African Journal of Agricultural Research Vol. 8(6), pp. 495-499, 25 February, 2013
Available online at http://www.academicjournals.org/AJAR
DOI: 10.5897/AJAR11.281
ISSN 1991-637X ©2013 Academic Journals

Full Length Research Paper

A novel method of analyzing rearing system on lamb growth and farm profitability

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Accepted 18 May, 2012

This experiment was conducted to compare the lamb growth performance under lamb suckling and milk replacer (MR) regimes. In total, forty four lambs (Cukurova Assaf (CA) and Cukurova Meat Sheep (CMS)) were consisted of the animal material. Artificial reared (AR) lambs were removed from ewes 2 days after postpartum and moved indoors. Lambs received calf milk replacer thrice daily until weaning at 6 weeks. At two weeks of age, all lambs had *ad-libitum* access to commercial lamb starter diet and alfalfa hay. Birth weight (BW), feed and MR intake were recorded and weight gain (WG) was measured at one week intervals. The group of AR lambs had heavier live weights and more rapid growth than suckled lambs until the end of 4th week. Weaning weights in the AR and ewe reared (ER) groups were 12.64 and 14.15 kg, respectively. Results showed an average daily weight gain (ADG) of 180 and 230 g for AR and ER, respectively. Genotype and rearing method was found statistically significant on ADG (P<0.05). Lamb survival at 91.7% was higher for AR than the 55% for ER (P < 0.001). These results show that lambs can be successfully reared with calf milk replacer at a lower cost than with ewe rearing.

Key words: Farm profitability, lamb, lamb survival, milk replacer.

INTRODUCTION

Under extensive or semi-extensive production systems, lambs are reared by nursing 60 to 75 days after birth and the ewes are not milked during this period. Different lamb rearing methods can be applied in order to provide the maximum marketable milk yield during the suckling period, thus to increase farm profitability (Keskin and Bicer 2002). Removing the lambs from the ewe and feeding milk replacer not only increasing marketable milk, it may in fact improve the total lactation milk production as the draw on the ewe maintains maximal milk synthesis (Martin et al., 1999). Milk replacer has been widely used in rearing lambs with the advantages of reducing milk feeding and labor costs and simplifying management (Heaney et al., 1982). Also, in the same time with good management, satisfactory lamb performance under artificial rearing can be achieved with high quality calf milk replacer or calf milk (Mc Kusick et al., 2001; Sevi et al., 2001).

It is very important to determine the optimum economic feeding period of lambs in small ruminant researches because feeds are 70% of the production cost (Ocak et al., 2007). For that purpose, regression analysis is commonly used to describe quantitative relationships between a response variable (net income) and an explanatory variable (feeding period) (Henderson, 1984). Therefore, the aim of study was to find out optimum feeding period of lambs with milk replacer by a mathematical function. Information on growth performance of lambs during pre-weaning, weaning period with milk replacer and lamb starter diet in comparison to ewe reared was lack. Thus, the purpose of the present

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Table 1. Lamb starter feed and alfalfa hay utilized in the experiment

	Concentrate ingredient	Forage
Maize (kg)	333	
Soy bean meal (kg) (46%)	40	
Wheat bran (kg)	146	
Cotton seed meal (kg) (26%)	150	
Maize germ meal (kg)	100	
Corn Gluten feed (kg)	150	
Razmol (kg)	0	
Molasses (kg)	50	
Limestone (kg)	24	
Salt (kg)	6	
Composition		
Crude protein (%)	16	11.6
Crude fat (%)	2.4	0.8
Crude cellulose (%)	8.8	34.52
Crude ash (%)	6.2	7.63
Moisture (%)	10	
Vit-Min. Premix (kg)	1	

experiment was to compare the effect of MR versus suckling on lamb growth and farm profitability.

