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Short communication

Variation in composition of pre-grazed pasture herbage in the United Kingdom, 2006–2012

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ABSTRACT

A total of 8814 samples of pre-grazed herbage samples was analysed by near infrared spectroscopy calibrated against wet chemistry between March 2006 and October 2012. There were decreasing trends over the seven-year period in annual mean crude protein (CP) and nitrates (NO_3). Within years, median values for dry matter (DM), water-soluble carbohydrates (WSC) and metabolisable energy (ME) tended to decrease whilst neutral and acid detergent fibre (NDF and ADF) tended to increase from March to October. There was little change in median monthly NO_3 during the season. Median CP tended to decrease from March to May and to increase thereafter. Within months, the range in concentration of most components tended to be greatest in mid-season, with the exception of DM and ADF which had relatively large ranges in March. The range in CP was large in all months except October. Mean DM was 183 (±39.4) g/kg fresh weight. Mean ME was 11.7 (±0.75) MJ/kg DM. Mean concentrations (g/kg DM) were, 214 (±52.0) for CP, 442 (±61.3) for NDF, 233 (±45.0) for ADF, 90 (±24.7) for WSC and 36.5 (±8.04) for oil. Mean NO_3 was 425 (±781) mg/kg fresh weight. In view of the large range in values within months it is recommended that pre-grazed herbage samples should be taken at weekly intervals to increase accuracy of grazing management and diet formulation for grazing ruminants.

1. Introduction

Eleven million hectares of grassland or 0.64 of the total utilised agricultural area of the United Kingdom is used for ruminant livestock production (DEFRA, 2013). It has been estimated that annual grazed pasture consumption by UK livestock amounts to 29 million tonnes of DM or 0.69 of total annual forage DM production (Wilkinson, 2011). Knowledge of the composition of pasture pre-grazing is an important factor in the determination of grazing strategies, diet formulation, the maintenance of good livestock nutrition and health, and is also relevant in the context of developing management strategies to mitigate the environmental impact of grazing.

Diet formulation to achieve target levels of animal production involves assessing the composition of feed ingredients and balancing nutrient supply to match estimated requirements. In the case of grazing livestock there is equally a need

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Abbreviations: ADF, acid detergent fibre; CP, crude protein; DM, dry matter; ME, metabolisable energy; MADF, modified acid detergent fibre; NDF, neutral detergent fibre; NIRS, near infra red reflectance spectroscopy; N, nitrogen; NUE, nitrogen use efficiency; NO_3, nitrates; SD, standard deviation; UK, United Kingdom; WSC, water-soluble carbohydrates.

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for information on the composition of herbage to be grazed so that nutrient deficiencies or excesses may be balanced by appropriate supplementation to improve accuracy of diet formulation.

Components of pasture herbage consumed by the grazing animal in excess of animal requirements, such as nitrogen (N) and phosphorus, are returned to land in urine and faeces. Emissions to the atmosphere of ammonia or nitrous oxide and leaching of nitrates and phosphates through soil to rivers, streams and groundwater are potential environmental hazards associated with grazing. For example, nitrogen use efficiency (NUE), defined as N output in livestock product as a proportion of total N intake, is an indirect indicator of nitrous oxide emissions since a low NUE indicates high excretion of N in manure. The NUE of ruminant production systems based on grazing is considerably lower than that of monogastric livestock and can be an order of magnitude lower than that of some arable crop production systems (Wilkinson and Audsley, 2013). NUE is inversely related to total N intake (Dewhurst, 2006; Ledgard et al., 2009) and the low NUE of livestock in pasture-based systems of milk and meat production is principally a reflection of the relatively high CP concentration of young leafy grass which can exceed 300 g/kg DM (Beever et al., 2000), and of the consequential excretion by the animal of N which is surplus to requirement.

