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Effects of long-term feeding of crude glycerine on performance, carcass traits, meat quality, and blood and rumen metabolites of finishing bulls

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ABSTRACT

The objective of this study was to examine performance, carcass traits, muscle chemical composition, and blood and rumen metabolites of bulls fed diets with different levels of crude glycerine. A total of 48 Fleckvieh bulls (initial age and live weight 222 ± 16 d and 232 ± 29 kg, respectively) were divided into four dietary treatment groups with different levels of glycerine supplementation: C (without glycerine), G5 (4.7% of glycerine), G10 (9.3% of glycerine) for the entire experimental period (266 ± 38 d), and CG10 (0% for 118 d and then 9.3% of glycerine until slaughter). The diets were similar in their energy and protein contents with glycerine proportionally substituting barley meal. Feed intakes were recorded daily and the bulls were weighed every two weeks until slaughter (592 ± 29 kg of live weight). In addition, blood samples were collected on day 0, 118, and 189 of the experiment. After slaughter, rumen fluid was collected, carcass characteristics were recorded, and *m. longissimus lumborum* composition was determined. No significant effect of glycerine inclusion was observed in any of the growth performance, carcass and meat quality traits studied. Also, no apparent effects on blood and rumen metabolites were detected. We conclude that crude glycerine can be used as a long-term substitution for barley meal up to the level of approximately 10% of dry matter in the diets of finishing bulls.

1. Introduction

The share of energy from renewable sources in all forms of transport in 2020 should be at least 10% of the final consumption of energy in transport in each EU member state (EU, 2009). However, the European Commission has currently proposed to limit biofuels produced from cereal and other starch rich crops, sugars and oil crops (EU, 2012). In spite of slightly decreasing production (EBB, 2011), the EU remains the region with the greatest biodiesel production worldwide. Approximately 7.9 kg of crude glycerine is generated per 100 l of biodiesel produced (Thompson and He, 2006). Therefore, the existing biodiesel industry is likely to provide a substantial amount of crude glycerine to be used not only for the production of chemical products, fuel additives, hydrogen, ethanol, etc., but also as an energy source in animal diets (Gunn et al., 2010a; Leoneti et al., 2012).

Previous studies concluded that glycerine from biodiesel production is an acceptable source of energy for poultry (Min et al., 2010) and pigs (Schieck et al., 2010). In ruminants, different quantities of glycerine are either converted to volatile fatty acids, particularly propionate and butyrate at the expense of acetate, or are directly absorbed from the digestive system and act as a precursor

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for gluconeogenesis in the liver (Rémond et al., 1993; Krehbiel, 2008). Feeding glycerine may also improve feed digestibility and increase the microbial protein production in the rumen of cattle in a dose-dependent manner (Wang et al., 2009).

The potential value of glycerine as a replacement for corn has been examined in diets for transition (Carvalho et al., 2011) and lactating (Donkin et al., 2009) dairy cows. The use of glycerine in feedlot diets has also been evaluated in several studies with cattle (Pyatt et al., 2007; Mach et al., 2009; Parsons et al., 2009) and lambs (Gunn et al., 2010b; Gomes et al., 2011), but the results concerning growth performance and carcass characteristics were ambiguous and inconclusive. In addition, earlier reports usually evaluated effects of glycerine fed to finishing cattle in different concentrations for a common period of time, usually shorter than 100 days (Mach et al., 2009; Parsons et al., 2009). Therefore, the objective of this study was to determine the effect of long-term feeding of diets with different levels of crude glycerine on performance, carcass traits, muscle chemical composition, and blood and rumen metabolites of bulls.

