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RAPID COMMUNICATION

Productive performance of beef bulls fed tall fescue silage or meadow fescue silage and complemented with cereal grains

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ABSTRACT

The purpose of this study was to compare the effectiveness of two different grasses offered to weaned beef breed bulls until slaughter. Three cuts of tall fescue (TF) and meadow fescue (MF) were harvested with as similar chemical composition as possible, pre-wilted and ensiled separately in bales. Forty newly weaned intact bulls of Continental beef breeds were kept indoors and randomized to one of the two silages, complemented with 2.5–3.0 kg grain/day, and followed until slaughter. The two silages were offered simultaneously from the same cut during most of the finishing period. Bulls receiving TF had a higher silage dry matter intake than bulls offered MF (7.69 *vs.* 7.04 kg^{-d}; $P = 0.0026$) but had lower carcass weight (370 *vs.* 380 kg; $P = 0.0357$). From this limited study it was concluded that replacing traditional MF silage with TF silage might compromise the carcass performance of finishing beef bulls.

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KEYWORDS
Tall fescue; meadow fescue; bulls; beef cattle; carcass composition

Introduction

In order to adapt to climate change in northern Europe, the choice of grass species for silage making is central in order to obtain high dry matter (DM) yields also under extreme weathers such as drought or excessive wet growing conditions. There are on-farm trade-offs between DM yield and feed value to be made in selecting optimal grass species. Traditional grasses, such as meadow fescue (*Festuca pratensis* L.) and timothy (*Phleum pratense* L.), are well documented as grasses with high nutritive values (Johansen & Nordang, 1993; Bertrand et al., 2008), but they are not very drought tolerant (Mäkinen et al., 2018). As an alternative, tall fescue (*Festuca arundinacea* Shreb.) with its high DM yield, drought tolerance and winter hardiness is an interesting alternative (Drapeau et al., 2005; Richard et al., 2020). However, studies on dairy cows show that milk yield decrease in animals fed tall fescue, compared to animals fed meadow fescue or timothy, due to tall fescue's higher concentration of neutral detergent fiber (NDF) (Sousa et al., 2021). Furthermore, Schaefer et al. (2014) found steers grazing tall fescue had lower weight gain than steers grazing meadow fescue. It is well known that the concentration of NDF in bovine forage-rich diets is negatively correlated with production level (corr coeff 96.5%, Arelovich et al., 2008), due to its contribution to rumen fill (Allen et al., 2019). Lignin is the primary limitation of the rate of NDF degradation in grass (Van Soest, 1987). The degradability of lignin in grass fiber is due to the crosslinking of lignin to glucoronoarabinoxylans via ester and ether linkage with ferulates (Jung & Phillips, 2010; Hatfield et al., 2017). Ferulic and p-coumaric acids are polyphenolic compounds, called hydroxycinnamic acids, which is a compound in grass cell walls (Jung & Casler, 1991). Hence, replacing traditional grasses with drought-resistant varieties in order to diminish the risk of a low harvest yield, might be counter-acted by a lower feed intake with lower production levels and thereby a lower overall profitability in animal production.

Nutritional requirement for intensive beef breed bulls is lower than for dairy cows (NRC, 2016, 2021). To our knowledge, there is no study comparing performance of beef breed slaughter bulls offered forage-dominated diets consisting of meadow fescue and tall fescue grown under Nordic conditions. Thereby, the aim of this study was to investigate if feed intake, weight gain and carcass composition of beef breed slaughter bulls would be maintained if traditional meadow fescue silage was replaced by tall fescue silage.

Material and methods

The two grass species used in this study were tall fescue (TF) Swaj (*Festuca arundinacea*) and meadow fescue (MF)

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Tored (*Festuca pratensis*). Both grasses were grown at a commercial farm in southwestern Sweden (57°45´N, 12°50´E), where they were established as monocultures in April 2020, covered by spring-wheat, which was harvested in September 2020. The grass leys were planned to be harvested three times during 2021, with as similar chemical composition as possible, and therefore fertilized with 126, 81 and 105 kg N/ha before first, second and third cut, respectively. The grasses, containing <1% weed, were pre-wilted for approximately two days, depending on weather and preserved in round bales with an integrated bale wrapper, without additives due to their high DM content.

