

Effects of Milk Replacer and Starter Feed on Growth Performance, Serum Biochemical Parameters, and Nutrient Apparent Digestibility in Mid-to-Late Lactation Lambs (Postprint)

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Abstract

This experiment was conducted to investigate the effects of feeding milk replacer and starter feed on growth performance, serum biochemical indices, and apparent nutrient digestibility in lambs during the mid-to-late lactation period. Seventy-five 30-day-old lambs with similar body weight were randomly allocated into 5 groups, with 3 replicates per group and 5 lambs per replicate. The groups were fed as follows: milk replacer 1 + starter feed (Group A), milk replacer 1 (Group B), milk replacer 2 (Group C), ewe milk + starter feed (Group D), and ewe milk (Group E). Body weight and body measurements were recorded at 30, 40, 50, 60, and 70 days of age; fecal samples were continuously collected for 3 days during days 68-70 to determine apparent nutrient digestibility; and jugular blood samples were collected at 70 days of age to measure serum biochemical indices. The results showed: 1) At 30, 40, 50, 60, and 70 days of age, Group D had higher body weight, body length, body height, and chest circumference than Groups A and E, Group E was higher than Group B, and there was no significant difference between Groups B and C ($P > 0.05$); however, during the 60-70 day period, the average daily gain of Group A was significantly higher than that of Group D ($P < 0.05$), and Group B was significantly higher than Group E ($P < 0.05$). 2) No significant differences were observed among groups in serum urea nitrogen content or activities of alanine aminotransferase, glutamyltransferase, and lactate dehydrogenase ($P > 0.05$); serum total protein and triglyceride contents in Group D were significantly higher than those in Group A ($P < 0.05$), and triglyceride content in Group E was significantly higher than that in Groups B and C ($P < 0.05$); no significant differences were found in serum albumin and globulin contents among Groups A, D, and E ($P > 0.05$), but Group D exhibited an increasing trend, and Group E was significantly higher than Groups B and C ($P < 0.05$); serum glucose content in Groups A,

D, and E was significantly higher than that in Groups B and C ($P < 0.05$); serum alkaline phosphatase activity in Group A was significantly higher than that in all other groups ($P < 0.05$); no significant differences were observed in the aforementioned serum biochemical indices between Groups B and C ($P > 0.05$). 3) Nutrient intake in Group A was significantly higher than that in Groups B and C ($P < 0.05$), with no significant difference between Groups B and C ($P > 0.05$); no significant differences were detected in apparent digestibility of dry matter, calcium, and phosphorus ($P > 0.05$); apparent digestibility of crude protein, gross energy, neutral detergent fiber, and acid detergent fiber in Group A was significantly higher than that in Groups B and C ($P < 0.05$), and no significant difference was observed between Groups B and C ($P > 0.05$). In conclusion, feeding milk replacer and starter feed exerted varying degrees of influence on growth performance, serum biochemical indices, and apparent nutrient digestibility in lambs, and the feeding regimen of milk replacer plus starter feed for lambs could achieve early weaning, demonstrating potential for practical application.

Full Text

Effects of Milk Replacer and Starter Feed on Growth Performance, Serum Biochemical Parameters, and Nutrient Apparent Digestibility in Lambs during Mid-to-Late Lactation

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Abstract: This study investigated the effects of feeding milk replacer and starter feed on growth performance, serum biochemical parameters, and nutrient apparent digestibility in lambs during mid-to-late lactation. Seventy-five 30-day-old lambs with similar body weights were selected and randomly divided into five groups with three replicates per group and five lambs per replicate. The lambs were fed as follows: milk replacer 1 + starter (Group A), milk replacer 1 (Group B), milk replacer 2 (Group C), ewe's milk + starter (Group D), and ewe's milk (Group E). Body weight and body measurements were recorded at 30, 40, 50, 60, and 70 days of age. Fecal samples were collected for three consecutive days to determine nutrient apparent digestibility between 68 and 70 days of age. Jugular venous blood samples were collected at 70 days of age to measure serum biochemical parameters. The results showed: 1) At 30, 40, 50, 60, and 70 days of age, the body weight, body length, body height, and heart girth of Group D were higher than those of Groups A and E, while Group E was higher than Group B, with no significant differences between Groups B and C ($P > 0.05$). However, during the 60-70 day period, the average daily gain of Group A was significantly higher than that of Group D ($P < 0.05$), and Group B was significantly higher than Group E ($P < 0.05$). 2) Serum urea ni-

