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ScienceDirect
Small Ruminant Research 68 (2007) 296–302
Small Ruminant Research
www.elsevier.com/locate/smallrumres

Effect of ewe's milk versus milk-replacer rearing on mineral composition of suckling lamb meat and liver

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Received 18 April 2005; received in revised form 16 September 2005; accepted 29 November 2005
Available online 18 January 2006

Abstract

The effect of ewe's milk versus artificial rearing on the mineral content of suckling lambs muscle and liver was investigated, using a practically non-destructive sampling of carcasses. Mineral content was determined by inductively coupled plasma atomic emission spectroscopy (ICP-AES).

Significant differences in mineral composition of muscle and liver were observed between the two groups belonging to each type of weaning. In muscle, these differences were mostly detected for Na, Zn and particularly Mn contents. As for the liver's mineral content, significant higher concentrations of K, P and Cu and lower amounts of Zn and Mn were observed in samples from ewe's milk reared lambs, when compared to those from hand reared ones.

Results obtained lead to the conclusion that mineral composition of suckling lamb's muscle and liver differed significantly according to the mineral intake of the ingested milk or formula. However, determination of the mineral content of either lambs' muscle or liver does not seem to provide an accurate and sensible method for discriminating between carcasses from either type of rearing.

Keywords: Suckling lamb; Meat composition; Liver composition; Mineral elements; Milk-replacers

1. Introduction

"Castilla y León" is the Spanish region with the largest sheep stock (ca. 6 millions), from which approximately 2.5 millions are slaughtered annually for human consumption. Most of these (ca. 60–70%) are suckling lambs 'lechales' with ages between 25 and 45 days and with a carcass weight of less than 7 kg, coming from milk production systems (Sañudo et al., 1998). The relevance and high edible quality of suckling lamb meat from Churra, Castellana and Ojalada breeds produced in the 'Castilla y León' region has been recognised, and thus protected, by a geographical indication: PGI 'Lechazo de Castilla y León' (Council Regulation 2081/92/EC).

Usually, after a few-days feeding with the calostrum, suckling lambs either remain with their mothers to suckling the ewes' milk or are reared with a milk-substitute. Apparently, rearing suckling lambs, with either type of feeding implies some differences, regarding economical aspects (Pérez et al., 2001), namely feed conversion and cost of feeding; meat quality (i.e. nutritional characteristics and eating quality) and animal welfare (De la Fuente et al., 1998; Sevi et al., 1999; Napolitano et al., 2002), supporting for either of those possibilities. Notwithstanding the possible advantages of milk-replacer rearing

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doi:10.1016/j.smallrumres.2005.11.010

systems, in regulations of several lamb meat quality labels, as the PGI 'Lechazo de Castilla y León' (Spain) – an European lamb meat quality label in which Churra is an authorised breed – it is required that suckling lambs are only fed with maternal milk, possibly to improve the last two aspects.

Minerals are essential trace nutrients in humans and animals. Meat is an important source of several minerals, namely iron, zinc and phosphorus, in the occidental diet. Also, it is recognised that mineral content can be responsible for technological properties of meat, i.e. colour, tenderness and oxidation. Mineral contents of sheep and lamb tissues have been reported by several workers (Hazell, 1982; Ono et al., 1984; Krełowska-Kułas, 1992; Studzinski et al., 1992; Hoke et al., 1999; USDA, 2002; Hoffman et al., 2003; Sheridan et al., 2003). However, to our knowledge, information regarding suckling lambs could not be found to date.

It has been reported in different experiments that mineral content of ovine (and of other animal species) tissues can vary considerably, and its concentration seems to be affected by genetic, physiological and environmental factors. Amongst non-genetic factors, the effect of dietary concentrations of elements and their chemical form, and the interactions with other nutrients have been the topics most researched (Wong-Valle et al., 1989; Medeiros et al., 1989; Pond, 1989; Grace and Lee, 1990; Ledoux et al., 1995; Sandoval et al., 1997; Pott et al., 1999; Reykdal and Thorlacius, 2001; Van Ravenswaay et al., 2001). In these cases, tissue accumulation of trace elements, namely Cu, Mo, Mn, Se, Zn, has been the main approach taken in explaining the observed variability on mineral content. Furthermore, the effect of growth promoters and hormones on mineral composition of ovine tissues has also been investigated (Gilka et al., 1989; Boila et al., 1990).

In this sense, the aims of this study were, on the one hand to determine the mineral content of two suckling lamb tissues (muscle and liver). Additionally, to investigate potential differences in the concentration of minerals in those tissues between ewe's milk and milk-replacer reared suckling lambs, using a practically non-destructive sampling of the carcasses, and then to evaluate the potential use of these differences to differentiate carcasses according the type of rearing.

2. Materials and methods

2.1. Samples

A total of 65 carcasses of breast reared suckling lambs 'lechales' from a regional breed 'Churra' and another 65 carcasses, from Churra 'lechales' hand reared with milk replacer, were randomly sampled in an industrial slaughterhouse during a 5 months period, and the mineral content of the antero-external part of the *brachiocephalic* muscle (ca. 20 g) was determined for these 130 carcasses. All carcasses used in the experiment originated from suckling lambs that were bred and reared in farms (25) affiliated to ANCHE–ANCHE is the biggest Churra breeders association in 'Castilla y León' with 128 farms and 82,000 sheep –, and had a live weight range of 9–12 kg.

Moreover, 10 of all those 65 muscle portions from each type of rearing where randomly chosen for determining their proximal composition. And finally, 10 livers from the 65 carcasses of suckling lambs reared with ewe's milk and other 10 from the 65 animals reared with milk replacer were randomly collected for the determination of mineral content and proximate composition. Muscle and liver samples were homogenised and frozen at −40 °C until the analysis were performed.

In addition, samples of the five different commercial milk replacers used by ANCHE, were analysed. The proximate composition of the milk substitutes according to their labels, was: moisture, 4–5%; crude protein 23–24%; crude fat, 23–25%; ash, 6.6–8.6%; starch, 0–3%; crude fiber, 0–0, 5%; the ingredients: powdered milk and milk solids, vegetable fats and oils, products and subproducts from cereals, mineral supplements, i.e. iron and copper and Vitamins, i.e. E and A.

2.2. Nutritional analysis

Moisture (ISO, 1973), fat (AOAC, 1999a) and protein (AOAC, 1999b) contents of muscle and liver were determined according to methods recommended by international organizations. Additionally, livers' pH was determined potentiometrically.

Regarding mineral content, duplicate aliquots of approximately 1 g (±0.01) of powdered-milk replacer, muscle or liver were accurately weighed, and digested with 10 mL of concentrated HNO_3 in tightly closed screw cap glass tubes, for 12–18 h at room temperature and then for a further 4 h, at 90 °C. Five millilitre of the mineralised solutions were diluted 1:2 (v/v) with deionised water for the analysis of Cu, Mn, Zn, Fe, Ca and Mg, or 1:10 (v/v) for the analysis of Na, K and P. Mineral content were determined by inductively coupled plasma atomic emission spectroscopy (ICP-AES) with a Perkin-Elmer Optima 2000 DV equipment. Instrument operating conditions were: radiofrequency power, 1400 W; plasma gas flow, 15.0 L/min; auxiliary gas flow, 0.2 L/min; nebulizer gas flow 0.75 L/min, crossed-flow;