MATERIALS AND METHODS

The experiment lasted for 42 days and was conducted on Cukurova Asaf (CA) and Cukurova Meat Sheep (CMS) that were born in 2009 lambing season, carried out at Cukurova University, Department of Animal Science in Adana, Turkey. 44 lambs were randomly assigned into ewe reared (ER) and artificial reared (AR) groups. 13 CA and 11 CMS lambs were AR while 9 CA and 11 CMS were ER. AR lambs were separated from their dams 2 days after parturition and housed in a separate straw bedded pen. CA artificially reared lambs consist of 10 twin born lamb, 3 single born lamb, 9 male and 4 female lambs while CMS artificially reared lambs consist of 6 single born and 5 twin born, 8 male and 3 female lambs. Control group of CA consist of 7 single born, 2 twin born, 4 male and 5 female lambs while CMS 3 single born, 8 twin born lambs, 4 female and 7 male lambs. All lambs were fed the same amount of diet containing 2400 kcal ME and 16% crude protein per kg. Compositions of lamb starter diet and alfalfa hay are given in Table 1.

The lambs in the control group (ER) were kept with their dams until an age weaning of 42 days, the artificially reared group was fed colostrum *ad libitum* for 2 days, and then lambs were separated from their mothers and given the milk replacer until 42 days old. A commercial calf milk replacer was used (Josera®) having guaranteed analyses of not less than 22% CP and 18% fat. Liquid milk replacer was prepared fresh daily and given at 37°C. Lambs were fed with milk replacer thrice a day. Both groups were given equal amounts of highly palatable 50 g starter feed and alfalfa hay at 14 days of age. The daily amount of concentrate per lamb was 75 g at the 3rd week, 100 g at the 4th week, 150 g at the 5th week and 200 g at the 6th week. The daily intake and the composition of milk replacer is shown in Table 2. ER lambs were allowed to be nurse their mother until an age weaning of 42 days. Animals were weight at 1 week interval. Average daily gains (ADG) were calculated from the differences of in weights.

Statistical analysis

The model below was used to determine if extending factors affected birth weight and live weight at different periods at the beginning and end of the experiment.

$$Y_{ijklm} = \mu + A_i + B_j + C_k + D_l + \varepsilon_{ijklm}$$

Where, Y_{ijklm} is live weights of lamb at the different periods (kg); μ : is mean of population; A_i is effect of ith diet type; B_j is the effect of jth genotype; C_k is the effect of kth birth type; D_l is the effect of lth sex, and ε_{ijklm} is random error.

Z-test was then applied to determine any further differences between the survival rate (%) for rearing method, genotype, birth type and sex. Moreover, in this study, cumulative net income for each period as weeks was based on weekly live weight increase of the lambs and feed consumption. The cumulative net income ($\hat{Y}_i$, \$/period) was assumed as dependent variable while the feeding period (*X*, week) was stated as independent variable in the regression model (Dagdemir et al., 2007). An analysis of regression was performed in quadratic function: $\hat{Y}_i = b_0 + b_1 X + b_2 X^2$ where b_0 is the constant, b_1 *and* b_2 are the regression coefficients (Minitab V. 13.20, 2000). To determine the optimum feeding period of CA and CMS lambs, derivative function was calculated by using the regression model and then the equation was equalized to zero. In conclusion, *x*-value calculated by derivative function can be used as optimum feeding period.

Table 2. Content of milk replacer and daily intake per lamb.

Chemical analyses		Age	Amount/lamb
Crude protein	22%	1 day	Colostrum
Crude fat	18%	2 day	Colostrum
Crude ash	9%	3 day	0.6 L/day
Crude fiber	1%	4 day	0.6 L/day
Lactose	36%	5 day	0.7 L/day
Calcium	0.8-1.4%	6 day	0.8 L/day
Phosphorus	0.85%	7 day	1 L/day
Magnesium	48 mg/kg	2 week	1.5 L/day
Zinc	40 mg	3 week	1.5-2. L/day
Selenium	0.4 mg	4 week	2.0-2.25 L/day
Lysine	1.75%	5 week	1.5-2.0 L/day
Vitamin A	48000 i.u.	6 week	1.0-1.5 L/day
Vitamin D3	2.000 IU		
Vitamin E	4000 IU		
Vitamin K3	6 mg		
Vitamin C	250 mg		
Vitamin B1	16 mg		
Vitamin B2	8 mg		
Vitamin B6	8 mg		
Vitamin B12	50 mcg		