trogen content and the activities of alanine aminotransferase, gamma-glutamyl transferase, and lactate dehydrogenase showed no significant differences among groups ($P>0.05$). Serum total protein and triglyceride contents in Group D were significantly higher than those in Group A ($P<0.05$), while triglyceride content in Group E was significantly higher than that in Groups B and C ($P<0.05$). Serum albumin and globulin contents showed no significant differences among Groups A, D, and E ($P>0.05$), though Group D had higher values; Group E was significantly higher than Groups B and C ($P<0.05$). Serum glucose content in Groups A, D, and E was significantly higher than that in Groups B and C ($P<0.05$). Serum alkaline phosphatase activity in Group A was significantly higher than that in other groups ($P<0.05$). All serum biochemical parameters showed no significant differences between Groups B and C ($P>0.05$). 3) The feed intake of various nutrients in Group A was significantly higher than that in Groups B and C ($P<0.05$), with no significant differences between Groups B and C ($P>0.05$). The apparent digestibility of dry matter, calcium, and phosphorus showed no significant differences among groups ($P>0.05$). The apparent digestibility of gross energy, crude protein, neutral detergent fiber, and acid detergent fiber in Group A was significantly higher than that in Groups B and C ($P<0.05$), while Groups B and C showed no significant differences ($P>0.05$). It is concluded that feeding milk replacer and starter feed has different effects on performance, serum biochemical parameters, and nutrient apparent digestibility in lambs. The feeding regimen combining milk replacer and starter feed can achieve early weaning of lambs and has certain practical value for application.

Keywords: lamb; milk replacer; growth performance; serum biochemical index; nutrient apparent digestibility

1. Materials and Methods

1.1 Experimental Animals Seventy-five 30-day-old lambs with similar body weights were randomly divided into five groups (A, B, C, D, and E) with three replicates per group and five lambs per replicate. The feeding regimens were as follows: Group A received milk replacer 1 + starter feed, Group B received milk replacer 1, Group C received milk replacer 2, Group D received ewe's milk + starter feed, and Group E received ewe's milk. The milk replacer groups were formulated to contain 25% crude protein, while the starter feed groups contained 27.2% and 25.2% crude protein respectively.

1.2 Feed Composition The composition and nutrient levels of the milk replacers and starter feed are shown in Tables 1 and 2.

1.3 Feeding Management The milk replacers used in this experiment were self-formulated according to the nutritional requirements of lambs, with uniform particle size. The ingredients included soybean, rice, milk powder, whey powder, vegetable oil, CaHPO_4 , limestone, NaCl , and premix. The soybean and rice were ground to pass through a 2.5 mm sieve, then mixed with the other ingredients

in a specific ratio (solid-to-liquid ratio of 4:1), blended for 1 minute, and stored for use. From 30 to 40 days of age, lambs were fed three times daily at 08:00, 13:00, and 17:00, with 1,500 g/d of milk replacer 1 per lamb. From 41 to 70 days of age, feeding frequency was reduced to twice daily at 08:00 and 15:00, with 2,000 g/d of milk replacer 2 per lamb. The starter feed was provided ad libitum.

1.4 Housing Management Lambs in the milk replacer groups were housed in individual pens, with five lambs per pen and each pen measuring 15 m². The ewe' s milk groups were kept with their mothers. All lambs had free access to water. During the experimental period, each lamb in the milk replacer groups received 1,000 g/d of starter feed, while the ewe' s milk groups received starter feed ad libitum.

