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SUMMARY

Data from 283 ewes and their offspring (413 lambs) weaned at 42 or 60 days, and 52 lambs slaughtered from 2 to 60 days of age were used in this study. Ewes weaned at 60 days produced more milk than those weaned at 42 days. In addition, twin-suckling ewes produced more milk than ewes suckling singles. However, commercial milk yield was slightly higher in ewes suckling single lambs. There were no differences in commercial milk yield between ewes weaned at 42 or 60 days post-partum. Carcass weight and weight of other body components of lambs slaughtered at 2, 42, or 60 days are presented. Regression equations predicting carcass weight from live weight were developed. Male lambs required less milk per unit of carcass gain than females and, similarly, twins required less milk than singles.

INTRODUCTION

The effects of quantity and feeding pattern of milk substitute and time of weaning on the performance of artificially reared lambs has been extensively studied (Ørskov et al., 1971; Morgan and Owen, 1972; Penning et al., 1973; Penning and Treacher, 1975). There is generally a negative correlation between daily milk allowance and concentrate feeding; restricted milk intake is compensated for by increased solid feed consumption during the milk feeding period. Lambs weaned at 6 weeks of age had better conversion of dry matter to liveweight gain compared with either earlier-weaned artificially-reared lambs (Penning et al., 1973) or later weaned suckling lambs (Ørskov et al., 1971).

In Cyprus, milk production will continue to be an important economic trait of sheep. Thus, every attempt to increase the quantity of milk sold without impeding the growth of lambs is of great importance (Louca, 1972; Lawlor et al., 1974; Hadjipanayiotou and Louca, 1976). Paradoxically, though meat production is usually insufficient in countries where sheep are used as dual purpose animals, lambs are often slaughtered at low live weight and at a time when the cost per unit carcass gain is high compared with slaughtering at higher liveweights.

The objectives of this work were to obtain data on the performance of Chios ewes and their lambs at two weaning ages and to study the efficiency with which milk is converted to lamb carcass.

MATERIALS AND METHODS

A total of 283 multipara Chios ewes and their offspring (413 lambs) were used. Fifty four ewes with 69 lambs and 229 ewes with 344 lambs were weaned at 60 and 42 days of age, respectively. Lambs were allowed to suck colostrum for the first 48h. Only lambs born as singles or twins were left with their dams. In the case of triplets or quadruplets only two lambs were left to suckle, and extra lambs were reared artificially on sheep milk.

Trial 1. Sixty - day weaning

Ewes suckling single or twin lambs were housed separately in adjacent pens. Lambs were allowed to suck continuously until weaning. From day 12 post-partum they were offered ad libitum a pelleted diet containing 16% crude protein, and lucerne hay.

Trial 2. Forty - two - day weaning

Ewes were allocated at 3 days post-partum to four groups on the basis of date of lambing, and each group had an approximately equal number of single or twin lambs, and male or female lambs. Lambs were allowed to suck continuously for the first 4 weeks. Partial suckling (8h daily) was practised thereafter until weaning. All lambs had free access to a pelleted diet containing 16% crude protein, and lucerne hay.

Milk yield of ewes and milk consumption of lambs were measured by the suckling technique (Had-

jipanayiotou and Louca, 1976) on day 13, 26 and 35 for lambs weaned at 42 days of age and on day 13, 26, 35 and weekly thereafter for lambs weaned at 60 days of age. All ewes were milked twice daily by hand to remove surplus milk. Each ewe was offered daily 1.0 kg of barley hay and 2.2 kg of a concentrate mixture containing 16% crude protein. Feed offered was measured daily and feed residues twice weekly. Liveweight of ewes was recorded at lambing and at weaning. Birth and weaning weights of lambs were also recorded.

A total of 46 suckling lambs were slaughtered. Sixteen lambs (8 males and 8 females) were slaughtered at 2 days, 20 lambs (13 males and 7 females) at 42 ± 4 days and 10 (5 males and 5 females) at 60 ± 4 days of age. Six more lambs reared artificially on sheep milk were slaughtered at 42 days of age. Three of these lambs were offered milk ad libitum whereas the other three were offered milk ad libitum until 4 weeks of age, and 1 kg daily in the following two weeks.

