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Sheep fed only silage or silage supplemented with concentrates 2. Effects on lamb performance and fatty acid profile of ewe milk and lamb meat

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ABSTRACT

Production performance of ewes fed only silage, or silage supplemented with a maximum of 50% concentrates (barley, peas, rapeseed cake), from mid-gestation until weaning was evaluated during two years. Lambs had access to the same diets as their dams while nursing. Ewe milk samples were collected at weeks 2 and 4 after lambing to evaluate the dietary influence on the fatty acid (FA) profile. After weaning, lambs from each ewe feeding programme either continued on the same diet or were switched to the other and the study continued for an additional five weeks year 1 (Y1) and seven weeks year 2 (Y2). Feed intake, weight gain and body condition of the lambs were recorded. At slaughter, muscle samples were taken to study the FA profile. The silage fed during Y2 was lower in crude protein content and contained more indigestible neutral detergent fibre and a higher amount of acids than the silage fed in Y1. The intake level of the lambs, particularly those fed only silage, was generally lower in Y2. In both years, weight gain was highest in the lamb groups fed concentrates after weaning and lowest in the group fed only silage. The FA profiles of milk and lamb muscle were influenced by the diet and nutritional status of the ewes. Milk from silage-fed ewes was higher in C18:3n-3 and conjugated linoleic acid, whereas milk from concentrate-fed ewes was higher in C18:0 and C18:2n-6. In Y1 the muscle of lambs fed concentrates pre-weaning had lower C16:0 and higher C18:1*c*-9 levels. The influence of diet on lamb muscle FA profile was less pronounced in Y2. In both years the C18:3n-3 levels were lower in muscle from lambs fed concentrates. In conclusion, the FA profile of lamb muscle was strongly influenced by the ewe diet and milk FA profile. Lambs on the same pre-weaning diet had a more similar profile than lambs with the same post-weaning diet. Feeding intensity and duration were the factors influencing the lamb muscle FA profile. A diet with only silage produced meat with a higher proportion of n-3 FA beneficial for human health; however, the lamb nutritional requirements for optimal growth were difficult to meet even with high-nutrient-quality silage.

1. Introduction

A two-year study was undertaken in which ewes and their lambs were fed only silage, or a ration of silage with added concentrates. The aim was to study animal performance on a purely forage-based ration; this approach is sometimes used in Swedish sheep production, mainly in

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organic farming. This paper presents results for the lambs; the ewe results are reported in Bernes and Stengärde (submitted for publication).

In lamb meat production it is important that the lambs grow well, and a high feed intake that meets the nutritional requirements for optimal growth is required. Forage intake in lambs is closely related to fibre content of the forage and also to the fibre digestibility (Bernes et al., 2008; Jung and Allen, 1995). Particle size and dry matter (DM) content are other factors that may influence forage intake (Beaulieu et al., 1993; Fitzgerald, 1996a). In addition, the fermentation quality and content of acids affect voluntary feed intake (Gherardi and Black, 1991; Rooke, 1995). The inclusion of concentrates in a forage-based ration mostly leads to higher nutrient intake and higher weight gain, as reported in several studies (Fitzgerald, 1996b; Jabbar and Anjum, 2008).

Many studies have concluded that the fatty acid (FA) composition of both milk and meat are influenced by the animal's diet. Oilseeds can provide an energy-dense source of protein which can be utilized to compensate for the negative energy balance experienced during early lactation and also to influence the FA profile of milk. Generally, the addition of a ruminal available oil source results in a decrease in *de novo* synthesis, while incorporating ≥C18:0 FA provided by the oilseed. Oilseeds tend to cause a decrease in the levels of saturated fatty acids (SFA) and a concurrent increase in monounsaturated fatty acids (MUFA) in milk, with slight increases in polyunsaturated fatty acids (PUFA) (Chilliard and Ferlay, 2004).

The influence of the ewe's diet on the milk FA profile consequently influences the offspring. As long as the lambs are suckling, their tissue FA composition is largely dependent on the dam's diet (Valvo et al., 2005). Bas and Morand-Fehr (2000) reported that this influence can linger for several months post-weaning.

