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The effect of adding stinging nettle (*Urtica dioica*) haylage to a total mixed ration on performance and rumen function of lactating dairy cows

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ABSTRACT

In vitro studies found that inclusion of dried stinging nettle (*Urtica dioica*) at 100 mg/g dry matter (DM) increased the pH of a rumen fluid inoculated fermentation buffer by 30% and the effect was persistent for 7 days. Our objective was to evaluate the effects of adding stinging nettle haylage to a total mixed ration on feed intake, eating and rumination activity, rumen pH, milk yield, and milk composition of lactating dairy cows. Six lactating Holstein-Friesian cows were used in a replicated 3 × 3 Latin Square design experiment with 3 treatments and 3 week periods. Treatments were a control (C) high-starch (311 g/kg DM) total mixed ration diet and two treatment diets containing 50 (N5) and 100 (N10) g nettle haylage (DM/kg) as a replacement for ryegrass silage (Lolium perenne). There was an increase (linear, $P < 0.010$) in the proportion of large particles and a reduction in medium (linear, $P = 0.045$) and fine particles (linear, $P = 0.026$) in the diet offered with increasing nettle inclusion. A numerical decrease (linear, $P = 0.106$) in DM intake (DMI) was observed as nettle inclusion in the diet increased. Milk yield averaged 20.3 kg/day and was not affected by diet. There was a decrease (quadratic, $P = 0.01$) in the time animals spent ruminating as nettle inclusion in the diet increased, in spite of an increase in the number of boli produced daily for the N5 diet (quadratic, $P = 0.031$). Animals fed the N10 diet spent less time with a rumen pH below 5.5 ($P < 0.05$) than cows fed the N5 diet. Averaged over an 8.5 h sampling period, there were no changes in the concentration or proportions of acetate or propionate in the rumen, but feeding nettle haylage reduced the concentrations of n-butyrate (quadratic, $P < 0.001$), i-butyrate (linear, $P < 0.009$) and n-caproate (linear, $P < 0.003$). Milk and fat and protein corrected milk yield were not affected when nettles replaced ryegrass silage in the diet of lactating dairy cows, despite a numerical reduction in feed intake. Rumination activity was reduced by the addition of nettle haylage to the diet, which may reflect differences in fibre structure between the nettle haylage and ryegrass silage fed. Changes observed in rumen pH suggest potential benefits of feeding nettle haylage for reducing rumen acidosis. However, the extent to which these effects were due to the fermentability and structure of the nettle haylage compared to the ryegrass silage fed, or a bioactive component of the nettles, is not certain.

Abbreviations: ADF, acid detergent fibre with residual ash; aNDF, neutral detergent fibre with residual ash; DM, dry matter; DMI, dry matter intake; TMR, total mixed ration; SARA, subacute rumen acidosis; VFA, volatile fatty acids.

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1. Introduction

Feeding high levels of readily fermentable carbohydrate to lactating dairy cows as a means of satisfying energy demand can predispose the rumen to sub-optimal fermentation patterns which can in turn reduce cellulolytic activity in the rumen and initiate the development of ruminal acidosis through decreased rumen pH. Two types of acidosis are described, acute acidosis which is clearly defined as prolonged periods of rumen pH below 5.0 (Nocek, 1997) and subacute rumen acidosis (SARA) which has been defined as sustained reductions in rumen pH below 5.8 (Nocek, 1997; Maekawa et al., 2002; Krause et al., 2003; Penner et al., 2007). This is the point at which the rumen environment is considered to become sub-optimal and correspondingly the point at which health and economic performance may be compromised.