Lambs were slaughtered without prior fasting. Blood, skin, head, feet, organs and hot carcass weight were recorded. The digestive tract was weighed both full and empty. Carcass weight (International Standards, IS) was defined as body weight minus the head, feet, skin, alimentary tract and internal organs except kidneys and kidney fat. Carcass weight (Cyprus Standards, CYS) was carcass weight (IS) plus the weight of head and «liver». Weight of «liver» included spleen, heart, trachea, lungs, mesenteric fat and liver. Carcasses were hung in a cold room at 2° C for 24h and cold carcass weight was recorded. Rib-eye area was measured in chops which included the 12th rib. Fat thickness was measured at 3 points over the longissimus dorsi muscle. Dressing percentage was calculated as the ratio of cold carcass to live weight.

Standard statistical techniques (Steel and Torrie, 1960) were used in analyzing the data.

RESULTS

Liveweight changes, total milk yield, commercial milk yield and feed consumption of ewes weaned at 42 or 60 days post-partum are presented in Table 1. Rate of growth, milk consumption, milk to gain ratio and solid feed intake of lambs weaned at 42 or 60 days of age are presented in Table 2.

Carcass weight, carcass traits and other body components of lambs slaughtered at 2, 42 and 60 days are presented in Tables 3, 4 and 5. Prediction equations to estimate cold carcass weight from live weight of these lambs were calculated and are presented in Table 6.

The carcass weight of male lambs slaughtered at 2 days was heavier ($P<0.01$) than that of female lambs. Singles had also heavier ($P<0.01$) carcasses than twins (Table 7). As expected, lambs slaughtered at 60 days had a heavier carcass weight and higher carcass gain than lambs weaned at 42 days, and male or single lambs had heavier carcass weights and higher carcass gains ($P<0.01$) than female or twin lambs, respectively.

The amount of milk required to produce one unit of carcass weight was similar for lambs slaughtered at 60 or 42 days of age (Table 7). Male lambs required less milk to produce one unit of carcass weight ($P<0.01$) than female lambs, and twin lambs required less milk to produce one unit of carcass weight ($P<0.05$) than single lambs.

DISCUSSION

In dual purpose ewes, early weaning and partial suckling of lambs, without unduly affecting lamb growth, result in higher commercial milk yields (Hadjipanayiotou and Louca, 1976; Economides, 1980). In the present study ewes weaned at 60 days produced more milk than ewes weaned at 42 days, but commercial milk yield until weaning was similar because older lambs had the ability to consume all milk available in the udder. Additional commercial milk could be obtained from ewes weaned at 42 days during the period 43-60 days post-partum. Ewes weaned at 60 days suffered higher liveweight losses which, as expected, were higher in twin suckling ewes because of higher milk yield. In agreement with earlier reports (Treacher, 1978; Maxwell et al., 1979; Economides, 1980) ewes suckling twins and weaned at 42 or 60 days produced more milk than ewes suckling singles (24 and 31%, respectively). Lambs weaned at 60 days were heavier than those weaned at 42 days. Suckling until 60 days post-partum caused a delay in solid feed intake of lambs. In other studies lambs weaned at 42 days had a better feed conversion ratio than lambs weaned later (Ørskov et al., 1971; Penning and Treacher, 1975) and solid feed consumption was lower with higher

TABLE 1. Performance of ewes at 42 or 60 days post-partum.

	42 day weaning				60 day weaning			
	Type of birth				Type of birth			
	Singles	SD	Twins	SD	Singles	SD	Twins	SD
No. of ewes	114	-	115	-	39	-	15	-
Lambing weight (kg)	63.3	7.1	63.0	6.5	62.8	7.6	64.8	5.1
Liveweight change (kg)	-1.8	4.3	-2.3	3.9	-3.3	5.1	-5.1	3.9
Milk yield (kg)								
Total	108.0	23.4	134.0	30.3	139.0	22.4	182.0	33.0
Commercial	49.0	19.9	41.0	18.0	46.0	22.0	37.0	25.8
Feed consumption (kg)								
Concentrates	95	-	97	-	120	-	136	-
Hay	34	-	34	-	50	-	45	-

TABLE 2. Performance of lambs weaned at 42 or 60 days.