2. Materials and methods

2.1. Animals and diets

Experimental procedures were approved by the Animal Care Committee of the Institute of Animal Science. A total of 48 Fleckvieh bulls were purchased from three commercial herds and loose housed in four pens with straw bedding. The animals were weighed and identified with electronic identification ear tags. An adaptation period of approximately 1 month followed, in which the bulls were trained to feed from twelve electronically controlled feeding troughs (Insentec, Marknesse, The Netherlands) enabling accurate measurement of individual feed intakes. Then they were distributed according to their live weight, age, and sire into four dietary treatment groups (12 animals in each) with different glycerine supplementation (on a dry matter basis): C (without glycerine), G5 (4.7% of glycerine), G10 (9.3% of glycerine) for the entire experimental period (on the average 266 d), and CG10 (0% of glycerine for 118 d and then 9.3% of glycerine for, on the average, 148 d). The diets were similar in energy and protein contents with glycerine and soybean meal proportionally substituting barley meal in diets G5, G10 and CG10 (Table 1). Rapeseed-derived glycerine from a single batch (Agrone Trading, Čáslav, Czech Republic) was added to the total mixed ration as a liquid. Throughout the experiment, the composition of the diets was adjusted slightly on the basis of chemical analyses of regularly collected samples of diet ingredients. One bull from the group G5 and one from G10 had to be removed from the experiment due to respiratory problems and leg injury, respectively.

Diets were sampled twice a month and dried using a freeze drying method (Freeze dryer ALPHA 1–4 LSC, Martin Christ Gefriertrocknungsanlagen GmbH, Germany). Residual moisture was determined by oven drying for 6 h at 105 °C. Ash was determined after 6 h at 550 °C and ether extract after 6 h extraction with petroleum–ether using Soxtec 1043 (FOSS Tecator AB, Höganäs, Sweden). Nitrogen was determined using the Kjeldahl method (Kjeltec AUTO 1030 Analyser, Höganäs, Sweden) according to AOAC Official Method 976.05 (AOAC, 2005), and crude protein (CP) was calculated as N × 6.25. The ADF and lignin (ADL) contents were determined in accordance to AOAC Official Method 973.18 (AOAC, 2005). The NDF content of samples and digested residues was analysed in the presence of sodium sulphite and with α-amylase treatment (Van Soest et al., 1991) and was presented ash-free. Fibre fractions were determined using Fibertec 2010 (FOSS Tecator AB, Höganäs, Sweden). The average ingredient and chemical composition of diets is given in Table 1. All the diets were fed *ad libitum*.

Table 1
Ingredient and nutrient composition of diets.

Item	Treatment group		
	C[a]	G5[b]	G10[c]
Ingredient (g/kg DM)			
Maize silage	355.4	357.3	359.4
Alfalfa silage	118.1	118.6	119.3
Wheat straw	44.2	44.3	44.6
Wheat grain meal	122.4	122.9	123.7
Barley grain meal	279.4	214.2	150.1
Soybean meal	58.9	74.5	87.4
Glycerine[d]	0	46.5	93.5
Salt	1.3	1.4	1.4
Vitamin-mineral supplement[e]	20.3	20.4	20.6
Nutrient			
Dry matter (g/kg fresh weight)	443.2	453.0	460.2
CP (g/kg DM)	150.3	148.9	158.1
Ash (g/kg DM)	69.0	69.7	73.1
Ether extract (g/kg DM)	2.20	18.6	17.1
NDF (g/kg DM)	430.8	428.2	421.0
ADF (g/kg DM)	263.4	231.6	224.1
ADL (g/kg DM)	75.7	60.9	73.1
PDI[f] (g/kg DM)	89.0	87.5	87.3
NEF[g] (MJ/kg DM)	6.51	6.32	6.51

[a] C, 0% of glycerine
[b] G5, 5% of glycerine
[c] G10, 10% of glycerine
[d] Contained per 1 kg: glycerine 800 g, methanol < 5 g, ash 80 g.
[e] Contained per 1 kg: Ca—230 g, P—10 g, Na—50 g, Mg—40 g, Cu—1200 mg, Mn—4000 mg, Zn—5000 mg, Se—30 mg, I—150 mg, Co—20 mg, Vitamin A—600 000 IU, Vitamin D3—100,000 IU, Vitamin E —1000 mg.
[f] Protein digested in the small intestine (Vérité and Peyraud, 1989; Vermorel, 1989).
[g] Net energy of fattening (Vermorel, 1989).

2.2. Animal performance and carcass characteristics

Individual daily feed intakes were recorded throughout the entire experimental period. The bulls were weighed every 2 weeks at the same time of day and before transportation to the abattoir of the Institute of Animal Science (final weight). Four bulls were slaughtered on each slaughter day (the heaviest one from each group) following standard procedures. Within 1 h after slaughter, the carcasses were uniformly dressed and assessed by a trained classifier for conformation (an 18-point scale) and fatness (a 15-point scale) according to the EU beef