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Effect of concentrate presentation form on concentrate wastage, eating pattern, and concentrate preference in Holstein bulls fed a finishing high-concentrate diet

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ABSTRACT

Two experiments were conducted to evaluate the effects of concentrate presentation form on concentrate wastage, eating pattern, and concentrate preference in Holstein bulls fed a finishing high-concentrate diet. Additionally, the evolution of quality of this concentrate from the feed mill to the feeder was analyzed. In experiment 1, 112 Holstein bulls (272 ± 4.4 kg of body weight and 216 ± 1.0 days of age) were randomly distributed in 6 pens equipped with a computerized concentrate single-space feeder with lateral protections, a separated straw feeder, and a water bowl. Pens were assigned to either presentation forms of concentrate, pellets (PE) or crumbles (CR). The experiment followed a replicated Latin square design with 28-days periods. All animals received concentrate and straw *ad libitum*. Daily concentrate consumption and eating pattern, weekly straw consumption, and twice-weekly concentrate wastage were recorded for the last 14 days of each period. Animals were weighed every 14 days. For each concentrate manufacture, durability, hardness, density, and percentage of fines were determined at the feed mill, silo, feeder, and spillage collectors. In experiment 2, 6 Holstein bulls (404 ± 14.1 kg of BW and 254 ± 3.6 days of age) were enrolled to assess the concentrate preference for previous presentation forms of concentrate (PE or CR). The experiment consisted in a 7-days adaptation period and a 6-days free-choice period during which PE and CR were offered simultaneously. In Experiment 1, bulls fed PE had greater ($P < 0.01$) concentrate consumptions (7.18 vs. 6.87 ± 0.07 kg/d) and lesser ($P < 0.01$) wastage (0.06 vs. 0.11 ± 0.001 kg/d) compared with those fed CR. Bulls receiving CR spent more time at the feeder ($P < 0.01$) than bulls fed PE (44.4 vs. 40.7 ± 0.71 min/d). In Experiment 2, animals preferred numerically PE over CR (65.5 vs. 34.5 ± 4.89% to total concentrate consumption ratio). Lastly, as expected, concentrate quality based on durability was not a stable parameter, and it more progressively deteriorated ($P < 0.01$) from the mill to the feeder in CR than PE (96.7 vs. 87.1 ± 1.00%). The present study supports the hypothesis that a concentrate form like crumbles, which produces a great percentage of fines at the feeder, can increase concentrate wastage, and, also, it affects eating pattern, increasing the time spent at the feeder, and consequently decreases the concentrate intake. Lastly, animals prefer pellets over crumbles.

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1. Introduction

A pelleted concentrate is one of the most common feed presentations (Castillo et al., 2006) in Mediterranean beef feeding systems, representing an estimated extra cost in feed manufacturing compared with mash (Capdevila, 1993). Extensive research, mostly in non-ruminant animals, has demonstrated that a good pellet quality improves feed efficiency compared with mash or concentrate presentations with poor quality such as reground pellets, or pellets with a high percentage of fines (Jensen and Becker, 1965; Trevis, 1979; Kertz et al., 1981; Jones, 1985; Zatari et al., 1990; Stark et al., 1994). In most of these studies, the impaired feed efficiency when feeding poor quality pellets or mash was attributed to an increase in feed wastage and content of fines in the feeder (Behnke, 1994); however, concentrate wastage was not measured herein. Crumbles (regrinding pellets) could simulate a poor concentrate quality. The hypothesis of the present study was that the impoverishment of concentrate quality like crumbles would increase the percentage of fines at the feeder because bulls would prefer intact pellets over reground pellets, and this fact may negatively affect: 1) concentrate wastage; and, 2) eating pattern, showing an increase of concentrate eating time that may be translated in an increase of concentrate wastage. These data could be helpful to estimate the potential economic benefit of improving concentrate quality on wastage and profitability in beef industry. Thus, the objectives of the current study were: 1) to evaluate the effect of concentrate presentation form on concentrate wastage and eating pattern; 2) to assess the evolution of concentrate quality from the mill to the feeder; 3) to determine the concentrate preference for two different presentation forms of concentrate in Holstein bulls fed a high-concentrate diet.