	42 day weaning				60 day weaning			
	Males	SD	Females	SD	Males	SD	Females	SD
No. of lambs	179	-	165	-	38	-	31	-
Birth weight (kg)	4.50	0.81	4.19	0.77	4.90	0.73	4.60	0.82
Weaning weight (kg)	15.60	2.91	14.0	2.33	22.1	3.85	18.90	2.43
Average daily gain (kg)	0.250	0.049	0.224	0.038	0.290	0.060	0.240	0.03
Milk sucked (kg)	53.0	15.2	51.0	14.1	85.0	20.6	83.0	16.20
Milk to gain ratio	4.85	0.84	5.20	1.03	5.0	0.94	5.8	0.83
Feed consumption (kg)								
Concentrates	2.0	-	2.0	-	3.0	-	3.0	-
Hay	1.0	-	1.0	-	1.0	-	1.0	-

milk intake (Gardner et al., 1964; Peart, 1968; Ørskov et al., 1971; Penning and Treacher, 1975).

Dressing percentage was similar at 42 and 60 days and higher than that at two days of age. Weight of head, heart, liver, lungs, blood and feet decreased, and that of tail, mesenteric, intestinal fat and full digestive tract increased from 2 to 60 days of age when expressed as a percentage of final liveweight.

Final liveweight was regressed on cold carcass weight of lambs slaughtered at different ages and the equations derived were used to calculate carcass gain using lambs slaughtered at 2 days as the initial slaughter group. All prediction equations showed that final liveweight accounted for 95 to 99% of the total variation in cold carcass weight (Table 7). The equations for suckling lambs slaughtered at around 42 days of age were calculated when milk consump-

TABLE 3. Carcass traits of lambs slaughtered at 2, 42, and 60 days

	Age at slaughter (days)								
	2			42			60		
	Mean	SD	Dressing[a] (%)	Mean	SD	Dressing[a] (%)	Mean	SD	Dressing[a] (%)
MALE LAMBS									
Hot carcass IS[b] (kg)	2.43	0.56	46.98	7.69	2.11	49.18	9.39	1.70	48.80
Hot carcass CYS[b] (kg)	3.09	0.63	59.63	9.30	2.43	59.50	11.30	1.96	58.60
Cold carcass IS (kg)	2.31	0.59	44.63	7.46	2.10	47.70	9.12	1.71	47.40
Cold carcass CYS (kg)	2.97	0.66	57.30	9.07	2.41	58.00	11.00	1.96	57.20
Rib-eye area (cm^2)	2.96	1.10	-	6.23	1.48	-	7.32	1.12	-
Fat thickness (mm)	-	-	-	-	-	-	0.87	0.51	-
FEMALE LAMBS									
Hot carcass IS (kg)	2.27	0.50	47.26	7.10	1.38	49.26	9.06	1.57	48.81
Hot carcass CYS (kg)	2.90	0.60	60.30	8.57	1.52	59.40	10.87	1.81	58.50
Cold carcass IS (kg)	2.11	0.47	43.89	6.87	1.34	47.67	8.78	1.50	47.31
Cold carcass CYS (kg)	2.74	0.57	56.90	8.34	1.48	57.90	10.59	1.74	57.00
Rib-eye area (cm^2)	2.54	0.82	-	6.22	1.13	-	7.71	0.55	-
Fat thickness (mm)	-	-	-	-	-	-	1.07	0.72	-

a $\frac{\text{carcass weight}}{\text{final weight}} \times 100$

b See Materials and Methods for definition

TABLE 4. Body components of male lambs slaughtered at 2, 42 and 60 days (kg)