The composition of the DM of pasture herbage varies with stage of plant maturity, yield per hectare (otherwise known as pasture cover or amount on offer pre-grazing), season, species, cultivar and level of fertilisation (Jarrige, 1989; Beyer et al., 2003). For example, during primary growth the development of stem tissue is reflected in increases in plant cell wall and water soluble carbohydrates and decreases in protein, lipid and minerals (Beever et al., 2000). In addition, the concentration of internal water in herbage decreases with advancing plant maturity (John and Ulyatt, 1987). Intake of DM by the grazing animal may be reduced by high concentrations of internal water in herbage (Vérité and Journet, 1970; John and Ulyatt, 1987; Cabrera Estrada et al., 2004). Low concentrations of DM in pre-grazed herbage, reflecting both high internal water concentrations and external water from rainfall, may combine to restrict the amount of DM consumed by the grazing animal.

Givens et al. (1993) found that concentrations of metabolisable energy (ME) in herbage samples from commercial grassland in England declined with advancing plant maturity. The daily decrease was more rapid in spring than in autumn, most likely reflecting stem growth in the spring period. There was greater variation in ME in spring herbage than in summer or autumn herbage, possibly associated with differences between samples in the proportion of stem tissue which in turn reflected variation in plant species composition and level of grassland fertilisation.

Databases in the United Kingdom of the composition of feeds for ruminant livestock contain little information to inform nutritional decision-making during the grazing season. The “Feed into Milk” Feed Database Version 5 contains a single entry for “Grass, grazing” (Thomas, 2004). The UK Tables of Feed Composition and Nutritive Value for Ruminants contain information on 243 samples of “fresh grass” sub-divided by cultivar and by concentration of ME (MAFF, 1986a, 1992).

The data in this paper, derived from 8814 samples taken on grassland farms in the United Kingdom over a seven-year period, are an attempt to rectify some of the deficiencies in the UK feed databases by including an examination of between-year and seasonal within-year trends in herbage composition.

2. Materials and methods

Samples of pre-grazed pasture herbage were submitted for laboratory analysis by a wide range of advisers and consultants over a seven-year period from January 2006 to December 2012. Two sub-sets of data were available for study: one sub-set (G, 4040 samples) was from grassland on which the species of grazing livestock was not specified and a second sub-set (DG, 4774 samples) was obtained solely from dairy farms. The protocol recommended for obtaining both sub-sets of samples was for the sampler to walk diagonally across the area of pasture about to be grazed in a X-shape, pausing at five sampling points at random to cut with scissors a minimum of two samples at each sampling point, each of 25–50 g of herbage fresh weight, to 4–5 cm above ground level to simulate bites taken by a grazing animal. Individual samples were to be bulked immediately to produce a total weight of about 200 g fresh weight of herbage, sealed in a polyethylene bag and shipped immediately to the laboratory of Frank Wright Trouw Nutrition International for analysis.

Samples were analysed on the day of receipt by the laboratory. On arrival, each sample was mixed thoroughly by hand and a sub-sample of about 100 g fresh weight was weighed then dried in a microwave oven (1800 W) for 1 min and re-weighed. Dry matter concentration was corrected for residual moisture determined by near infra-red reflectance spectroscopy (NIRS) using Foss 5000 and XDS spectrometers (Foss UK Ltd., Birchwood, Warrington, Cheshire, UK) calibrated to in-house wet chemistry. The ratio of standard deviation to standard error of cross-validation ranged from 3:1 to 10:1 and coefficients of determination ranged from 0.78 to 0.99.

Nitrate ions (described here as “nitrates”, NO_3) were determined semi-quantitatively by the Merckoquant Nitrate Test (Merck Chemicals Ltd., Beeston, Nottingham, UK).

Other components were predicted by NIRS using in-house calibration equations based on the following methods: CP was determined by the Dumas combustion method (AOAC, 2006) using a LECO FP528 Nitrogen Analyzer (LECO Instrument (UK) Ltd., Stockport, Cheshire, UK). NDF, assayed without a heat stable amylase and expressed inclusive of residual ash, was determined by the method described in MAFF (1993). ADF, inclusive of residual ash, was determined by the method of Van Soest (1963). ME was predicted from MADF, determined according to the method described in MAFF (1986b). WSC (sugars) were determined by the anthrone-sulphuric acid method described in MAFF (1986b) and ether extract (oil, method A) was determined by ether extract according to the method described in MAFF (1986b). Any values that lay outside either