EFFECT OF DIET FIBRE CONTENT ON NITROGEN EXCRETION AND EFFICIENCY IN PIEMONTESE YOUNG BULLS

Biagini D., Lazzaroni C.
Department of Animal Science, University of Torino, via L. da Vinci 44, 10095 Grugliasco, Italy
phone: +39 11 6708711; e-mail address: davide.biagini@unito.it

1 INTRODUCTION

The livestock sector is often considered one of the major causes of environmental pollution, especially with regard to nitrogen (N), contributing to its release into the environmental as only a small part of the N input is recovered in animal products. The efficiency of N conversion in animal products (meat, milk and calves) in ruminants is principally related with the product typology and with dietary composition: N utilization and efficiency change by manipulating these factors. Dietary composition is usually related to the feeds local resources and to the productive system adopted.

In recent years we are facing to some important changes in the rearing systems, following the application of the new rules at EU level. For example, the organic livestock development after the promulgation of the Reg. CE 1804/99 and Reg. CE 834/07 or of local legislations (e.g. Rural Development Plan), encourages extensive and sustainable systems and local breeds rearing by mean of economical and institutional aid. In addition, the increasing consumers demand for "environmental friendly" products stimulates the diffusion of extensive rearing systems, also for specialised beef production. It is well known that the extensive rearing systems have several environmental functions and services, some certainly positive (animal welfare, territorial maintenance, spontaneous fires control, landscape appreciation, rural employment, food security, etc.), but others also negative (environmental pollution, erosion, system entropy growth, etc.) (Aimone and Biagini, 1999; Biagini and Lazzaroni, 2001).

For beef cattle, an extensive rearing system implies the use of diets more rich in forages, i.e. fibre, than in concentrate that could increase the farmer's income but affect the efficiency in nutrients usage. Piemontese cattle, numerically the most important Italian beef breed, are reared also in marginal agricultural area, rich in forage resource that could be used for cattle nutrition. So the presence of a considerable number of Piemontese cattle in local marginal areas, reared in a sustainable way, could represent a deterrent to the territorial damage and could have important repercussion on the local socio-economic environment, but the different feeding system adopted could increase the N environmental release if compared to an equal number of cattle reared intensively. Therefore, a trial was carried out to verify the effect of diets rich in fibre on N excretion and efficiency of fattening Piemontese young bulls.

2 MATERIALS AND METHODS

Two groups of 10 Piemontese hypertrophied calves, homogeneous for initial age and weight (8 months of age, 200 kg LW), were reared in two pens (one for each experimental group) under the same environmental condition. The groups were fed for a theoretical daily gain of 1.2 kg with an increasing amount of hay and concentrate to meet the increasing energy and protein requirements, according to the INRA scheme for young bulls of late maturing beef breeds (Garcia *et al.*, 2007), with a diet rich in fibre (FD; forage 60% DM intake; NDF 33.76%; ADF 18.98%) compared to a traditional one (TD; forage 30% DM intake; NDF 19.39%; ADF 10.51%). To provide animals the same amount of protein level, the diets N concentrations were 2.14 and 1.82% DM as average, respectively in TD and FD. According to the feeding requirements, the feedstuff composition was changed from the rearing (until 15 month of age) to the fattening period (until slaughtering), while hay supplies were changed at 16, 17 and 18 month of age of animals; the feeds chemical characteristics of all feedstuffs and hays used during the trial are reported in table 1.

During the trial daily group feed consumption, monthly individual weights, average daily weight gain (ADG), and feed conversion rate (FCR) were recorded. The animals were reared until the same fattening degree according to the market requirements visually evaluated by an expert butcher.

TABLE 1 **Feeds characteristics (% on DM)**

	feedstuff 1	feedstuff 2	hay 1	hay 2	hay 3
DM	87.9	89.9	89.1	89.6	87.8
CP	15.8	15.1	8.7	3.9	7.0
EE	2.6	2.8	3.1	0.8	1.3
NDF	17.3	14.7	60.1	68.5	63.6
ADF	6.9	6.0	32.0	49.5	37.6
Ash	5.0	5.8	8.4	7.2	8.6
NSC	69.7	70.3	47.8	38.6	45.5
UFV	1.06	1.08	0.60	0.59	0.60

Nitrogen excretion was calculated according to the European Commission criteria (ERM-AB-DLO, 1999) as difference between N content in diet and N retention in animal weight gain, and N efficiency as ratio between N retained and N intake. N excretion indexes (N excretion/kg LW and N excretion/head/year) were also calculated.

Data, except N balance elements, were analysed by GLM ANOVA procedure (SPSS, 2008). The model for the live performance and N excretion indexes analysis was:

$$y = \mu + \alpha i + \varepsilon ij$$

where: μ = general mean; αi = feed effect; εij = random error effect.

3 RESULTS AND DISCUSSION

The effect of the diet rich in fibre (FD) was evident at the end of the trial as showed by the rearing performances and feed consumptions reported in table 2, but these data required some comments. In fact, at 18 month of age, when the TD group reached the proper muscular and fattening development according to the market requirements, even if the performances of both groups were comparable, as showed in table 3 (i.e. live weight was 499 vs. 455 kg respectively in TD and FD, without statistical differences), the FD group did not showed the proper muscular development and fattening degree and the animals required an extra fattening period.

