Prediction of silage intake – current knowledge and future approaches

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Grass silage forms the basal forage for the vast majority of dairy and beef cattle in Ireland, the U.K. and the Nordic countries. However, the chemical composition of silages produced on farm in these countries varies dramatically due to the impact of many factors including sward type, fertiliser application, harvesting and ensiling management, additive treatment, period of storage, fermentation process etc. Given this variation, it is critical to know both the metabolisable energy (ME) concentration and the intake potential of silage offered to cattle to enable the producer to provide the correct level of concentrate supplementation to achieve the optimum level of animal performance. The prediction of the ME concentration of the silage has been possible for some time, however the prediction of intake potential of silage by beef and dairy cattle has eluded researchers until recently.

In the past thirty years many studies have been undertaken to determine the factors influencing silage intake with initial studies producing multifactor relationships to predict intake. However, the accuracy of these relationships was limited due to the fact that they were based on data obtained from a number of studies and were confounded by factors such as breed of animal, previous nutritional history, physiological state, length of feeding period, concentrate feed level and composition. More recently, a major study (Steen *et al*., 1998) was undertaken at this Institute to determine the factors affecting silage intake when offered to beef cattle. One hundred and thirty-six silages were selected to be representative of the broad range of silages which are produced annually, and purchased from commercial farms in Northern Ireland. These silages had been produced from different sward types using different management strategies at ensiling and a range of additive treatments. The 136 silages were offered as the sole diet to 192 steers which had an initial live weight of 415 kg in a partially balanced changeover design experiment. The changeover design used in this experiment enabled the variations in intake due to animal effects to be removed statistically. During the feeding study detailed measurements of intake, chemical composition, *in vivo* digestibility and use of Near Infrared Reflectance Spectroscopy (NIRS) and electrometric titration were undertaken.

The chemical composition of the silages varied dramatically. For example, the concentrations of dry matter varied from 155 to 413 g/kg, ammonia nitrogen

from 45 to 385 g/kg total N, dry matter digestibility from 0.53 to 0.80 and silage intake when offered as the sole feed from 4.3 to 10.9 kg DM/day.

Relationships between individual constituents within the silages and silage intake have been developed to provide an over-view of the extent to which intake is related to, or determined by, the concentration of different chemical constituents within the silages. The results of this analysis clearly indicated that intake was poorly related to some chemical constituents such as pH, buffering capacity and lactic, acetic and butyric acids, which previously were considered to have a major affect on silage intake. Factors of moderate importance included dry matter and ammonia nitrogen concentrations. The key factors which influenced silage intake were the protein and fibre fractions and the rate and extent of digestion of these components within the animal.

One of the most interesting outcomes of this major study was the fact that NIRS, on both dried and fresh samples, provided the most accurate prediction of silage intake ($R^2 = 0.90$) (Park *et al*., 1997). Subsequently a Silage Feeding Information System has been developed commercially at Hillsborough using NIRS.

Thirteen of the 136 silages described above were also offered to dairy cows in late lactation in order to develop a relationship between intake of silage when offered as the sole feed to both beef and dairy cattle.

Is there an ideal concentrate for different silages?

Considerable progress has been made in recent years at this Institute in predicting silage intake when offered as the sole diet. However in most farm situations silages are usually supplemented with varying levels and types of concentrates when offered to high producing dairy and beef cattle. There has been considerable speculation within the animal feed industry whether it is possible to formulate specific concentrates to supplement silages differing in chemical composition, subsequently increasing animal performance from grass silage-based diets. In order to investigate this hypothesis two studies (Keady *et al*., 1998 and 1999) have been undertaken at this Institute with nine grass silages, differing considerably in chemical composition, offered to lactating dairy cows in early lactation. The silages were supplemented with 10 kg of concentrates per day offered in four equal feeds through out-of-parlour feeders. A total of eleven different concentrates were formulated to contain similar crude protein and metabolisable energy concentrations but differing levels of starch and digestible undegradable protein (DUP). The high starch concentrates were formulated predominantly from wheat, barley and soyabean meal while the low starch concentrate was formulated predominantly from sugar beet pulp,

citrus pulp and soyabean. The protein sources in the low and high DUP concentrates were soyabean and SoyPass (Xylose-treated soyabean meal) respectively. Regardless of silage composition, which varied considerably in fermentation, dry matter and digestibility characteristics, changing the ingredient composition of the concentrate did not alter silage intake or milk yield. However, irrespective of silage type, increasing concentrate starch content increased milk protein concentration by 0.56 g/kg per kg starch intake and decreased milk fat content.

Prediction of silage feeding value from the herbage prior to ensiling

Recent developments in feed characterisation of grass silage (Park *et* al., 1997; Steen *et al*., 1998) have facilitated considerable improvements in prediction of silage feeding value. However, this information would be of considerably greater value in practice if predictions of silage value could be determined from analysis of herbage prior to ensiling. A study has just been completed at Hillsborough (Keady *et al*., 2000) where grass, from a total of 75 treatments, was ensiled in 225 small scale silos from swards which had received different management practices prior to and at ensiling. The swards had received either 72, 96, 120, 144 or 168 kg N/ha and were harvested either on 10, 17, 24 or 31 May or 7 June. At ensiling the herbage was ensiled either untreated (U) or treated with formic acid (F) at 3 ml/kg, or an inoculant (I) (Ecosyl, Zeneca Bio-Products) at 3 ml/kg. Following a 176 day fermentation period the silos were opened and sampled for chemical analysis and the prediction of digestible organic matter in the DM and potential dry matter intake using NIRS as described by Park *et al*. (1997). There were large variations in the chemical composition of the herbage at ensiling and in the subsequent silages. Relationships between the chemical composition of the herbage at ensiling for each additive treatment and the feeding value, i.e. intake potential, D-value and potential ME intake, have been developed to provide an over-view of the extent to which intake is related to, or determined by, the chemical composition of the herbage at ensiling. The effects of herbage composition on potential ME intake of untreated and formic acid and inoculant treated silages are presented in equations 1, 2 and 3:

MEI for U = 78.6 – 0.0042 (yield) – 0.076 (NDF) + 0.349 (DM) + 2.596 (PN) – 0.0221 (nitrate) ($R^2 = 0.94$) Equation 1

MEI for F = -4.1 + 2.557 (PN) – 0.0036 (yield) + 0.264 (DM) + 7.28 (pH) ($R^2 = 0.93$) Equation 2

MEI for I = 75.2 – 0.0053 (yield) – 0.087 (Hemi) + 2.401 (PN) + 0.2715 (DM) – 0.0143 nitrate + 0.493 (EE) ($R^2 = 0.94$) Equation 3

where: MEI = metabolisable energy intake (MJ/day); yield = DM yield at harvest (kg DM/ha); NDF = neutral detergent fibre (g/kg DM); DM = dry matter (g/kg); PN =

protein N (g/kg DM); nitrate = mg/kg DM; Hemi = hemicellulose (g/kg DM); EE = ether extract (g/kg DM); pH = pH of grass at ensiling.

Other than digestibility, which was inversely related to herbage yield, the chemical parameters of the parent herbage which were most strongly correlated with silage intake were not the major silage parameters as identified by Steen *et al*. (1998)

Conclusions

Considerable progress has been made in the prediction of silage intake. Silage digestibility, and fractions of nitrogen and fibre are the most important factors affecting silage intake. Regardless of silage type, there were no silage type by concentrate interactions on silage intake, milk yield or milk composition. The chemical composition of the herbage at ensiling is closely related to the feeding value of the subsequent silage.

References

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