RESULTS

Changes in live weights for lambs and ADG are presented in Table 3. Body weights of the lambs of the two groups were not statistically significant (P<0.05). The group of AR lambs had heavier live weights and more rapid growth than ER lambs until the end of 4th week. At 42 days of age, ADG and live weight of AR and ER were 181 g and 12.64 kg and 238 g and 14.15 kg, respectively. Birth type was statistically significant at the 6th week of age and single births body weight was higher than twins during the experimental period. Lamb survival at 91.7% was higher for AR than the 55% for ER (p>0.001). Genotype, birth type and sex had no significant effect on lamb survival rate. Female lamb's weekly live weight was lower than males and grew faster. Initial weight of AR lambs were greater than for ER lambs (p<0.001). In the first week following birth, AR lambs had more weight gain than ER lambs after which increased linear until 5 week of age.

Table 3 showed that birth type affected the live weight of lambs at six week of age during experiment period (p=0.046), and also the difference for lamb survival rate and daily weight gain between rearing methods was found to be statistically significant (p<0.001).

Determining a more profitable rearing system was the other goal of our study. The economic comparison of the system is given in Table 4. Although Table 4 indicated that the feed cost of the lambs fed milk replacer was higher than those in control group, the highest lamb survival rate in the treatment group compared to the control group caused an increase of 439.99 $ net income at the end of the experiment. Also, the estimated regression equation explaining the relationship between net income (*y*) and period (*x*) is as follows:

$$\hat{Y}_i = 278.56 - 201.79X + 36.58X^2$$

R^2 = 0.855

The estimated equation was derived according to *X* variable. After that the obtained equation was to zero ($y' = dy/dx = 0$), optimum feeding period was calculated as follows;

$$y' = -201.79 + 73.16x = 0$$

x = 2.76 week

Here, the optimum feeding period was calculated as 2.76 weeks when the equation was solved. This result presented that the optimum period was approximately 19 days for CA and CMS lambs which were fed via lamb milk replacer. These results also clinch our argument that the rearing regimes during growth periods are one of the most important factors for rantability.

AR also has an important contribution on milk production of the ewe. Rearing lambs with milk replacer increased marketable milk yield in CA and CMS sheep 63 and 29.4 l per sheep compared to the control group in 42 days, respectively. Total income from milk is calculated as 92.4$ per sheep for 42 days.

Table 3. Last-square means and standard errors of weekly live weight, ADG and lamb survival rate in lambs.

