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Original research article

Effects of weaning age on growth, nutrient digestibility and metabolism, and serum parameters in Hu lambs

Jianmin Chai [a], Qiyu Diao [a], Haichao Wang [a], Yan Tu [a], Xiaojing Tao [b], Naifeng Zhang [a, *]

[a] Feed Research Institute of Chinese Academy of Agricultural Sciences, Key Laboratory of Feed Biotechnology of the Ministry of Agriculture, Beijing 100081, China
[b] Jiangsu Taizhou Helen Sheep Ltd. Taizhou 225300, China

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ABSTRACT

This study was conducted to investigate the effect of weaning age on growth performance, nutrient digestion and metabolism, and serological indicators, and to obtain an optimal weaning age in Hu lambs. Forty-eight newborn Hu lambs (birth weight, 2.53 ± 0.14 kg) were randomly divided into 4 groups. The lambs in control group (ER) suckled their dams. The lambs in other three experimental groups were weaned on milk replacer at 10, 20, and 30 days of age (EW10, EW20, and EW30 groups), respectively. The results were as follows: 1) lambs in EW10 and EW30 groups had a lower ($P < 0.05$) ADG than those in ER group within 10 days post-weaning; the weaned lambs began to show a higher ($P < 0.05$) ADG than those in ER group after 20 days post-weaning. 2) EW10 and EW20 groups had a higher ($P < 0.05$) creep feed intake than EW30 and ER groups from 15 to 60 days of age. 3) The apparent digestibility of dry matter, organic matter, gross energy, nitrogen, ether extract and phosphorus, and the deposition of nitrogen and phosphorus did not differ ($P > 0.05$) among groups; however, the apparent digestibility and deposition of calcium in early weaned lambs were lower ($P < 0.05$) than those in ewe-reared lambs. 4) The albumin content in EW30 group was lower ($P < 0.05$) than that in ER group; the globulin content in EW30 group was higher ($P < 0.05$) than that in other groups; the content of serum insulin-like growth factor-I in weaned lambs tended to increase compared with lambs in ER group. Finally, the growth rate of lambs decreased within 10 days post-weaning, but early weaning boosted creep feed intake, leading to better growth and health later in life. The Hu lambs can be weaned on milk replacer and creep feed at 10 days of age.

1. Introduction

Early-weaning of lambs has become a key process for improving the efficiency and profitability of the intensive sheep husbandry. Weaning age, as one of the key parameters in early weaning, is crucial for the success of early-weaning of lambs (Teke and Akdag, 2012). Due to underdevelopment and rapidly growth of gastrointestinal tract, it is essential to obtain the best weaning age to minimize weaning stress and guarantee post-weaning healthy growth of lambs. Weaning lambs on milk replacer (MR) instead of solid feed has been steadily gaining ground. However, results on weaning age of lambs vary widely because of the diversity of feeding and management practices and the various genotypes of lambs. Lanza et al. (2006) weaned lambs at 1 day of age and fed them a MR. Yeom et al. (2002) carried out early weaning at 7 days of age. Most previous studies examined the growth rate for a single period, instead of focussing on the growth curve and nutrient metabolism of weaned lambs throughout their production cycle. In addition, weaning at different ages would result in different types of weaning stress, which would affect subsequent growth and health of lambs. It is necessary to find the optimal weaning age for the specific lamb under a specific feeding and management

* Corresponding author.
E-mail address: zhangnaifeng@caas.cn (N. Zhang).
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condition. Hu sheep are a prolific indigenous mutton breed in China. However, the weaning age of Hu lambs has not been fully examined (Chen et al., 2012). Therefore, we hypothesized that weaning the Hu lamb on MR at an appropriate age could minimize weaning stress and benefit their later growth. Thus, the objective of this study was to investigate the effect of different weaning ages on growth performance, nutrient digestibility, and serum parameters in Hu lambs, and to obtain an optimal weaning age for improving the efficiency and profitability of intensive Hu lamb production.

2. Materials and methods

The experimental procedure was approved by the Animal Ethics Committee of CAAS, and humane animal care and handling procedures were followed throughout the experiment. This study was conducted on the farm of Taizhou Helen Sheep Ltd. in Jiangsu Province, China (latitude 32°44′N, longitude 120°24′E), from October to December in 2013.

2.1. Experimental design, animal and diets

A single factor randomized design was applied and weaning age of lambs was taken as the experimental factor. Forty-eight Hu lambs (birth weight, 2.53 ± 0.13 kg; 24 males and 24 females) were selected based on their birth type, gender, and birth weight and randomly assigned into 4 groups. Each group had 3 replicates with 4 lambs per replicate. The lambs were ewe-reared (ER group), or early weaned at 10, 20 and 30 days of age (EW10, EW20, and EW30 groups) and fed a MR (Beijing Precision Animal Nutrition Research Centre, patent number ZL02 128844.5) until 60 days of age. All lambs had ad libitum access to a commercial textured creep feed from 15 to 60 days of age, and their creep feed intakes were recorded daily. The nutrient levels of ewe milk, MR, and creep feed are presented in Table 1. Each lamb was weighed at 10, 20, 30, 40, 50 and 60 days of age and average daily gains (ADG) were calculated.

