Estimated requirements of net energy, digestible protein and NDF intake of young Chianina bulls from 400 kg liveweight to slaughter

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ABSTRACT

Three equations have been elaborated and proposed to predict the requirements of net energy and protein digestible in the intestine and NDF voluntary intake of growing young Chianina bulls, starting from 400 kg live weight.

The animals examined in the present study were 100 young Chianina bulls starting from about 400 kg live weight, at 10 months of age, up to the average slaughter weight of 800 kg at 20 months average age. The diet was based on hay and concentrates.

The equation for the prediction of net energy fits quite perfectly to another experimental equation formerly proposed by Giorgetti and is characterised by a very high value of the correlation coefficient for the regression comparison between observed and predicted figures (R^2=0.90). The statistical reliance degree of the PDIN prediction equation is lower, but still very good (R^2=0.75 between observed and predicted values), but that of the estimate of NDF daily intake resulted very poor (R^2=0.26 between observed and predicted values), probably due to the non homogeneity of the intake capacity of the 100 examined animals. The correlation between daily gains and the concentration of NDF in the diet DM results good (R^2=0.87), showing that young Chianina bulls take advantage of the diet fibre.

Further useful indications on the nutritional and dietary requirements of young Chianina bulls are added to the scarce information currently available.

Key words: Feed requirements, NDF intakes, young Chianina bulls.

RIASSUNTO

FABBISOGNI STIMATI DI ENERGIA NETTA, PROTEINE DIGERIBILI E CAPACITÀ DI INGESTIONE DI NDF DEI VITELLONI CHIANINI A PARTIRE DA 400 KG DI PESO

Sono state elaborate e vengono qui proposte tre equazioni per la previsione dei fabbisogni giornalieri di energia netta (espressa in UF carne) e proteine digeribili nell'intestino (espresse in g di PDIN) e per la stima della capacità di ingestione di NDF, da parte di vitelloni Chianini a partire da 400 kg di peso corporeo.

Il materiale animale oggetto dello studio era costituito da 100 vitelloni Chianini a partire dal peso di circa 400 kg, a circa 10 mesi di età, portati al peso medio di macellazione di circa 800 kg, a 20 mesi di età media. La dieta era basata su fieno di prato stabile e concentrati.

L'equazione di previsione dei fabbisogni di energia netta ricalca perfettamente un'altra equazione già proposta da Giorgetti ed è caratterizzata da un elevato valore del coefficiente di correlazione del confronto di regressione fra i valori osservati e quelli previsti (R²=0,90). Il grado di affidabilità statistica dell'equazione di previsione dei PDIN è risultato più basso, ma ancora molto buono (R²=0,75 fra valori osservati e valori previsti), ma quello della previsione della capacità di ingestione giornaliera di NDF è risultato veramente basso (R²=0,26 fra valori osservati e valori previsti), probabilmente a causa della non omogeneità delle capacità di ingestione dei 100 animali studiati. La correlazione fra gli incrementi medi giornalieri e le concentrazioni di NDF riferite alla sostanza secca della dieta è risultata buona (R²=0,87), a dimostrazione del fatto che i vitelloni Chianini utilizzano bene la fibra della razione.
Ulteriori utili indicazioni sui fabbisogni nutritivi e dietetici dei vitelloni Chianini sono così andati ad aggiungersi alle scarse informazioni disponibili fino ad oggi.

Parole chiave: *Fabbisogni nutritivi, Capacità di ingestione, Vitelloni Chianini.*

Introduction

Beef breeds other than the Italian Chianina have been extensively studied in France, Great Britain and North America and requirements in terms of net energy and proteins digestible in the intestine, together with voluntary feed intake, have been estimated (INRA, 1978; Verité *et al.*, 1987; Vermorel *et al.*, 1987; NRC, 2001; Sauvant *et al.*, 2002).