Samples were collected from ten silage bales of each grass species and cut. The samples were merged and a pooled sample from each grass species and cut were sent for analysis of metabolizable energy (ME), NDF, indigestible NDF (iNDF) and crude protein (CP) determined by near infrared (NIR) technique (Q interline Quant) at Eurofins Agrotesting Sweden, Kristianstad. Dry matter content of silages was determined by drying a 100 g pooled sample for each grass species and cut in a drying cabinet at 60°C for 48 h at the Rural Economy and Agricultural Society Sjuhärad, Sweden. The chemical composition of the TF and MF silages are shown in Table 1 and the chemical composition of the grain was 13.6 ME, 150 g NDF, 172 g iNDF and 120 g CP per kg.

The silages were fed in a trial, performed from 4 October 2021 until 29 July 2022, at the farm of the Rural Economy and Agricultural Society Sjuhärad, Länghem, Sweden (57°61´N, 13°26´E), where 40 newly weaned and dewormed (1 mL/10 kg body weight, Noromectin®, Norbrook Laboratories, Ireland), intact beef breed slaughter bulls were acquired and raised in an indoor system until slaughter. The animals were crossbreeds between Simmental, Charolais and/or Limousine, where 28 calves originated from one farm and 12 calves came from a neighbor farm. During a two-week pre-experimental period, the calves were offered grass silage at *ad libitum* intake combined with 1.0 kg barley/wheat (50:50) per animal and day. The calves were weighed and divided into four groups of ten individuals each, equally balanced by weight and original breeding farm. The four groups were separately fed and kept on straw bedding in a loose housed system. Grass silages were offered at *ad libitum* intake from round bale feeders with diagonal pipes (Ofab/Bala Agri), where bales were weighed before feeding and two of the groups were offered TF and two groups were offered MF. Refusals was estimated by viewing each bale and did not exceed 4 kg DM per bale. Average starting live weights (mean ± SD) (350 ± 30 and 348 ± 36 kg for TF and MF respectively) and age (7.9 ± 0.8 and 7.9 ± 0.6 month for TF and MF respectively) were similar for the four groups.

A graphical description of the experimental design is shown in Figure 1. The two silages were offered simultaneously from the same cut, starting with the second cut due to high content of DM, ME and CP, progressing to first cut, and finishing with the third cut. At the end of the trial (from the 18th of May), different cuts were offered due to a lack of silage, where the then remaining 13 TF bulls were offered second cut silage and the remaining 16 MF bulls were offered third cut during an average period of 43 days (13% of the total animal days). Daily silage intake per cut and for the entire rearing period was calculated on an animal group level.

All animal groups were offered the same amount of barley/wheat mix (50:50) at the amounts of 2.5 kg per bull and day until 31 December and thereafter 3.0 kg per bull and day until slaughter. The grain was offered once a day with the amount based on the number of bulls per group. No individual documentation of grain consumption was made. During the entire experiment, the feed rations were supplemented with vitaminized minerals (Deltamin Kött from Svenska Foder) to meet the recommended requirements of the animals (Spörndly, 2003). All bulls had free access to water and salt and were weighed once a month. The individual target slaughter weight for the bulls was set to 680 kg live weight. Therefore they were slaughtered at different dates from April 1st to July 29th, 2022. All bulls were weighed on two consecutive days before slaughter and the average weight of these was used for calculations.

The bulls were slaughtered in a commercial abattoir. The cold carcass weight was estimated as 0.98 × hot

Table 1. Chemical composition of dry matter (DM), metabolizable energy (ME), neutral detergent fiber (NDF), indigestible neutral detergent fiber (iNDF), crude protein (CP), pH, lactic acid, acetic acid, butyric acid, and date of harvest of tall fescue (TF) and meadow fescue (MF) silages in three different cuts ($n = 1$).

Item	1st cut		2nd cut		3rd cut	
	TF	MF	TF	MF	TF	MF
DM, g/kg	615	455	713	570	555	390
ME, MJ/kg DM	10.6	10.3	11.1	11.1	10.8	10.7
NDF, g/kg DM	504	529	480	475	480	495
iNDF, g/kg of NDF	153	164	114	131	149	147
CP, g/kg DM	178	153	166	194	174	150
pH	5.87	5.50	6.06	5.60	5.67	4.72
Lactic acid, g/kg DM	8	16	13	14	11	28
Acetic acid, g/kg DM	12	7	7	9	1	13
Butyric acid, g/kg DM	1.4	1.5	0.5	1.3	1.4	4.5
Date for harvest	May 30	May 30	June 28	June 30	Aug. 2	Aug. 12