Investigated factors	Birth weight (kg)			Initial weight(kg)			BW at 1 week(kg)			BW at 2 week(kg)			BW at 3 week(kg)			BW at 4 week(kg)			BW at 5 week(kg)			BW at 6 week(kg)			ADG(kg)		Lamb survival (%)
	n	$\overline{X}$	$S_{\overline{x}}$	n	$\overline{X}$	$S_{\overline{x}}$	n	$\overline{X}$	$S_{\overline{x}}$	n	$\overline{X}$	$S_{\overline{x}}$	n	$\overline{X}$	$S_{\overline{x}}$	n	$\overline{X}$	$S_{\overline{x}}$	n	$\overline{X}$	$S_{\overline{x}}$	n	$\overline{X}$	$S_{\overline{x}}$	$\overline{X}$	$S_{\overline{x}}$	
Rearing method																										
AR	24	4.27	0.18	24	5.01[a]	0.20	24	5.70	0.24	23	6.53	0.32	22	7.89	0.41	22	9.25	0.50	22	10.69	0.58	22	12.64	0.70	0.18[b]	0.01	91.7[a]
ER	24	3.83	0.19	24	4.13[b]	0.20	19	5.23	0.26	18	6.39	0.31	18	7.69	0.37	18	9.20	0.50	18	10.79	0.59	11	14.15	0.59	0.23[a]	0.01	55.0[b]
P	0.094			0.004			0.189			0.753			0.726			0.947			0.902			0.176			0.037		<0.001
Genotype																										
CA	25	3.97	0.20	25	4.44	0.24	23	5.33	0.27	22	6.25	0.35	21	7.52	0.44	21	8.80	0.54	21	10.26	0.59	16	12.99	0.83	0.20	0.02	69.6
CMS	23	4.17	0.17	23	4.79	0.19	20	5.67	0.21	19	6.73	0.24	19	8.12	0.31	19	9.70	0.43	19	11.25	0.55	17	13.29	0.66	0.20	0.01	81.0
P	0.449			0.260			0.337			0.275			0.287			0.209			0.231			0.785			0.976		>0.05
Birth type																										
Single	22	4.21	0.20	22	4.78	0.26	20	5.62	0.28	19	6.55	0.36	18	8.08	0.41	18	9.52	0.53	18	11.12	0.59	13	14.33[a]	0.59	0.22	0.02	65.0
Twin	26	3.95	0.18	26	4.46	0.19	23	5.37	0.23	22	6.41	0.28	22	7.58	0.37	22	8.98	0.48	22	10.42	0.57	20	12.37[b]	0.72	0.19	0.01	83.3
P	0.339			0.319			0.484			0.750			0.377			0.446			0.402			0.046			0.145		>0.05
Sex																										
Male	31	4.09	0.15	31	4.73	0.99	27	5.59	0.21	25	6.60	1.35	25	7.97	0.36	25	9.55	0.47	25	11.07	0.53	24	13.08	0.65	0.20	0.06	82.8
Female	17	4.03	0.25	17	4.36	1.10	16	5.32	0.31	16	6.28	1.52	15	7.53	0.43	15	8.69	0.51	15	10.17	0.64	9	13.30	0.84	0.20	0.05	64.3
P	0.833			0.260			0.460			0.488			0.454			0.244			0.293			0.853			0.798		>0.05

[a,b]. Differences among treatment within same column.

Table 4. Average feed intake and feed cost for lambs.

Period (weeks)	n	Lamb replacer (L/week)		Feed cost ($/week/lamb)			Weight gain (kg/week)		Cumulative income ($/week)		Cumulative net income ($/week)
		Per lamb	Total	Per lamb	Total	n*	Per lamb	Total	Per lamb	Total	
1	24	3.7	88.8	0.86	20.76	5	5.70	28.50	19.89	99.47	78.71
2	23	10.5	241.5	2.46	56.67	5	6.53	32.65	22.79	113.96	57.29
3	22	12.3	270.6	2.87	63.14	4	7.89	31.56	27.54	110.14	47.00
4	22	14.9	327.8	3.49	76.70	4	9.25	37.00	32.28	129.25	52.42
5	22	12.3	270.6	2.87	63.14	4	10.69	42.76	37.31	149.25	86.11
6	22	8.8	193.6	2.06	45.27	11	12.64	139.04	44.11	485.26	439.99

1 kg live weight price: 3.49 $; 1 L lamb milk replacer price: 0.24 $; n* number of animals that were alive weekly.

DISCUSSION

ADG of AR and ER lambs (180 and 230 g, respectively) were higher than the 170 and 180 g obtained by Napolitano et al. (2002) on Comisano lambs, as well as 159 and 189 g reported for Barbaresca lambs by Lanza et al. (2006). Results from our study suggest that milk replacer intake thrice a day may be a reason for higher ADG.