As far as we are aware, in the literature only a few works have been published on the subject (Antongiovanni *et al.*, 1983, 1990; Giorgetti *et al.*, 1995). The first paper was aimed at the estimation of energy requirements of Chianina bullocks between 300 and 600 kg live weight, but in the light of further experimental data, the requirements were overestimated. The paper by Giorgetti *et al.* (1995) provides energy requirement figures very close to those presented in the present work. The comparison between the two sets of data represents a kind of validation of the energy requirement estimates proposed herein. In addition, the present paper provides equations for the prediction of requirements of proteins digestible in the intestine and of the voluntary intake of NDF.

The work is a further contribution to the knowledge of requirements of growing Chianina bullocks, between 400 kg and slaughter weight, which in some cases was more than 900 kg at 21 months of age.

Material and methods

The examined animals were 100 young Chianina bulls, live weight about 400 kg (mean =416 kg, SD=112 kg) at the start of the observation period, at the age of about 10 months (mean=10.3 months, SD=2.9 months), slaughtered very close to 800 kg live weight (mean=774 kg, SD=75 kg), at the average age of about 20 months (mean=19.7 months, SD=1.3 months). The observation study was carried out for seven years, from 2000 through 2006, by the farm "Il Forteto" located in in the Mugello region of Tuscany, a few miles north of Florence. The animals were usually calved in the open air, on pastures, and kept with their mothers as long as possible. At about 10 months of age they were transferred to an indoor barn and kept in pens with 10 bullocks per pen, where they were observed for feed intake and individual weight gain. The observation period lasted slightly longer than 9 months, on average (mean=283 days, SD=89 days). Recorded average daily gains were 1.250 kg, SD=0.182 kg.

The diet was based on mixed hay and a concentrate mixture (see Table 1 for chemical composition and nutritional traits and

Table 2 for the ingredient composition of the mixture). The ration was programmed in order to provide 1 kg concentrate per 100 kg live weight and hay free choice. Feed intake was controlled with the approximation possible with pen group feeding. The mean value of the forage/concentrate ratio was 53.0% hay (SD=4.2%).

Samples of hay and concentrate mixture were analysed each year for dry matter, crude protein, ether extract, ash, according to A.O.A.C. (1990) and for fibre fractions according to van Soest (Goering and van Soest, 1970). The figures in Table 1 are mean values of 3 samples per year. TDN and metabolizable energy (ME) were calculated by means of the equations presented by NRC (2001) for dairy cows. The net energy content, expressed as UFV, the French units for beef cattle, were calculated starting from ME, using the equations proposed by INRA (Vermorel *et al.*, 1987), at the animal production level of 2.0. The amount of protein digestible in the intestine (PDIN) was attributed looking at table figures relative to

hays and concentrates as similar as possible to our feeds. Only PDIN (the protein digestible in the intestine, considering the amount of microbial protein synthesizable from the feed degradable protein) was considered, because it was assumed that energy was not the limiting factor.

The equations proposed in the "results and discussion" section for net energy (UFV) and protein (PDIN) requirements are actually correlation equations with body live weight (LW) and average daily gain (ADG), both in kg.

As the first step, the means of requirements relative to ADG's only were estimated by the differences between the measured intakes of UFV and PDIN corresponding to different gains. As an example, for a body weight of 450 kg and a gain of 1.4 kg/d, let the recorded net energy intake be 7.7 UFV/d and for another animal weighing the same 450 kg, but gaining 1.0 kg/d, let the intake be 6.6 UFV/d. The difference 7.7 – 6.6=1.1 UFV/d was attributed to the higher weight gain 1.4 – 1.0=0.4 kg/d. That is 1.1/0.4=2.75

Table 1.   Chemical composition and nutritional traits of the diet ingredients (g · kg^{-1}).

		Hay	Concentrate mixture
Dry matter		847.5	867.0
Crude protein		58.0	310.5
Ether extract		10.5	51.2
NDF		634.0	300.0
NDIP (crude protein of NDF)		40.0	11.0
ADF		57.5	102.0
ADIP (crude protein of ADF)		13.0	5.0
ADL		57.5	1.8
Ash		58.0	7.0
TDN$_{2x}$		498.4	796.4
Metabolizable energy	Mcal · kg^{-1}	1.78	2.84
NE (French units)	UFV · kg^{-1}	0.50	0.95

Table 2. Ingredient composition of the concentrate mixture (kg · 100 kg⁻¹).