1.5 Sample Collection Body weight and body measurements (body height, body length, and heart girth) were recorded at 30, 40, 50, 60, and 70 days of age. Between 68 and 70 days of age, fecal samples were collected for three consecutive days using the acid-insoluble ash method to determine nutrient apparent digestibility. At 70 days of age, 10 mL of jugular venous blood was collected from each lamb after a 12-hour fast. Serum was separated by centrifugation at 3,000 rpm for 10 minutes, and the supernatant was stored at -20°C for subsequent analysis. Serum biochemical parameters were measured using an automatic biochemical analyzer (Manon-K9840) according to national standards (GB/T 6432-94). Dry matter was determined by the 105°C drying method, crude protein by the Kjeldahl method, neutral detergent fiber and acid detergent fiber by the ANKOM-A2000i/A200i method, gross energy by the oxygen bomb calorimetry method (OR-2010, GB/T 213-2008), calcium by atomic absorption spectrophotometry (SP-3500/3800, GB/T 13885-2003), and phosphorus by UV spectrophotometry (UV-2800/2802, GB/T 6437-2002).

1.6 Statistical Analysis Data were analyzed using SPSS 20.0 software. One-way ANOVA and Duncan' s multiple comparison tests were used to determine significant differences among groups. Results are expressed as mean \pm standard error (mean \pm SE). Differences were considered significant at $P < 0.05$.

2. Results

2.1 Body Weight and Average Daily Gain As shown in Table 3, there were no significant differences in body weight among the five groups at 30 days of age ($P > 0.05$). At 40 and 50 days of age, the body weight of Group E was significantly higher than that of Group B ($P < 0.05$), while no significant differences were observed among Groups B, C, and E at 60 and 70 days of age ($P > 0.05$). At 50 and 60 days of age, the body weight of Group D was significantly higher than that of Group A ($P < 0.05$), but no significant differences were found between Groups A and D at 70 days of age ($P > 0.05$).

During the 30-40 day period, the average daily gain of Group E was significantly higher than that of Group B ($P < 0.05$), while no significant differences were observed between Groups B and E during the 40-50 day period ($P > 0.05$). During the 50-60 and 60-70 day periods, the average daily gain of Group B was significantly higher than that of Group E ($P < 0.05$), and the overall average daily gain of Group E was significantly higher than that of Group B ($P < 0.05$). During the 30-40 and 40-50 day periods, the average daily gain of Group D was significantly higher than that of Group A ($P < 0.05$), while no significant differences were observed between Groups A and D during the 50-60 day period ($P > 0.05$). During the 60-70 day period, the average daily gain of Group A was significantly higher than that of Group D ($P < 0.05$), and the overall average daily gain of Group D was significantly higher than that of Group A ($P < 0.05$). No significant differences in average daily gain were observed between Groups A and B throughout the experimental period ($P > 0.05$), though the overall average daily gain of Group A was significantly higher than that of Group B ($P < 0.05$). No significant differences in average daily gain were observed between Groups D and E during the 30-40 and 40-50 day periods ($P > 0.05$), but during the 50-60 and 60-70 day periods, the average daily gain of Group D was significantly higher than that of Group E ($P < 0.05$). No significant differences in body weight or average daily gain were observed between Groups B and C throughout the experimental period ($P > 0.05$).

2.2 Body Measurements As shown in Table 4, no significant differences in body height, body length, or heart girth were observed among the five groups at 30 days of age ($P > 0.05$). At 40, 50, 60, and 70 days of age, the body measurements of Group D were significantly higher than those of Group A ($P < 0.05$), while no significant differences were observed between Groups A and D at 70 days of age ($P > 0.05$). No significant differences in body measurements were observed between Groups A and B throughout the experimental period ($P > 0.05$), though Group A showed higher values. No significant differences in body measurements were observed between Groups D and E throughout the experimental period ($P > 0.05$). No significant differences in body measurements were observed between Groups B and C throughout the experimental period ($P > 0.05$).

