higher income from milk sale and to increase profitability of their farms. With excellent management and creep feeding of Awassi lambs, they would be successfully reared in MIX system with a higher income. Further study is needed to determine the effect of suckling method on the lifetime production ability of female lambs.

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