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Short communication

Chopping of whole-crop barley silage improves intake and live-weight gain of young dairy steers

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ABSTRACT

This experiment evaluated the effect of chopping whole-crop barley silage on intake, diet selection and live-weight gain in young dairy steers. Whole-crop barley harvested at the dough stage of maturity and preserved as round bale silage was fed *ad libitum* in its long form or precision-chopped to 63 pen-housed dairy steers (average weight 173, s.d. 39 kg). In addition, each animal received 0.6 kg of soybean meal, 0.4 kg of barley grain and 0.08 kg of mineral feed daily. Chopping increased dry matter intake of whole-crop barley silage by 23% and live-weight gain by 22%. Higher concentrations of starch in the orts from steers when fed unchopped silage reflected sorting against grain, probably caused by long awns in the unchopped silage, which were not present in the chopped silage. No sorting against grain occurred in the chopped silage. Chopping increased intake of whole-crop barley silage and live-weight gain of young dairy steers, probably due to negative effects of long awns in the unchopped whole-crop barley silage on intake.

1. Introduction

Whole-crop cereals are often preserved as round bale silage in Sweden. Forages in round bales have a larger particle size than precision-chopped forages and this larger particle size can impair intake in growing cattle fed grass silage (Deswysen and Vanbelle, 1978) and legumes (Jaster and Murphy, 1983). However, the effect of particle size on intake of whole-crop cereals is poorly investigated and most studies on whole-crop cereals have been performed using precision-chopped crops. Rustas et al. (2010) were able to increase intake by chopping round-baled whole-crop barley silage (WCBS) harvested at the dough stage of maturity when fed to dairy steers weighing 350 kg. The increased intake could not be explained by eating or ruminating behaviour and the authors **concluded** that the difference in intake was due to long awns present in the unchopped but not in the chopped WCBS. Awns are bristly entities of the grain and might depress intake of whole-crop cereals when fed to growing cattle (Christensen et al., 1977; Wallsten et al., 2009). Rustas et al. (2010) found selective refusal of starch, indicating avoidance of grain by the animals fed unchopped WCBS that can be attributed to long awns associated with grain. Selective refusal of grain of whole-crop cereals will increase fibre concentration and potentially decrease intake and performance of growing cattle, especially for young cattle, which are not well adapted to utilise low-quality forages (Welch, 1982). The aim of the present study was to examine the effect of chopping on feed intake, diet selection and live-weight gain in young dairy steers fed round-baled WCBS.

2. Materials and methods

2.1. Whole-crop barley silage

Whole-crop barley was produced and harvested at the dough stage of maturity according to Rustas et al. (2009), year 2, at the Götala Research Station, Swedish University of Agricultural Sciences, Skara, in south-west Sweden. The barley crop

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was harvested and preserved as round-baledsilage according to Rustas et al. (2010). During baling, knives were not engaged in the baler to ensure longest possible particle length. Three litres of Kofasil® Majs (50% sodium benzoate, 25% sodium propionate; Addcon Agrar GmbH, Bonn, Germany) were applied per tonne fresh matter during baling. Bales were conserved for at least 90 days before feed-out. The WCBS was either fed in its long physical form or after being chopped to a theoretical length of cut of 20 mm using a precision chop forage wagon (JF ES 3500; JF-Stoll, Sønderborg, Denmark). Average ear proportion of the harvested crop was determined according to Rustas et al. (2009). Ear and stalk were dried separately at 105 °C for 24 h.

2.2. Experimental design and diets

Swedish animal welfare regulations were followed during the experiment and the experimental procedures were approved by the Ethical Committee on Animal Experiments in Gothenburg, Sweden (Dnr. 422–2004).

In the experiment, 63 dairy steers (30 Swedish Holstein, 33 Swedish Red) with an average initial live weight (LW) of 174 (s.d. 38.9) kg were used in a randomised block design with pen as the experimental unit. The steers were blocked according to their LW 1 week before the experiment. To fit the 10 pens and two treatments (unchopped and chopped WCBS) used in the experiment, there were two pens with heavy steers (216 kg LW, s.d. 22.9) and three pens with light steers (149 kg LW, s.d. 19.2) in each of the treatments and 6 or 7 steers per pen. The adaptation period to the experimental diets was 1 week and the experimental period was 63 days. The steers were stalled in an uninsulated barn with deep wheat straw bedding and solid concrete floor at the manger.