2.3 Serum Biochemical Parameters As shown in Table 5, no significant differences in serum urea nitrogen content or the activities of alanine aminotransferase, gamma-glutamyl transferase, or lactate dehydrogenase were observed among the five groups ($P > 0.05$). Serum total protein, albumin, and globulin contents showed no significant differences among Groups A, D, and E ($P > 0.05$), though Group D had higher values. Serum total protein and globulin contents in Group E were significantly higher than those in Groups B and C ($P < 0.05$), while serum albumin content in Group E was significantly higher than that in Group B ($P < 0.05$). Serum glucose content in Groups A, D, and E was significantly higher than that in Groups B and C ($P < 0.05$). Serum triglyceride content in

Group D was significantly higher than that in Groups A, B, and C ($P < 0.05$), while Group E was significantly higher than Groups B and C ($P < 0.05$). Serum alkaline phosphatase activity in Group A was significantly higher than that in the other four groups ($P < 0.05$). No significant differences in serum biochemical parameters were observed between Groups B and C ($P > 0.05$).

2.4 Feed Intake and Nutrient Apparent Digestibility Due to the difficulty in collecting fecal samples from suckling lambs, this experiment only measured feed intake and nutrient apparent digestibility in Groups A, B, and C. As shown in Table 6, the dry matter intake of Group A was significantly higher than that of Groups B and C ($P < 0.05$), while no significant differences were observed between Groups B and C ($P > 0.05$). No significant differences in dry matter apparent digestibility were observed among the three groups ($P > 0.05$). The crude protein intake of Group A was significantly higher than that of Groups B and C ($P < 0.05$), and the crude protein apparent digestibility of Group A was significantly higher than that of Groups B and C ($P < 0.05$). No significant differences in neutral detergent fiber intake were observed among the three groups ($P > 0.05$), but the neutral detergent fiber apparent digestibility of Group A was significantly higher than that of Groups B and C ($P < 0.05$). No significant differences in acid detergent fiber intake were observed among the three groups ($P > 0.05$), but the acid detergent fiber apparent digestibility of Group A was significantly higher than that of Groups B and C ($P < 0.05$). The gross energy intake of Group A was significantly higher than that of Groups B and C ($P < 0.05$), and the gross energy apparent digestibility of Group A was significantly higher than that of Groups B and C ($P < 0.05$). The calcium intake of Group A was significantly higher than that of Groups B and C ($P < 0.05$), but no significant differences in calcium apparent digestibility were observed among the three groups ($P > 0.05$). The phosphorus intake of Group A was significantly higher than that of Groups B and C ($P < 0.05$), but no significant differences in phosphorus apparent digestibility were observed among the three groups ($P > 0.05$).

3. Discussion

3.1 Effects on Body Weight and Average Daily Gain The results of this experiment showed that during the 30-50 day period, lambs in Groups A, B, and C had lower body weights, while Groups D and E had higher body weights, consistent with previous research demonstrating that milk replacer feeding results in lower lamb body weights compared to ewe's milk feeding. This is primarily because the nutritional composition and digestibility of milk replacer differ from ewe's milk, affecting nutrient absorption and utilization. During the 50-60 day period, the body weight of Groups A, B, and C was lower than that of Groups D and E, but the average daily gain of Group E was significantly higher than that of Group D. During the 60-70 day period, the average daily gain of Groups A and B was significantly higher than that of Groups D and E, indicating that different feeding regimens affect lamb growth rates differently at various stages.

The improved growth performance in Groups A and B during the later period may be attributed to the successful transition to solid feed and adaptation to milk replacer, reducing digestive stress and improving nutrient utilization.

No significant differences in body weight or average daily gain were observed between Groups B and C, suggesting that the different protein levels in the two milk replacers (25% vs. 23%) did not significantly affect growth performance. This aligns with findings from previous studies showing that 25% crude protein in milk replacer is comparable to 21% and 29% crude protein levels. The body weight and average daily gain of Group A were higher than those of Group B, and Group D was higher than Group E, indicating that starter feed supplementation improved lamb growth performance. This is because starter feed provides additional nutrients, promoting rumen development and improving feed utilization efficiency.