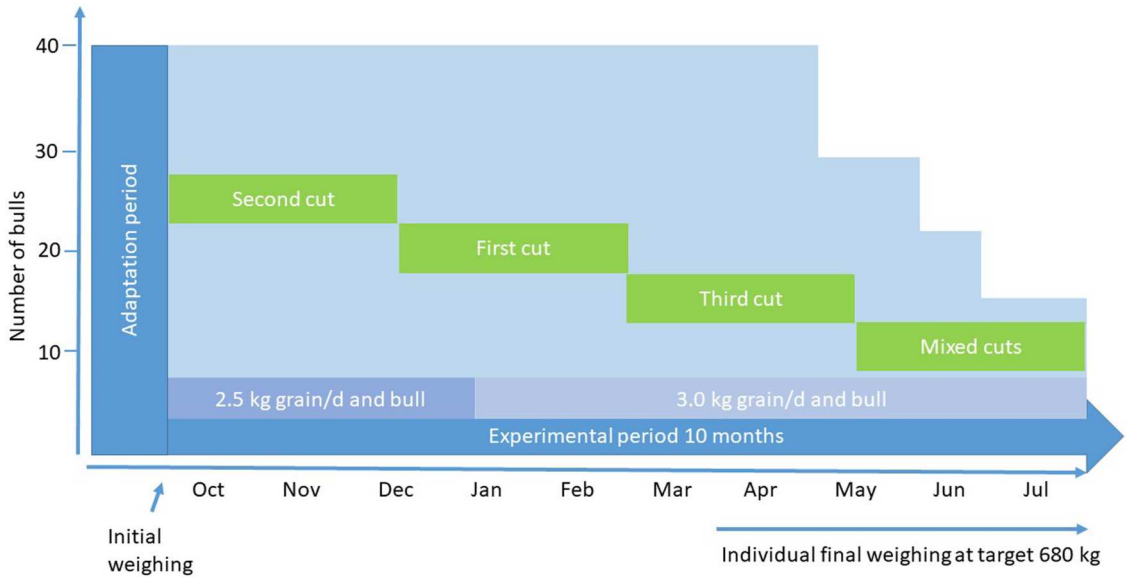

Figure 1. Graphical description of experimental design of animals offered tall fescue silage (TF) or meadow fescue silage (MF) complemented with grain.

carcass weight. Conformation and fat cover were graded according to the European Union Carcass Classification Scheme (Council of the European Union, 2007; Commission of the European Union, 2008). For the fat cover, the amount of subcutaneous fat was taken into account using a classification range from 1 to 5 (1: low, 2: slight, 3: average, 4: high, 5: very high). Based on the Swedish system (Swedish Board of Agriculture, 2002), each level of the conformation and fatness scores was subdivided into three sub-classes (e.g. R–, R, R+; 3–, 3, 3+) to produce a transformed scale ranging from 1 to 15, with 15 being the best conformation and highest fatness.

Two different statistical models were used, as the silage intake was recorded on a group level, whereas average live weight gain (LWG) and carcass traits were recorded for the individual animal nested within group. Data on silage intake was analyzed by analysis of variance with the MIXED procedure of Statistical Analysis Software (SAS) version 9.4 (SAS Institute Inc, 2018) using the model:

$$Y_{ikl} = \mu + \alpha_i + \beta_k + \alpha\beta_{ij} + e_{ijkl}$$

where μ is the population mean, α_i is the fixed effect of grass ($i = 1–2$), β_k is the fixed effect of cut ($k = 1–3$), $\alpha\beta_{ij}$ is the fixed effect of interaction between grass and cut and e_{ikl} is the error term.

LWG and carcass characteristics were analyzed by analysis of variance using the MIXED procedure as described before using the model:

$$Y_{ijk} = \mu + \alpha_i + b_j + e_{ijk}$$

where μ is the population mean, α_i is the fixed effect of grass ($i = 1–2$), b_j is the random effect of group ($k = 1–4$) and e_{ijk} is the error term. Significance was considered at $P \leq 0.05$ in the F-test.

Table 2. Average daily silage intake, live weight gain, age and live weight at slaughter, carcass weight, conformation, fatness and dressage percentage of 40 beef bulls offered feed rations based on silage of tall fescue (TF) or meadow fescue (MF). SEM is pooled standard error of the mean, DM is dry matter.

Item	Silage		SEM	*P*-value
	TF	MF		
Grass silage intake, kg DM/d	7.69	7.04	0.09	0.0026
Live weight gain, kg/d	1.46	1.39	0.05	0.4788
Age, month	15.9	16.4	0.44	0.5589
Live weight, kg	695	696	2.78	0.8203
Carcass weight, kg	370	380	3.09	0.0357
Dressing, %	53.3	54.4	0.00	0.1629
Conformation[a]	9.75	9.60	0.23	0.6487
Fatness[b]	6.60	6.50	0.18	0.7033

[a]EUROP system: 9 = R+, 10 = U-.
[b]EUROP system: 6 = 2+, 7 = 3-.

