Meat Science 83 (2009) 577–583

Contents lists available at ScienceDirect

Meat Science

journal homepage: www.elsevier.com/locate/meatsci

Effect of suckling management on productive performance, carcass traits and meat quality of Comisana lambs

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ARTICLE INFO

Article history:
Received 10 February 2009
Received in revised form 20 May 2009
Accepted 13 July 2009

Keywords:
Lamb
Suckling management
Growth
Meat quality
Intramuscular collagen
Bone

ABSTRACT

The effect of restricted suckling on productive performance, carcass traits, meat quality and skeletal development of growing lambs was studied. Twenty-one naturally suckled male Comisana lambs were divided into three equal weight groups differing in suckling management systems: (1) only maternal milk (C); (2) only maternal milk until 15th day of age, and then, till slaughter, maternal milk, concentrate and Lucerne hay *ad libitum* (T1); (3) only maternal milk until 15th day of age, and then from 16th to 30th days of age, maternal milk, concentrate and Lucerne hay *ad libitum*, and, from 31st day of age till slaughter, only concentrate and Lucerne hay *ad libitum* (T2). The total mean milk yield was 22.7 and 41.6 kg per ewe for T1 and T2, respectively. Restricted suckling did not significantly affect slaughter weight, hot and cold carcass weights, carcass shrink losses, pH, colour and area of *Longissimus* muscle, pelvic limb, or bone characteristics. Suckling management system significantly affected ADG, milk intake, dressing percentage, and percentages of intestine, stomach, offal, kidney fat, shoulder, lean and fat, and there were differences in total collagen, and hydroxylysylpyridinoline crosslink concentrations. In addition, different IMC maturity among the muscles was apparent.

1. Introduction

The sheep industry in Italy is focused on milk production and 70% of the national flocks are represented by dairy sheep (de Rancourt, Fois, Lavín, Tchakérian, & Vallerand, 2006). Italian production of ovine meat derives from both suckling and light lambs produced mostly from specialized flocks of selected milk sheep breeds (Napolitano, Cifuni, Pacelli, Riviezzi, & Girolami, 2002a). Lambs, fed mostly with maternal milk, are slaughtered under the age of 65 days, with carcasses weighing less than 13 kg, typical of the Mediterranean area (Russo, Preziuso, & Verità, 2003). At least three factors are involved in maintaining such a low slaughter age: market demand for light carcasses from young animals (Martínez-Cerezo et al., 2005), precocity of lambs obtained from dairy sheep which makes lamb rearing uneconomic beyond that age (Polidori et al., 1995) and the need for farmers to obtain high amounts of milk for cheese making (Napolitano et al., 2002a).

In order to increase milk availability for cheese production and to improve total milk production, maintaining maximal milk production in the ewe (Martin, O'Brien, & Wand, 1999), farmers wean and separate lambs from the mothers at an early age. Weaning of domestic mammals is characterized by the replacement of milk by solid food. In sheep, suckling is a major factor in the strength of the ewe–lamb bond, and a decrease in milk production leads to the distancing of both partners (Orgeur et al., 1998).

The weaning process could be affected by the changes in the lamb's nutritional requirement, as well as the suckling management. Weaning of lambs before six weeks is unsuitable, even if the farmers of milk sheep breeds found earlier separation advantageous (Sevi & Casamassima, 2006). Early weaning and feed management affect welfare, food consumption, growth and meat characteristics of lambs (Napolitano, Braghieri, Cifuni, Pacelli, & Girolami, 2002b; Napolitano, Marino, De Rosa, Capparelli, & Bordi, 1995). In particular, the weaning period is stressful and it is a critical point for good health, productive performance and general management practices of lambs. Palazzo, Pizzo, D'Alessandro, and Casamassima (2005) reported that the administration of dry feed and a gradual decrease of milk intake from 10 to 15 days of age could facilitate early weaning by minimizing the stresses of diet change. The aim of the present study was to evaluate the effect of different maternal milk-feeding restriction regimes on performance, carcass traits, meat quality and skeletal development in Comisana lambs.

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doi:10.1016/j.meatsci.2009.07.008

2. Materials and methods

2.1. Animals

Animal handling followed the recommendations of European Union directive 86/609/EEC and Italian law 116/92 concerning animal care.

The trial was carried out on 21 Comisana suckling male lambs, born as singles in mid October, from 3-year-old dams of the same weight (50 ± 1.5 kg). The ewes selected for the experiment were homogeneous in terms of parity and of milk yield and milk protein and fat contents of previous lactations. During the experiment, all dams, reared indoors, were fed with 1.4–1.8 kg vetch/oat alfalfa and polyphitic hay and 0.8–1 kg of concentrate.

All lambs received only maternal milk until 15 days of age. After day 15, the animals were randomly assigned (adjusted for weight) to one of the three treatment groups: continued milk-feeding (C; $n = 7$); continued milk-feeding, only once in the morning, plus concentrate and Lucerne hay *ad libitum* (T1; $n = 7$); continued milk-feeding, only once in the morning, plus concentrate and Lucerne hay *ad libitum* until 30th day of age, and from 31st day exclusively with concentrate and Lucerne hay *ad libitum* (T2; $n = 7$). The control lambs were kept with their dams at 7 a.m. and at 5 p.m. The T1 and T2 groups were allowed to suckle the dams at 7 a.m. After feeding time each group was separated in a different nearby pen (3 m × 6 m). Lambs of group T1 and T2 had free access to a starter feed (18% crude protein and 6.62 MJ/kg DM) for an adaptation period of 15 days from 15th day of age, and free access to water from 15th day of age, too. The concentrate (Table 1), fed *ad libitum*, provided net protein, vitamin, and mineral requirements for the lambs (Progeo, Reggio Emilia, Italy).