3.2 Effects on Body Measurements Body measurements reflect the skeletal development and overall growth of lambs. In this experiment, the body measurements of Group D were higher than those of Group A, and Group A was higher than Group B, indicating that ewe's milk feeding resulted in better skeletal development than milk replacer feeding, and starter feed supplementation improved skeletal development. This is because ewe's milk contains more bioactive substances that promote growth and development. No significant differences in body measurements were observed between Groups B and C, consistent with the body weight results, further confirming that different protein levels in milk replacer did not significantly affect lamb growth.

3.3 Effects on Serum Biochemical Parameters Serum total protein, albumin, and globulin are important indicators of protein metabolism and nutritional status. In this experiment, no significant differences in serum total protein, albumin, or globulin were observed among Groups A, D, and E, but Group D had higher values, and Group E was significantly higher than Groups B and C. This suggests that ewe's milk feeding provided better protein nutrition than milk replacer feeding. Serum glucose content in Groups A, D, and E was significantly higher than that in Groups B and C, indicating that starter feed supplementation improved energy status. Serum triglyceride content in Groups D and E was significantly higher than that in Groups B and C, reflecting better fat metabolism in ewe's milk-fed lambs.

Serum alkaline phosphatase is a marker of bone metabolism and growth potential. The significantly higher alkaline phosphatase activity in Group A compared to other groups suggests that milk replacer + starter feeding may enhance bone metabolism. Serum alanine aminotransferase, gamma-glutamyl transferase, and lactate dehydrogenase are indicators of liver function and metabolic status, and no significant differences among groups suggest that different feeding regimens did not adversely affect liver function.

3.4 Effects on Feed Intake and Nutrient Apparent Digestibility Feed intake and nutrient apparent digestibility directly affect growth performance. In this experiment, the feed intake of various nutrients in Group A was significantly higher than that in Groups B and C, indicating that starter feed supplementation increased total feed intake. The apparent digestibility of dry matter, calcium, and phosphorus showed no significant differences among groups, but the apparent digestibility of gross energy, crude protein, neutral detergent fiber, and acid detergent fiber in Group A was significantly higher than that in Groups B and C. This suggests that starter feed supplementation improved nutrient digestibility, possibly by promoting rumen development and enhancing digestive enzyme activity.

The lack of significant differences in nutrient digestibility between Groups B and C indicates that different protein levels in milk replacer did not significantly affect nutrient utilization. The improved digestibility in Group A is likely due to the complementary effects of milk replacer and starter feed, which provided a more balanced nutrient profile and stimulated digestive system development. These results demonstrate that the combination of milk replacer and starter feed can effectively support lamb growth and development while facilitating early weaning.

4. Conclusion

Feeding milk replacer and starter feed affects lamb growth performance, serum biochemical parameters, and nutrient apparent digestibility differently. The feeding regimen combining milk replacer and starter feed can achieve early weaning of lambs and has practical value for application in lamb production systems.

References

- [2] GLIMP H A. Effect of diet composition on performance of lambs reared from birth on milk replacer[J]. *Journal of Animal Science*, 1972, 34(6):1085-1088.
- [3] RUEDA A, VALVERDE A, FERNANDEZ J A, et al. Biliary secretion in suckling goats: the effect of maternal milk and of a lamb milk replacer[J]. *Archives of Physiology and Biochemistry*, 1996, 104(2):239-245.
- [4] SARKER M B, ALAM M H, SAHA B K, et al. Effects of soybean milk replacer on growth, meat quality, rumen and gonad development of goats[J]. *Small Ruminant Research*, 2015, 130:127-135.
- [17] LEE H J, KHAN M A, LEE W S, et al. Growth, blood metabolites, and health of Holstein calves fed milk replacer containing different amounts of energy and protein[J]. *Asian Australasian Journal of Animal Sciences*, 2008, 21(2):198-203.
- [19] HERNÁNDEZ-CASTELLANO L E, MORENO-INDIAS I, MORALES-DELANUEZ A, et al. The effect of milk source on body weight and immune

status of lambs[J]. Livestock Science, 2015, 175:70-76.

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