	Age at slaughter (days)								
	2			42			60		
Body Component	Mean	SD	%[a]	Mean	SD	%[a]	Mean	SD	%[a]
Head	0.35	0.04	6.67	0.75	0.13	4.81	0.87	0.08	4.50
Sweet breads	0.01	0.01	0.25	0.08	0.03	0.53	0.07	0.02	0.34
Spleen	0.01	0.00	0.20	0.04	0.01	0.25	0.04	0.01	0.22
Heart	0.04	0.01	0.72	0.09	0.04	0.58	0.10	0.03	0.52
Liver	0.12	0.02	2.34	0.28	0.06	1.81	0.34	0.10	1.77
Trachea	0.01	0.00	0.23	0.06	0.04	0.37	0.05	0.01	0.24
Lungs	0.11	0.02	2.18	0.27	0.06	1.72	0.32	0.06	1.65
Kidneys	0.03	0.01	0.66	0.07	0.02	0.45	0.09	0.01	0.46
Kidney-fat	0.02	0.01	0.26	0.07	0.05	0.44	0.07	0.02	0.34
Tail	0.02	0.01	0.42	0.21	0.12	1.34	0.30	0.14	1.54
Mesenteric fat	0.02	0.01	0.32	0.12	0.02	0.74	0.18	0.02	0.91
Intestinal fat	0.01	0.00	0.14	0.07	0.05	0.45	0.09	0.05	0.47
Digestive tract (full)	0.48	0.14	9.19	2.57	0.35	16.40	3.15	0.50	16.35
Blood	0.30	0.06	5.86	0.84	0.20	5.35	0.92	0.20	4.78
Feet	0.22	0.03	4.32	0.46	0.08	2.97	0.56	0.07	2.90
Skin	0.78	0.16	14.99	1.73	0.30	11.08	2.44	0.48	12.70

a Percent of final weight

TABLE 5. Body components of female lambs slaughtered at 2, 42 and 60 days (kg)

	Age at slaughter (days)								
	2			42			60		
Body Component	Mean	SD	%[a]	Mean	SD	%[a]	Mean	SD	%[a]
Head	0.34	0.04	7.08	0.67	0.06	4.68	0.80	0.06	4.30
Sweet breads	0.02	0.01	0.48	0.06	0.02	0.42	0.07	0.01	0.37
Spleen	0.01	0.00	0.20	0.03	0.01	0.22	0.04	0.01	0.21
Heart	0.04	0.01	0.86	0.09	0.02	0.61	0.10	0.03	0.55
Liver	0.10	0.42	2.12	0.27	0.04	1.85	0.34	0.06	1.82
Trachea	0.01	0.00	0.28	0.04	0.01	0.27	0.04	0.01	0.23
Lungs	0.10	0.02	2.00	0.23	0.05	1.60	0.29	0.04	1.56
Kidneys	0.04	0.01	0.72	0.07	0.01	0.45	0.08	0.01	0.41
Kidney-fat	0.02	0.01	0.41	0.05	0.03	0.35	0.10	0.05	0.52
Tail	0.02	0.01	0.41	0.22	0.09	1.52	0.22	0.07	1.58
Mesenteric fat	0.03	0.01	0.51	0.14	0.02	0.96	0.18	0.03	0.95
Intestinal fat	0.01	0.00	0.13	0.07	0.04	0.48	0.14	0.06	0.77
Digestive tract (full)	0.42	0.14	8.82	2.28	0.17	15.79	3.40	0.58	18.31
Blood	0.31	0.09	6.53	0.78	0.12	5.41	0.87	0.12	4.69
Feet	0.22	0.03	4.60	0.41	0.07	2.83	0.48	0.08	2.58
Skin	0.74	0.12	15.45	1.62	0.24	11.25	2.12	0.35	11.44