As with the effects during lactation, oilseeds fed during the finishing period increase the daily caloric intake of lambs and can influence the FA profile of the tissue. Oilseeds high in C18:2n-6 decrease tissue concentrations of C16:0 and increase the C18:2n-6 level, depending on the extent of biohydrogenation in the rumen (Sinclair, 2007). In general, lamb meat, like all ruminant meat, is considered to be high in SFA and to have a low PUFA/SFA ratio. Changes in the PUFA/SFA ratio can be achieved through manipulation of rumen fermentation and selecting feedstuffs that increase the proportion of desirable FA in the meat (Sinclair, 2007). Human health recommendations encourage increased intake of n-3 FA, specifically C20:5n-3 and C22:6n-3 (Smit et al., 2009).

The objective of this study was to determine the effect of pre- and post-weaning diet on lamb growth performance and the subsequent effect of diet on the FA composition of lamb muscle. The influence of diet was based partly on the milk FA profile, as influenced by the ewes' diet during nursing, and partly on the lambs' post-weaning diet. The influence of the different feeding periods was assessed based on changes in the lamb muscle FA profile after a diet cross-over at weaning.

2. Material and methods

2.1. Experimental plan

During two years (Y1 and Y2), lambs were used in a study where a diet with only silage was compared to one with silage and concentrates. The mothers of the lambs had been fed similar diets in adherence to organic production protocols, which limit the inclusion of concentrates to 50% of the DM intake, as described by Bernes and Stengärde (submitted for publication). The ewe treatments are referred to as CON (silage + concentrates) and SIL (silage only). The concentrates fed during lactation included, on average, 40% barley, 40% peas and 20% rapeseed cake. Half of the lambs from each ewe group were switched to the alternate diet after weaning. The lamb treatments were:

SS = only silage both pre- and post-weaning.
SC = only silage until weaning, silage plus concentrates thereafter.
CC = silage plus concentrates both pre- and post-weaning.
CS = silage plus concentrates before weaning, only silage after.

2.2. Animals and housing

The flock consisted of White Swedish Landrace/Texel crossbreeds with an adult ewe weight of around 80 kg. The sheep were kept in straw-bedded pens in an uninsulated building. The lambs were born in mid-March. On the day of weaning, the lambs were aged, on average, 66 days (s.e. 1.0) in Y1 and 69 days (s.e. 1.2) in Y2. In Y1, 23 ewe lambs and 34 ram lambs were included in the study. In Y2, 36 ram lambs were used. After weaning the lambs were blocked according to sex (Y1 only) and weight (heavy, medium and light) so there were two pens for each sex and weight group from each pre-weaning treatment. One of these pens then was switched over to the alternative feeding regime. At the beginning of the post-weaning period there were 24 pens in Y1 and 12 pens in Y2, each containing two or three lambs.

After weaning the lambs were allowed one adaptation week. Thereafter, in Y1, data were collected for a period of five weeks before all ram lambs were slaughtered. In Y2, data were collected for a period of seven weeks after adaptation. At the end of the experiment in Y2, five or six of the heaviest lambs per treatment were slaughtered in order to obtain samples for FA analysis. All slaughtering and carcass grading was conducted at a commercial abattoir.

In both years the mean indoor temperature during the feeding experiment was estimated to be 17 °C with a minimum of 9 °C. The maximum temperature in Y1 was 23 °C, and in Y2 it was 28 °C.

2.3. Feeds

All rations in the study complied with the Swedish organic production regulations (KRAV, 2010). The silage fed during both years was dominated by grass. In Y1 all silage was from the same field and was produced in round bales, which were coarsely chopped before feeding. The silage used in Y2 was precision-chopped and came from three different clamps, each from a single field.

Before weaning the lambs received the same feeds as their dams. Their feed intake was not recorded during this period. The concentrates consisted of whole barley, crushed peas and cold-pressed rapeseed cake (Ekologisk rapskaka, Vegolia AB, Sweden). Before weaning the rapeseed amounted to 20% of the concentrates in Y1 and 35% in Y2. During the feeding study, after weaning, the concentrate proportion in Y1 was 40% barley, 40% peas and 20% rapeseed cake. In Y2 the composition was, on average, 48% barley and 26% each of peas and rapeseed cake.

Silage was fed *ad libitum* and the rations were adjusted several times a week, not exceeding the maximum concentrate inclusion according to KRAV (2010), namely 50% of the daily DM intake during the first month after weaning and thereafter a maximum of 30%. The lambs also received a mineral and vitamin mix (Effekt Fårmineral m Cu, Lantmännen Lantbruk, Sweden), in addition to free access to water and salt.

2.4. Data recorded

The collection of data pertaining to lamb performance started one week after weaning. Feed rations were weighed per pen on each day and feed refusals were registered five days per week. Silage samples were collected on two feeding occasions per week. The samples were mixed