In vitro studies found that inclusion of dried stinging nettle (*Urtica dioica*) at 100 mg/g of diet increased the pH of a fermentation buffer (90 ml diluted buffer (Mauricio et al., 1999) with 10 ml strained live rumen fluid) by 30% in batch culture (Kleim et al., 2005a) and that the effect was persistent for a period of 7 days in continuous culture (Kleim et al., 2005b). These observations suggest that stinging nettle has the potential to be used to promote rumen health in animals consuming high levels of readily fermentable carbohydrate by stabilising the rumen environment with respect to rumen pH. Stinging nettle extract contains a number of bioactive compounds, including histamine, serotonin, moroidin, and other phenolic compounds and flavenoids (Riehemann et al., 1999; Gülçin et al., 2004; Dar et al., 2013) and has long been used as an alternative anti-inflammatory therapy for arthritis (Yang et al., 2012). In addition, anti-microbial effects of stinging nettle extracts have been demonstrated (Gülçin et al., 2004; Modarresi-Chahardehi et al., 2012; Körpe et al., 2012). Other than having potentially anti-acidotic properties the value of nettles as a feed for livestock has been compared to 'good quality leguminous hay' (MAF, 1943) but we have found no previous reports of the effects of feeding stinging nettles to dairy cows. A possible integrated use of nettles as a fodder crop as part of fiber nettle textile production was suggested by Vogl and Hartl (2003). Aspects of the agronomy of nettle growing and dry matter crop yields from organically grown nettles in central Europe, albeit harvested for fibre production as described by Hartl and Vogl (2002) would support the potential of stinging nettle as a viable forage crop.

The objective of the present study was to evaluate the effects of adding stinging nettle haylage to a high-starch total mixed ration on feed intake, eating behaviour, rumination activity, rumen pH, milk yield and milk composition of lactating dairy cows.

2. Material and methods

2.1. Animals, experimental design, management and diets

Six rumen fistulated multiparous dairy cows (Holstein-Friesian) in late lactation (264 ± 50 days in milk), averaging 25.5 ± 5.2 kg milk per day and weighing an average 766 ± 22 kg at the start of the present study, were used in an experiment conducted as two simultaneous 3 × 3 Latin squares with 21-day experimental periods. Cows were housed in a cubicle yard with rubber chip filled mattresses and wood shavings as bedding. Drinking water was constantly available via a trough system. Cows were milked through a conventional herringbone parlour twice daily. Rumen fistulas were established and cannulas (Bar Diamond, Parma, Idaho, USA) inserted during a previous lactation. All procedures were licensed and monitored by the UK Home Office under the Animal Science (1986) Procedures Act.

Diets (Table 1) were fed as three total mixed rations (TMR) formulated to be acidogenic (relatively high starch) with each containing (DM basis) 288 g/kg maize silage harvested at 300 g/kg dry matter content by direct cut precision chop forage harvester to give a chop length of 40 mm and ensiled in a walled concrete bunker silo sheeted with two layers of 100 μm polythene weighted with tyres which remained sealed for a minimum period of six weeks before use and 612 g/kg concentrate fed as a blended meal composed (g/kg DM) of wheat (320), barley (144), rapeseed meal (64), soyabean meal (96), molassed sugarbeet pulp (144), wheatfeed (128), prairie meal (16), molasses with urea (Regumaize 44, SvG Intermol Limited, Merseyside, UK; 64) and a vitamin and mineral mixture (24) containing per kg of premix: vitamin A—500,000 IU/kg, vitamin D_3—100,000 IU/kg, vitamin E—1000 IU/kg, Co—50 mg/kg, Mn—4000 mg/kg, Cu—1500 mg/kg, Zn—5000 mg/kg, I—500 mg/kg, Ca—270 g/kg, P—40 g/kg, Na—40 g/kg, Mg—60 g/kg.

Table 1
Composition (g/kg DM unless stated) of dietary ingredients and experimental diets containing either 0 (C), 50 (N5) or 100 (N10) g/kg of stinging nettle haylage.

	Ryegrass silage	Maize silage	Nettle haylage	Concentrate blend	C	N5	N10
Dry matter	235	315	415	890	486	509	534
ME (MJ/kg DM)	11.3	10.4	9.8	14.7	12.1	12.1	12.0
Crude protein	177	82	171	182	172	168	165
aNDF	536	483	552	219	302	304	307
ADF	338	252	434	108	155	160	165
Starch	–	346	–	na[a]	311	311	311
Ash	113	41	118	66	52	52	53

[a] Not available.