Birth weight was higher than those reported by Emsen et al. (2004). The body weight was high compared with data from other references, such as 9.42 kg obtained by Emsen et al. (2004) for Awassi sheep weaned at 45 days of age, or 8.8 kg obtained by Baldwin (2000), in lambs weaned at 49 days of age from milk replacer. Relatively high body weight of 42 days of age is most likely due to the higher birth weight which provides an advantage for a higher weaning weight. Body weight of AR lambs at 4 weeks of age in this experiment was higher than those reported by Heaney et al. (1982). Similar to our findings, Yalcin et al. (1998) reported birth weight and weaning weight at 45 days for ER Awassi lambs 4.9 and 14.7 kg, respectively.

When data of lamb survival rate are compared, it was found that AR lambs (91%) were higher than ER (55%) in the present study. Lamb survival rate are affected from rearing method ($p<0.001$). Lamb survival rate were higher than those reported by Emsen et al. (2004) for similar aged lambs. Also Demiroren et al. (1995) found lamb mortality higher than our findings for Canadian, Suffolk, Qutaouais, Rideu and Finnsheep.

Conclusion

Lambs given milk replacer thrice daily had a higher growth rate and performance than did ER lambs and less lamb mortality. This system also allows a larger quantity of more ewe milk to be sold. In conclusion of this study, the application of artificial rearing system to crossbred sheep raising had no detrimental effect on lamb growth performance. Also growing lambs by milk replacer can improve the profitability of dairy sheep enterprises by an increase in commercial milk yield for sale. Breeders should consider this growth system as a means to get higher income from milk sale and to increase profitability of their farms.

REFERENCES

Baldwin RL (2000). Sheep gastrointestinal development in response to different dietary treatments. Small Rumin. Res. 35:39-47.

Dagdemir V, Demir O, Macit M (2007). Estimation of Optimum Fattening Period in Broiler. J. Appl. Anim. Res. 31:159-160.

Demiroren E, Shrestha JNB, Boylan WJ (1995). Breed and environmental effects on components of ewe productivity in terms of ewe productivity in terms of multiple births, artificial rearing and 8-month breeding cycles. Small Rumin. Res. 16:239-249.

Emsen E, Yaprak M, Bilgin OC, Emsen B, Ockerman HW (2004). Growth performance of Awassi lambs fed calf milk replacer. Small Rumin. Res. 53:99–102.

Heaney DP, Shrestha JNB., Peters HF (1982). Potential alternatives to lamb milk replacer for the artificial rearing of lambs. Canadian J. Anim. Sci. 62:1135–1142.

Henderson CH (1984). Applications of Linear Models in Animal Breeding. University of Guelph, Canada.

Keskin M, Bicer O (2002). Effects of milk replacer on kid growth and farm profitability in the Shami goat. Turkish J. Vet. Anim. Sci. 26:1133-1136.

Lanza M, Bella M, Priolo A, Barbagallo D, Galofaro V, Landi C, Pennisi P (2006). Lamb meat quality as affected by a natural or artificial milk feeding regime. Meat Sci. 73:313–318.

Martin J, O'brien A, Wand C (1999). Artificial Rearing of Lambs. Fact sheet. pp. 431–123.

MC Kusick BC, Thomas DL, Berger YM (2001). Effect of weaning system on commercial milk production and lamb growth of East Friesian dairy sheep. J. Dairy Sci. 84:1660–1668.

Minitab (2000). MINITAB Statistical Software, Release 13.20, Minitab Inc. State College, PA, USA.

Napolitano F, Cifuni GF, Pacelli C, Riviezzi AM, Girolami A (2002). Effect of artificial rearing on lamb welfare and meat quality. Meat Sci. 60:307-315.

Ocak S, Torun O, Guney O (2007). The Effect of Synchronization in Sheep on Rantabilty of a Farm. Hasad J. Anim. Sci. 23:0-53 (in Turkish).

Sevi A, Napolitano F, Casamassima D, Dell'aquilla S (2001). Effect of milk source on welfare and weight gain of lambs. Anim. Welfare 10:163–172.

Yalcin BC, Aktas G, Sandikcioglu M (1998). Effects of weaning at different ages on the growth of lambs and milk production of dams in the Awassi breed of sheep. J. Lalahan Agric. Fac. 3:45-55.