Each steer was weighed on 3 consecutive days at the beginning and at the end of the experimental period and once every week during the experiment. The steers were fed WCBS at 105–110% of their *ad libitum* intake once daily at 10.00. In addition, each steer was supplied with 0.4 kg rolled barley, 0.6 kg soybean meal and 80 g mineral feed. The concentrates were supplied on top of the silage in the morning during all experimental weeks except weeks 2, 5 and 8, when concentrates were supplied after removal of the orts and were eaten up before WCBS was fed. Orts were collected and weighed three times each week, except for the experimental weeks 2, 5 and 8.

2.3. Sampling and analyses of feeds and orts

Samples of both unchopped and chopped WCBS were collected every day at feed-out, frozen immediately and later pooled to: 1 sample per week for DM determination, 3 samples in total for determination of nutrient composition, 2 samples in total for determination of fermentation characteristics and 1 sample in total for determination of indigestible NDF (INDF). Samples of soybean meal and barley were collected every week. Barley grain was pooled to 2 samples and soybean meal was pooled to 1 sample for the experimental period. Orts from animals receiving unchopped silage were chopped. Representative daily samples of orts from each pen were frozen and later pooled to one weekly sample per pen for each of the experimental weeks 2, 5 and 8.

Silages and orts were dried at 60 °C for 18 h in a forced-air oven for DM determination. Samples of silage and orts, barley and soybean meal were analysed for nutritional composition according to Rustas et al. (2010). *In vitro* digestible organic matter (IVDOM) of silages and orts was determined after 96 h incubation in buffered rumen fluid (Lindgren, 1977). The INDF was determined after 288 h *in situ* incubation on dried WCBS samples milled through a 1.5-mm screen in a Wiley mill (Åkerlind et al., 2011).

The pH and concentrations of lactic, acetic, butyric and propionic acid together with ethanol and ammonia nitrogen in silage samples were determined as described by Rustas et al. (2010).

2.4. Calculations and statistical analyses

The extent of sorting was evaluated by relating the composition of orts from experimental weeks 2, 5 and 8 to the corresponding pooled samples of WCBS. Concentrates were excluded from the calculations as all were eaten up before WCBS was fed. The concentration of each nutrient of the ingested diet was calculated by dividing the amount of ingested nutrient by DM intake. The composition of ingested diet in percentage of offered diet was used to quantify the extent of sorting. Values larger than 100% indicated that steers sorted for the item (preference) and values lower than 100% indicated that steers sorted against the item (refusal). Values not differing from 100% indicated that steers did not sort. Experimental means of the extent of sorting was used in the statistical analyses. The extent of sorting was tested for a difference from 100 by *t*-tests. The composition of orts in relation to fed WCBS was tested in a similar way.

Treatment effects on intake, LWG and sorting were analysed according to the following model using the GLM procedure of Minitab (Minitab 15; Minitab Inc., State College, PA, USA):

$$Y_{ij} = \mu + B_i + P_j + e_{ij}$$

where Y_{ij} = observed response, μ = overall mean, B_i = effect of block (LW group; $i = 1$ to 2), P_j = effect of physical form (unchopped or chopped) of the WCBS ($j = 1$ to 2) and e_{ij} is the residual error. In the original model, LW group-by-treatment interaction was tested. As no significant interaction was found, effect of LW group was treated as a block effect. Results are shown as main effects of treatment averaged over blocks .

3. Results

3.1. Feed and diet characteristics

The chemical composition and nutritional characteristics of the silages are presented in Table 1. The composition of the diet, including concentrates, with unchopped WCBS was 380 g DM per kg and 44 g ash, 140 g CP, 191 g starch and 384 g NDF per kg DM. The composition of the diet with chopped WCBS was 355 g DM per kg and 58 g ash, 131 g CP, 178 g starch and 399 g NDF per kg DM.

The ear proportion of the barley crop was 0.59. The DM content of the ear portion was 412, of the stalk 311 and of the whole crop 371 g per kg.