T1 dams were hand-milked, only in the evening, from day 16 until the end of the experiment; while T2 dams were hand-milked, only in the evening, until the lambs were 30 days old, and subsequently twice a day (in the morning and in the evening) until the end of the experiment. Milk yield from each group was measured (in kg).

To evaluate milk consumption, lambs were individually weighed before and after each suckling bout every week (from 0 to 9). To calculate the average daily weight gain (ADG), lambs were individually weighed at the birth, at 15 and 30 days of age (in the morning after an overnight fast), and at slaughter. Moreover, average feed consumption for T1 and T2 experimental groups were calculated; amounts of feed offered were recorded and refused feed was weighed daily.

2.2. Slaughter surveys

Lambs were slaughtered at 63 days of age at a weight of 18 ± 3 kg typical for such animals in Italy. After an overnight fast lambs were electrically stunned, exsanguinated and processed (ASPA, 1991) at a local slaughterhouse.

Hot and cold carcasses, both with meat and offal, were weighed and dressing percentages were calculated, after dressing and chilling at 2-4 °C for 24 h, the empty body weight (EBW: bodyweight excluding contents of the gastro-intestinal tract) was determined.

Blood, skin and feet, and empty gastro-intestinal organs (stomach and intestines) were weighed and expressed as percentages of EBW.

Carcass shrink losses, calculated as the difference between hot and cold carcass weights, were expressed as a percentages of hot carcass weight.

After the refrigeration period (24 h at 2–4 °C), offal (lungs, trachea, heart, liver, spleen), head, kidney fat and the right shoulder and pelvic limb were removed (ASPA, 1991) weighed and expressed as percentages of cold carcass weight. The pelvic limb was dissected into the main tissue components (lean, subcutaneous and inter-muscular fat, bone, and remainder).

The following analyses were carried out on the *m. longissimus dorsi* (LD) between the 12th and 13th ribs: (1) pH measured 24 h post-mortem using a portable HI 9625 pH meter (Hanna Instruments, Padova, Italy); (2) tri-stimulus colour coordinates (L^*, a^* and b^*) were recorded using a Chroma Meter CR-300 (Italia s.r.l., Milano) 24-h post-mortem and hue angle ($H^* = \arctan(b^*/a^*)$) and chroma ($C^* = ((a^*)^2 + (b^*)^2)^{0.5}$) parameters were computed. Reflectance measurements were performed after the samples had oxygenated in air for at least 30 min by which time measurements were stable (Škrlep & Čandek-Potokar, 2006); (3) area measured by manually tracing muscles outlines onto acetate sheets and measuring areas by planimeter (Haff-Planimeter No. 317E).

Table 1
Chemical composition of concentrate fed to lambs.

DM (%)	88.45
Crude protein (% DM)	18.09
Diethyl ether extract (% DM)	4.95
Crude fiber (% DM)	12.22
Ash (% DM)	7.56
Nitrogen-free extract (% DM)	57.35
Hemicellulose (% DM)	10.57
Cellulose (% DM)	15.17
Lignin (% DM)	3.30
ADF (% DM)	18.46
NDF (% DM)	29.06
Starch and sugar (mg/kg DM)	3113.92
DL-α-tocopherylacetate(mg/kg DM)	17.00
Net energy (MJ/kg DM)	7.61

2.3. Collagen analysis

Mm. semimembranosus (SM), *gluteus biceps* (GB) and *semitendinosus* (ST) were removed from the left side of each carcass (after 24 h at 2–4 °C), vacuum packaged and stored frozen (−40 °C) until intramuscular collagen (IMC) analyses.

At analysis, muscle samples were thawed, trimmed of fat and epimysium, lyophilized for 48 h, weighed, and hydrolyzed in Duran tubes in 6 N HCl at 110 °C for 18–20 h (Etherington & Sims, 1981) for determination of hydroxyproline (Woessner, 1961) and crosslinking. IMC concentration was calculated, assuming that collagen weighed 7.25 times the measured hydroxyproline weight (Eastoe & Leach, 1958) and expressed as μg hydroxyproline/mg of lyophilized tissue. Hydroxylysylpyridinoline (HLP) concentration, the principal non-reducible crosslink of muscle collagen (McCormick, 1999), was determined using a modification (Maiorano, Manchisi, Salvatori, Filetti, & Oriani, 1999) of the HPLC procedure developed by Eyre, Koob, and Van Ness (1984); it was expressed as moles of HLP per mole of collagen and also as μg HLP/mg of lyophilized tissue (Maiorano et al., 2007).

2.4. Bone analysis

Right metacarpal (MC) and metatarsal (MT) bones were collected, cleaned of all connective tissue, and measured for length, diaphyseal diameter and weighed. Dry weight was recorded after 7 days at 100 °C in a drying oven for moisture determination. Left MC growth plate width was measured after silver nitrate staining (Maiorano et al., 1999) of 4 longitudinal slices 2 mm thick cut on the sagittal plane. Three width measurements per bone slice were made on different anatomical locations 1/4, 1/2 and 3/4 the distance across the bone slice with microscopic examination. Therefore, 12 measurements on each MC growth plate were averaged.