Results and discussion

The average silage intake during the rearing was 9% higher in bulls offered TF than in bulls offered MF, but the bulls offered TF had 3% lower carcass weight than bulls offered MF in spite of similar live weight and age at slaughter (Table 2). Also Sousa et al. (2021) found higher silage intake of tall fescue than of timothy in lactating dairy cows. Liveweight gain, dressage percentage, carcass conformation and fatness were not affected by grass species (Table 2). These results of liveweight gain and slaughter characteristics are in line with Kennedy

et al. (2018) who compared perennial ryegrass silage and tall fescue-perennial ryegrass silage, even if they shew higher silage intake of perennial ryegrass.

Intake in ruminants is mainly regulated by rumen distension when high-forage diets are fed and energy requirements are high (Allen, 2000), as they are for growing bulls. According to Allen et al. (2019), forage NDF concentration of the diet is the main factor contributing to rumen fill. In the present study, TF bulls had a higher feed intake than MF bulls, in spite of the concentrations of forage NDF and iNDF in the two experimental diets being similar, or even higher in the MF. Both TF and MF were preserved well, as indicated by low butyric acid concentration (Table 1). The TF had numerically higher pH and also higher DM content than MF (Table 1). An increased DM content of silage is known to have a positive effect at intake, at least up to about 35% DM content (Wright & Steen, 2000). However, the DM content of all silages in the present study was higher, and at those levels, DM content is rather negatively correlated to the intake (Richard et al., 2020). Hence, the higher intake in the TF bulls compared to the MF bulls cannot be explained by differences in fermentation products or DM content of the silages. There was a difference in pH between silages, especially in third cut where MF had a lower pH than TF. As discussed by Steen et al. (1998) a lower pH results in higher silage intake. The present study investigated intake over the total rearing period and not for specific cuts, as a possible effect on intake from the differing pH in the third cut cannot be shown.

No difference in LWG was found between bulls offered TF and MF, but the TF bulls had lower carcass weight and lower dressing percentage than the MF bulls, altogether indicating that the TF bulls had a higher rumen fill than the MF bulls during the rearing. This is in line with Sousa et al. (2021) who compared tall fescue- and timothy-based diets to lactating dairy cows and observed that, in spite of similar forage NDF concentrations, milk yield expressed as both kg milk and kg energy corrected milk were lower for cows offered tall fescue compared to cows offered timothy. The authors stated that there was an overall effect of forage species on cell wall composition, where tall fescue silages showed greater concentrations of hydroxycinnamic acids than timothy silages, resulting in a less digestible cell wall, which was related to a decreased rate of cell wall degradation of the tall fescue silages and, consequently, reducing the availability of the energy for milk production.

Hydroxycinnamic acids are polyphenolic compounds that act preventing potentially digestible cell wall polysaccharides from being extensively digested in the rumen (Novo-Uzal et al., 2011) and are considered to be the main forage-related factor limiting ruminal fiber digestibility (Adesogan et al., 2019). To our knowledge, Sousa et al. (2021) is the only study that has evaluated the concentration of hydroxycinnamic acids in tall fescue in Nordic conditions, and it was observed that tall fescue showed higher concentration of hydroxycinnamic acids compared to timothy, regardless of maturity stage. These results are supported by Novo-Uzal et al. (2011) in an *in vivo* study on wethers, where maize containing larger amounts of hydroxycinnamic acids had lower digestibility than maize with lower concentrations of these acids.

In the present study, the higher silage intake and lower carcass weight of the TF bulls compared to the MF bulls, was likely due to the greater concentration of hydroxycinnamic acids in the TF diet having compromised the digestion of forage cell wall in the rumen. Compromised rumen digestion leads to slow turnover of digesta in the rumen reducing the amount of energy available for body tissue growth, while increasing the body weight by the filling effect of the gastrointestinal tract resulting in a similar LWG of TF and MF bulls. The lower deposition of body tissues expected from the lower carcass weight in the TF bulls compared to the MF bulls, was hereby counter acted by a greater digesta in the gastrointestinal tract. In conclusion, even with similar chemical composition, feeding TF can compromise the carcass performance of growing bulls when compared to MF.

Conclusion

Daily silage intake was higher in bulls offered TF compared to bulls offered MF. On the other hand, carcass weight was lower in TF bulls than in MF bulls. Thereby it seems that feeding TF to beef breed bulls can jeopardize the slaughter output, compared to feeding MF.

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