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Effects of suckling length (45, 75 and 120 d) and rearing type on cortisol level, carcass and meat quality characteristics in Kivircik lambs

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ABSTRACT

Forty lambs were used to investigate effects of suckling length and rearing type (single and twin) on welfare parameters, carcass and meat quality characteristics. SC-45 and SC-75 lambs were weaned at 45-d and 75-d of age, respectively, whereas SC-120 lambs were not weaned until slaughter age of 120-d. The elevated cortisol concentration due to weaning stress returned to pre-weaning level at 2-d after weaning. SC-120 lambs had higher daily gain, plasma cortisol and glucose levels at exsanguination, hot carcass weight, dressing percentage and fatness score than weaned lambs. Suckling length did not influence instrumental meat quality characteristics, except shear force. SC-45 lambs had tougher meat than other groups according to instrumental and sensory analyses. SC-75 and SC-120 lambs had similar meat shear force value and sensory scores. Single lambs had higher daily gain, and greater scores for carcass characteristics and sensory evaluation, and lower pH_{24} and shear force than twin lambs.

1. Introduction

Sheep production in developing countries of Near East, in some Mediterranean countries and also in Turkey is mostly performed by people living in rural areas, based mainly on the use of natural grassland, stubble and fallow pastures, and carried out traditionally by small family type enterprises (Gürsoy, 2006). In these countries, lamb meat and cheeses produced from sheep milk are being marketed as high quality products and are providing an important income for the poor producers. Moreover, the products of sheep production are maintaining the basic proteins of animal origin need of the people in rural areas (Gürsoy, 2006).

In various countries, the weaning and slaughter ages of lambs are changing according to the intensification level of sheep production, consumption habits and socio-economical status of the society. In Mediterranean countries like Spain, Portugal and Italy a production model, in which lambs are being slaughtered at very early ages (30–60 days) and low live weights and consumed as unweaned lambs, is widely practiced (Sañudo, Sanchez, & Alfonso, 1998). Also in these countries, some producers are weaning the lambs at very early ages (0–2 days) and artificially rearing them so as to get more milk from the ewes (Napolitano, De Rosa, & Sevi, 2008). In most of Turkey, the lambs are suckling their mothers until slaughter age. However, this production model is decreasing the total sheep milk needed for cheese production. Therefore, some sheep breeders are weaning the lambs at the age of 1.5–3 months so as to process sheep milk to more valuable products (Gürsoy, 2006). The production models, in which lambs are weaned at 0–2 days of age or slaughtered at very low live weights, are not being practiced in Turkey.

In sheep production, one of the most problematic issues concerning animal welfare is weaning stress (Kilgour, Waterhouse, Dwyer, & Ivanov, 2008). Numerous authors (Mears & Brown, 1997; Napolitano et al., 2008; Rhind, Reid, McMillen, & Palmarini, 1998) reported increase in vocalisation and plasma cortisol concentration due to weaning stress in lambs. On the other hand, suckling length or weaning status may affect carcass (Cañeque et al., 2001; Sañudo, Sierra, et al., 1998) and meat quality (Ekiz, Yilmaz, Ozcan, & Kocak, 2012; Velasco, Cañeque, Lauzurica, Pérez, & Huidobro, 2004) of lambs. The aim of the current study was to evaluate the influence of suckling length (45 d, 75 d and 120 d) on lamb growth, carcass and meat quality characteristics, level of plasma cortisol during the five days after weaning and levels of certain biochemical and haematological stress parameters at slaughter in single and twin reared Kivircik lambs.

2. Materials and methods

The research protocol of the current study was approved by the Ethic Committee of Istanbul University (Approval number: 05–28.01.2010).

2.1. Animals, experimental groups and handling procedures

The study was carried out at experimental sheep farm of Istanbul University Veterinary Faculty. The animals used in the study were 40 male, purebred Kivircik lambs. All the lambs born in the Faculty sheep

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farm were ear tagged and birth dates, birth types (single or twin), sexes, birth weights and identification of their mothers were recorded. After giving birth, the mothers were placed in a separate pen together with their lambs. In the first 45 days after birth all the lambs were kept together with their mothers. In this period the lambs received good quality alfalfa hay and concentrated feed in addition to their mothers' milk. So as to record growth characteristics the lambs were weighed once every week. When the average lamb age in the flock was 45 days, lamb material of the study were chosen according to their rearing type (single or twin), growth rate, health status, sex and birth date. The lambs chosen in the study were among the male ones which did not experience any health problems, always displayed live weight gain in consecutive weighings and born within the middle 14 days of the lambing season. The lambs used in the study were allocated to three different suckling duration groups according to age and weight. At the beginning of the experiment, mean lamb weight and age in the three groups were similar ($F = 0.026$, $P = 0.974$ for lamb weight; $F = 0.048$, $P = 0.953$ for lamb age). Moreover, in each research group half of the lambs were single reared.

Suckling length groups investigated in the current study were:

a. SC-45 group ($n = 14$): These lambs were weaned at 45 days of age and were fattened in a pen in the sheepfold with *ad libitum* good quality alfalfa hay and concentrated feed until slaughter at 120 days of age.
b. SC-75 group ($n = 14$): These lambs were weaned at the average age of 75 days. After weaning they were fattened in a pen in the sheepfold with *ad libitum* good quality alfalfa hay and concentrated feed until slaughter at 120 days of age.
c. SC-120 group ($n = 12$): These lambs were kept together with their mothers in a pen in the sheepfold until 120 days of age. In addition to their mothers' milk, they were fed with *ad libitum* good quality alfalfa hay and concentrated feed.