TABLE 2 **Calves live performances and feed consumption (mean ± s.d.)**

	TD	FD
trial length (d)	307	420
initial LW (kg)	203.20 ± 31.53	205.50 ± 33.34
final LW (kg)	498.90 ± 45.17	564.40 ± 43.15 **
weight gain (kg)	295.70 ± 31.78	358.90 ± 52.01 **
ADG (kg/d)	0.96 ± 0.10	0.85 ± 0.12
FCR (kg DM/kg weight gain)	6.41 ± 0.64	9.18 ± 1.40 **
DM feedstuff consumption (kg)	1,337.62	1,527.28
DM hay consumption (kg)	538.79	1,704.73

**: P<0.01

The FD reached the right fattening degree only 4 months later, by following the traditional fattening diet. The fattening extra-period brought the FD group to a higher live weight (P<0.01) and feed consumption which affected negatively the rearing performances. In fact FD showed lower weight gains (P<0.01), higher feed conversion rate (P<0.01), and higher feed consumption, both as hay and concentrate, than TD.

Total DM intake, feed N concentration and weight gain are necessary data to evaluate N excretion and efficiency. As previously stated, diets N concentrations were 2.14 and 1.82% DM as average, in TD and FD respectively. The difference of 0.28 percentage points in N concentration correspond to a difference of 1.75 percentage points in CP concentration.

The lowest level of CP for the FD group could increase N usage efficiency, but the different DM intake so as the NDF and ADF diet concentration could affect rumen microbial fermentation, rumen bacteria stock ratio, organic matter digestibility, and then could make fruitless the effect of diet with low CP concentration and modify N availability. Several trials have shown that both total DM intake and/or dietary N concentration have generally negative correlation with N efficiency in cattle (Nadeau et al., 2006; Hristov and Jouany, 2005; Leonardi et al., 2003; Monteils et al., 2002; Frank et al., 2002; Castillo et al. 2001). As showed in table 4, reporting the data of the nitrogen balance, also in this trial the FD higher DM intake seems making pointless the effects of the lowest diet N concentration.

TABLE 3 **Calves mean live weight at the different ages (mean ± s.d.)**

Age (months)	TD	FD
8	225.40 ± 36.52	224.60 ± 35.68
9	253.90 ± 42.72	255.20 ± 37.47
10	284.40 ± 42.53	280.40 ± 38.23
11	317.53 ± 47.99	311.20 ± 40.13
12	355.80 ± 47.10	338.80 ± 40.21
13	377.10 ± 45.02	355.30 ± 44.78
14	397.50 ± 44.74	375.60 ± 40.69
15	420.60 ± 43.41	399.78 ± 39.28
16	445.00 ± 40.44	426.89 ± 44.41
17	481.40 ± 43.43	446.00 ± 41.94
18	498.90 ± 45.17	455.33 ± 39.47
19	---	479.89 ± 40.55
20	---	508.67 ± 44.85
21	---	534.44 ± 40.05
22	---	564.40 ± 43.15

TABLE 4 **Nitrogen balance, efficiency and excretion (mean ± s.d.)**

	TD	FD
daily N intake (g)	130.64	139.81
total N intake (kg)	40.11	58.72
daily N retention (g)	26.01 ± 2.80	23.07 ± 3.34
total N retention (kg)	7.98 ± 0.86	9.69 ± 1.40
daily N excretion (g)	104.64 ± 2.80	116.74 ± 3.34
total N excretion (kg)	32.12 ± 0.86	49.03 ± 1.40
N efficiency (%)	19.91 ± 2.14 **	16.50 ± 2.39
N excretion/kg LW (g)	109.94 ± 13.59	139.84 ± 25.43 **
N excretion/head/year (kg)	38.19 ± 1.02	42.61 ± 1.22 **

**: P<0.01

About the N balance, daily and total N intakes were 7% and 46% higher in FD than TD respectively. The difference in the weight gain affected N retention, higher in TD than FD for daily (+13%) but lowest for total retention (-18%). N daily and total excretions were higher in FD than TD (+12% and +53% respectively). Based on these data the N efficiency was significantly higher in TD than FD (P<0.01).

The N balance data are comparable and allow the estimation of the level of N release in the environment for the studied rearing systems only if the excretion data are referred to the same reference unit (e.g. time or weight). Also after this weighting, the TD showed lowest N excretion than FD: -10% and -21% if referred to the unit of live weight gain (P<0.01) or to the head/year (P<0.01) respectively.

4 CONCLUSION

The results of this trial showed that, in spite of FD being low in N diet concentration that should improve N efficiency, a diet rich in fibre seems to worsen N excretion and efficiency.

This result should be evaluated together with the positive function developed by an extensive rearing system, that for the Piemontese breed normally provide grazing animal on pastures of hilly and mountain area, but also with possible negative others effect not studied in this trial, so as higher requirements if grazing, and hence higher feed consumption, worse feed conversion indexes, higher nutrient losses, etc. So the appraisal of a rearing system should be all-embracing, and consider the feeding system which remains the most important factor affecting N efficiency and excretion and hence environmental release.

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