2. Materials and methods

The experiments were conducted according to the principles and specific guidelines of the IRTA Animal Care Committee.

2.1. Experiment 1

2.1.1. Animals, experimental design, and diets

A total of 112 Holstein bulls (272 ± 4.4 kg of BW and 216 ± 1.0 days of age) were reared under commercial conditions until they were sent to the slaughterhouse (436 ± 4.8 kg of BW and 328 ± 1.0 days of age). Animals were randomly allocated in one of 6 pens equipped with a computerized concentrate single-space feeder (0.50 m length × 0.26 m width × 0.15 m depth), with lateral protections (1.40 m length × 0.80 m height) forming a chute. Pens also had a separated straw feeder (3.00 m length × 1.12 m width × 0.65 m depth; 7 feeding spaces), and a water bowl. Furthermore, covered pens (12 m length × 6 m width) were deep-bedded with straw.

The experiment was designed as a replicated Latin square involving 2 treatments and 3 replications. Each square had 2 pens and 2 periods, and each experimental period consisted of 28 days (14 days for dietary adaptation and 14 days for measurements and data collection). Adaptation periods between 7 and 14 days are acceptable to assess the response in eating behavior and intake when testing dietary treatments (Grant et al., 2015). Pen was the experimental unit. Treatments were two different presentation forms of concentrate: 1) pellets (PE), and 2) crumbles (CR), the latter was obtained regrinding pellets as mentioned in the Introduction. The pellet quality could be modified using different ingredients (Thomas et al., 1998) or pelleting conditions (Thomas et al., 1997); however, these two methods affect the starch availability in the rumen, and presentation form of concentrate could be confounded by rumen starch availability. Crumbling was chosen because it allows altering pellet quality without modifying ingredients and pelleting conditions. However, even the grinding could also increase the surface area for microbial attack and could also thereby increase rumen nutrient digestion, this presentation form was chosen because it was the method that better guaranteed a continuous and stable pellet quality impoverishment. The ingredient and nutrient composition, following the NRC (1996) recommendations, was the same for both treatments (Table 1). The dietary ingredients were ground through a roller mill with screen openings of 2.75 mm. The mixed mash was steam-conditioned at 80 °C with a 0.5 min retention time, and then pelleted.

The pellet mill was equipped with a die ring (3.5 mm diameter holes and 70 mm thickness). The corresponding pellet exit temperatures, after pelleting, ranged ± 10 °C in relation to conditioning temperature. The pellet die knife was set at 10 mm from the die face. The pellets were pneumatically transferred to a cyclone cooler with a retention time of 20 min. The CR concentrate was obtained grinding cooled pellets with a roller mill using a 3.0 mm sieve, and crushing them to a consistency coarser than a mash obtaining a product with a more variable granulometry than pellets. Diets were manufactured from a 9000 kg master-batch, of which 4500 kg were in pellet form, and the other 4500 kg in crumble form. Each treatment concentrate was transported to the farm with the same truck, and stored into two different silos under the same conditions. During the experiment, 11 batches were manufactured. Animals had also *ad libitum* access to wheat straw (Table 1) and fresh water.

2.1.2. Computerized concentrate feeder

Animals received *ad libitum* concentrate via a computerized feeder (Voltec®, Lleida, Spain). The feeder consisted of a single-space trough with lateral barriers forming a chute (Verdú et al., 2015). The chute provided protection when an animal accessed the feeder to eat, and prevented interferences from other close animals from the sides, as the antenna detected transponders whenever animals were within 50 cm of feeder. Each feeder was equipped with an antenna (Azasa-