The lambs received concentrated feed with 16.9% crude protein and 2820 kcal/kg ME and alfalfa hay with 15.85% crude protein and 2070 kcal/kg ME.

2.2. Blood sampling and analyses

In order to investigate the effects of weaning age and rearing type on weaning stress, plasma cortisol concentrations were determined in heparinised blood samples taken on the day of weaning and on days 1, 2, 3 and 5 after weaning from the lambs of SC-45 and SC-75 groups. Plasma cortisol concentrations of SC-120 lambs, which suckled their mothers until slaughter, were determined in blood samples taken at 75-day of age. Blood sampling process was completed approximately within 1 min for each collection in order to avoid excessive stress.

Furthermore, certain haematological and biochemical parameters were determined in blood samples taken from each animal at exsanguination (EDTA samples for haematological analysis; heparinised samples for plasma cortisol and biochemical analysis). Samples taken into heparinised tubes were centrifuged at $1040 \times g$ for 15 min within 2 h of collection, and plasma was stored at −85 °C for further analysis. Packed cell volume (PCV) was determined by the standard capillary micro-haematocrit method and expressed in percentage. The total number of red blood cells (RBC) and haemoglobin (HGB) concentration were measured using haematology analyser (Abacus Junior Vet, Diatron, Austria). Neutrophile lymphocyte ratio (N/L) was determined using blood smears stained with Wright stain.

Cortisol concentrations in plasma were measured by using a diagnostic ELISA direct immunoenzymatic kit (DiaMetra, Foligno, Italy; Ref: DK0001; Lot No: 2186) and values were expressed as ng/ml. The sensitivity of the assay was 5 ng/ml. The intra- and inter-assay variations were 7 and 9.32%, respectively. Plasma concentrations of total protein (TP; Ref: 1001291; Lot No: D195), glucose (GLU; Ref: 1001192; Lot No: 172), creatine kinase (CK; Ref: 1001050; Lot No: 2188:T) and lactate dehydrogenase (LDH; Ref: 1001260; Lot No: 2216 T) were determined by a computer process-controlled multiparametric autoanalyser (TMS 1024, Tokyo-Boeki Medical System, Tokyo, Japan) using their accompanying commercial kits (Spinreact, Girona, Spain).

2.3. Transportation, slaughter procedures and carcass characteristics

When lambs reached 120-d of age, they were taken to the experimental abattoir of Istanbul University Veterinary Faculty, and were slaughtered at following morning according to the standard slaughter protocol in the experimental abattoir of the Veterinary Faculty at Istanbul University. Lambs were transported from experimental sheep farm to slaughterhouse as two batches (20 lambs per batches) by sheltered lorry. The lambs were loaded and unloaded individually by two experienced stockpersons. During loading of the lambs to the lorry one stockperson caught a lamb randomly in the home pen and carried it to the lorry for a distance of approximately 3 m by supporting abdomen of the lamb with two hands, and then handed the lamb to the second stockperson present in the lorry. The same lorry, driver and route were used for both transportation batches. Transport time was 45 min, and stocking density during transport was about 0.375 m^2/lamb. At the end of the transportation, one stockperson jumped into the lorry to unload the lambs. Stockperson in the lorry caught a lamb randomly and handed it to the second stockperson outside the lorry.

At the day of slaughter, pre-slaughter live weight was recorded after 12 h fasting with free access to water. Lambs were slaughtered after electrical stunning. After slaughter, non-carcass components (head, skin, feet, lungs and trachea, liver, heart, spleen, pancreas, gastro-intestinal tract and testicles) were removed, and then the hot carcass was weighed. In order to estimate empty body weight, gastro-intestinal tract content was removed, and the weight of empty gastro-intestinal tract was recorded. The carcasses were then chilled at 4 °C for 24 h, and then classified for fatness and conformation using 1–15 scales at 24 h after slaughter as described by Fisher et al. (2000). Chilled carcasses were then split along the vertebral column into left and right halves. *Longissimus muscle* (LM) section area and back fat thickness were measured between 13th thoracic and first lumbar vertebrae according to the description of Boggs and Merkel (1993).

2.4. Instrumental meat quality analyses

Carcass pH was measured on *longissimus thoracis* muscle between 12 and 13th thoracic vertebrae at immediately after dressing (pH_0) and at 24 h post slaughter ($pH_{24\,h}$) using a digital pH meter (Testo 205), equipped with a penetrating electrode and thermometer. pH meter was calibrated at abattoir 30 min before the slaughtering of first animal to measure pH_0, and at chiller temperature for measurement of $pH_{24\,h}$. At 24 h post mortem, *longissimus thoracis* muscle from the right side of the carcass was removed in order to assess water holding capacity (WHC), drip loss, cooking loss, shear force and meat colour. These samples were packaged under vacuum and then kept at 4 °C for 72 h.

In order to measure water holding capacity (WHC), modified Grau and Hamm method described by Beriain et al. (2000) was applied using 5 g meat samples. WHC was expressed as percentage of weight loss of 5 g meat samples, immediately after being kept under a pressure of 2250 g weight for 5 min. In the study, drip loss and cooking loss, which are indirect measures of water holding capacity, were also evaluated. Drip loss was determined on 19.7 to 23.6 g meat samples using the method described by Honikel (1998). Briefly, meat samples were weighed and then suspended in an inflated polyethylene bag without any contact with the bag. After a 24 h storage period at 4 °C, the samples were gently dried with paper towels, and reweighed. Drip loss (%) was