2.2. Raising management

Ewe-reared lambs stayed with their dams during the whole experimental period but were not allowed to access the ewes' diet. Other weaned lambs were separated from their dams with 4 lambs in a 4 × 2 m^2 indoor pen. A 3-day adaptation was carried out to wean lambs gradually from their dams. During the adaptation period, MR was offered gradually according to the body weight of lambs (0.67% of BW for d 1, 1.34% of BW for d 2, and 2% of BW for d 3) before the ewe's milk was totally replaced. The amount of MR given after weaning was adjusted according to the lamb BW (approximately 2%) every 10 days with 3 times daily (0700, 1300, and 1900 h) from 10 to 50 days of age and then 2 times daily (0800, 1800 h) from 51 to 60 days of age. Before feeding, the MR was dissolved in hot water to obtain a 40 °C solution (16.67% dry matter) and offered to each animal with a milk bottle. Clean water was offered ad libitum throughout the trial.

Table 1
Nutrient levels of ewe milk, milk replacer and creep feed (DM basis).[1]

Item	Ewe milk	Milk replacer	Creep feed
DM, %	31.12	94.47	86.37
ME, MJ/kg	19.11	17.69	13.30
CP, %	24.71	24.80	19.58
EE, %	45.27	15.43	3.77
Ash, %	4.14	7.70	8.52
Ca, %	3.70	1.02	0.95
TP, %	0.72	0.66	0.70

DM = dry matter; ME = metabolic energy; CP = crude protein; EE = ether extract; TP = total phosphorus.

[1] Nutrient levels were measured except ME. Metabolic energy of milk replacer was calculated according to the results of Wang et al. (2015) and NRC (2007), and that of creep feed was calculated according to Table of Feed Composition and Nutritive Values in China 2012 and NRC (2007), and that of ewe milk was calculated according to the results of digestive and metabolic experiments in the current study.

2.3. Sampling and analyses

A digestibility and metabolism trial was carried out from 50 to 60 days of age with 4 lambs randomly selected from each group. Lambs were moved from the floor pens into individual metabolism crates at 50 days of age. During the digestibility trial period, the ewe-reared lambs were put back to their dams to ingest ewe milk about 10 min whereas the weaned lambs feeding with MR. After 5 days of adaptation, the amounts of feed intake, faeces and urine were recorded from 56 to 60 days of age. During this time, total faeces were collected and weighed daily. After thorough and uniform mixing, 10% of total faeces was taken and mixed with a few millilitres of 12 mol/L HCL solution. The faecal samples from each lamb were pooled over the 5-day collection period. Total urine was collected into a plastic container containing 100 mL of 12 mol/L HCL solution to maintain pH below 3, the volume was measured, and recorded daily. Then 20% of the total urine was collected and pooled after the 5-day collection period. Samples of feed orts, faeces and urine were frozen in the refrigerator at −20°C for further analysis. After the digestibility trial, the frozen feed, orts, and faecal subsamples were thawed overnight at room temperature and analysed for air dry matter by drying in an oven at 65°C for 48 h and ground through a 1-mm sieve. The samples were then analysed for dry matter by drying in an oven at 135°C for 2 h, organic matter by ashing at 550°C for at least 8 h, crude protein using the macro-Kjeldahl procedure that was calculated as 6.25 × N, ether extract using a reflux system (ANKOM XT15, America) with petroleum ether at 90°C for 1 h, gross energy through an isothermic calorimeter (6400 Calorimeter, Parr Instrument Company, Illinois, USA), calcium using an atomic absorption spectrometer (Czerny-Turner AAS8000, America), and phosphorus determined by the molybdenum blue colorimetric method (AOAC, 1999).

At 60 days of age, blood samples obtained from 4 lambs per group were collected in heparinized tubes by jugular venipuncture and centrifuged within 2 h at 1,040 × *g* for 15 min to obtain serum (which was then stored at −20 °C for further analysis). The serum concentrations of total protein, albumin, globulin, serum urea nitrogen (SUN), cholesterol, glucose, non-esterified fatty acid (NEFA), triglyceride and alkaline phosphatase (ALP) activity were determined using an automated analyzer (Hitachi 7600, Tokyo, Japan). Insulin-like growth factor I (IGF-I) concentration was determined using enzyme-linked immunosorbent assay (ELISA) kits (R&D System Inc., Minneapolis, MN, USA).

2.4. Statistical analysis

The data of ADG and creep feed intake were analysed using the PROC MIXED procedure of one-way ANOVA with repeated measures of SAS software and conducted double comparative using LSD method (Version 9.2, SAS Institute Inc., Cary, NC) according to the following model: $Y_{ijk} = \mu + T_i + M_j + TM_{ij} + C(T)_{ik} + \varepsilon_{ij}$, where Y was the dependent variable, μ was the overall mean, T was the effect of group, M was the age after birth, C was the effect of lambs, and ε was the residual error. Group differences were considered significant when $P < 0.05$ and tendencies were discussed when $0.05 < P < 0.10$.

Data for nutrient utilization and serum parameters were analysed as a completely randomized design using one-way analysis of