a Percent of final weight

TABLE 6. Regression equations for prediction of carcass from liveweight

Age at slaughter (days)	Sex	International Standards	Cyprus Standards
2	Males	$\hat{Y}=-0.66+0.57X$	$\hat{Y}=-0.36+0.64X$
		$R^2=0.99$ N=8	$R^2=0.99$ N=8
	Females	$\hat{Y}=-0.29+0.50X$	$\hat{Y}=-0.17+0.61X$
		$R^2=0.98$ N=8	$R^2=0.99$ N=8
42	Males	$\hat{Y}=-1.28+0.56X$	$\hat{Y}=-1.10+0.65X$
		$R^2=0.99$ N=13	$R^2=0.99$ N=13
	Females	$\hat{Y}=-2.54+0.65X$	$\hat{Y}=-2.11+0.73X$
		$R^2=0.96$ N=7	$R^2=0.97$ N=7
60	Males	$\hat{Y}=-0.97+0.52X$	$\hat{Y}=-0.71+0.61X$
		$R^2=0.95$ N=5	$R^2=0.96$ N=5
	Females	$\hat{Y}=1.22+0.54X$	$\hat{Y}=-1.02+0.63X$
		$R^2=0.96$ N=5	$R^2=0.96$ N=5
42 and 60	Males	$\hat{Y}=-0.82+0.53X$	$\hat{Y}=-0.59+0.61X$
		$R^2=0.98$ N=18	$R^2=0.98$ N=18
	Females	$\hat{Y}=-0.85+0.53X$	$\hat{Y}=-0.54+0.61X$
		$R^2=0.96$ N=12	$R^2=0.96$ N=12

TABLE 7. Carcass gain and conversion of milk to lamb carcass (IS)

	42 day weaning				60 day weaning				
	Singles		Twins		Singles		Twins		
	Males	Females	Males	Females	Males	Females	Males	Females	SD
No. of lambs	70	52	104	104	17	22	26	16	-
Initial carcass weight (kg)	2.22	2.10	1.77	1.66	2.30	2.08	1.86	1.70	0.38
Final carcass weight (kg)	8.07	7.50	7.17	6.24	11.61	9.24	8.93	8.00	1.53
Carcass gain (kg)	5.85	5.40	5.40	4.58	9.31	7.16	7.07	6.30	1.43
Milk suckled per kg carcass gain	10.20	11.39	9.43	10.51	10.11	11.88	10.38	11.15	2.09

TABLE 8. Carcass gain and conversion of milk to carcass gain (CYS)

	20 day weaning				60 day weaning			
	Singles		Twins		Singles		Twins	
	Males	Females	Males	Females	Males	Females	Males	Females
Initial carcass (kg)	2.87	2.75	2.37	2.21	2.96	2.72	2.47	2.26
Final carcass (kg)	9.75	9.17	8.71	7.75	14.05	11.18	10.90	9.74
Carcass gain (kg)	6.88	6.42	6.34	5.54	11.09	8.46	8.43	7.48
Milk/carcass gain	8.67	9.58	8.03	8.69	8.49	10.05	8.71	9.39

tion was about 52 kg per lamb. To test further whether these prediction equations for carcass weight could be affected by the weight of gut contents at slaughter (since lambs were slaughtered without prior fasting) lambs were offered either 81 or 53 kg of milk and slaughtered at 42 days of age. The weight of the digestive tract plus contents (2.23 vs 2.16kg) or the weight of gut contents (1.40 vs 1.25kg) did not differ significantly at either level of milk intake. It can be concluded that the accuracy of prediction of carcass weight from liveweight is not influenced by the weight of gut contents of milk fed lambs consuming different quantities of milk.

Lambs weaned at 42 or 60 days converted milk to carcass with similar efficiency because solid feed intake was similar for both age groups. Twin lambs converted milk to carcass more efficiently probably because of lower liveweight and lower maintenance requirements or suckling milk of higher fat content. The amount of milk required per kg carcass gain ranged from 9.4kg (in male twin lambs) to 11.9kg (in female single lambs) using international standards for carcass weight, and 8.5 kg for male and 9.5 kg for female lambs (Table 8) using the Cyprus standards for carcass weight. Considering the price of sheep milk, the cost per kg carcass of

milk-fed lamb is extremely high and slaughtering at weaning is not justified, particularly when sheep are used as dual purpose animals.

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