Maize meal	37
Barley meal	33
Commercial protein supplement [*]	30

(*) composed of soybean meal, sunflower meal, calcium salts of palm oil.

UFV/d per kg live weight gain in animals weighing 450 kg. For 650 kg LW and 1.2 kg/d gain, let the intake be 9.4 UFV whilst for another bull of the same weight, gaining 1.0, let the intake be 8.7 UFV/d. The difference 9.4 – 8.7=0.7 UFV/d was attributed to the difference of 0.2 kg of ADG, that is 0.7/0.2=3.5 UFV/d per kg live weight gain in animals weighing 650 kg.

As the second step, the calculated mean values of requirements of weight gains only were correlated with LW's. The equation was:

$$UFV_{gain}/d=(0.004 \cdot LW + 0.6285) \, ADG$$

Then, for each animal the estimated gain requirement was subtracted from the whole net energy intake, in order to estimate the hypothetical maintenance requirement, and the maintenance values were correlated with LW's as well. The equation was:

$$UFV_m/d=0.0075 \cdot LW + 0.8372$$

The total daily energy requirement is obviously given by the sum of the two:

$$UFV/d=0.004 \cdot LW \cdot ADG + 0.6285 \times ADG + 0.0075 \cdot LW + 0.8372$$

That is, the proposed equation:

$$UFV/d=(0.004 \cdot ADG + 0.0075) \, LW + 0.6285 \cdot ADG + 0.8372.$$

Exactly the same procedure was adopt-ed to calculate the prediction equation for PDIN. For the prediction of NDF voluntary intake, the procedure was simpler because NDF intake is not sensibly affected by ADG's but only by the beef animal's weight.

Results and discussion

As previously explained, the prediction equations for NE (UFV) and PDIN requirements and for NDF voluntary intake were calculated from the observed individual intakes, considering the expected average daily gains (ADG) and body live weights (LW), both in kg. The proposed equations for entire males are:

$$UFV/d=(0.004 \cdot ADG + 0.0075) \, LW + 0.6285 \cdot ADG + 0.8372 \quad (1)$$

$$PDIN \, (g/d)=(-0.056 \cdot ADG + 0.681) \, LW + 328.98 \cdot ADG + 75 \quad (2)$$

$$NDF \, (g/d)= 5.5093 \cdot LW + 1575.4 \quad (3)$$

The next step was the validation of equation (1), proposed in the present paper for young Chianina bulls, by comparing it with the analogue, much more complex, equation proposed by Giorgetti *et al.* (1995), calculated from direct measurements performed on Chianina bulls more than ten years ago:

$$UFV/d=0.036 \cdot LW + 0.8526 \cdot ADG^{(0.2771 + 0.6449 \log ADG)} \quad (4)$$

In order to do that, a regression equa-

tion was calculated by comparing the NE requirements predictable by our equation (1) and the requirements predictable by the one proposed by Giorgetti (4). The regression equation is:

$$y=1.0156 x - 0.1673 \quad R^2=0.9978 \qquad (5)$$

where y=daily NE requirements predictable by equation (4) and x=daily NE requirements predictable by the proposed equation (1).

The two equations are practically interchangeable, but ours is much simpler. In fact, R^2 is practically 1. Figure 1 is the graphical representation of the regression.

As a further step, a second regression equation was calculated between the actual NE daily intakes and the predicted ones, by using equation (1):

$$y=0.9472 x + 0.7299 \quad R^2=0.9009 \qquad (6)$$

where y=daily NE requirements predictable by equation (1) and x=actual NE intake.

The correlation coefficient is 0.9. Figure 2 presents the graphical aspect of this equation.

A third comparison was made between actual PDIN daily intakes and predicted ones, resulting in the equation:

$$y=0.6204 x + 303.22 \quad R^2=0.7489 \qquad (7)$$

where y=predicted PDIN (g/d) and x=measured PDIN intake (g/d). The correlation coefficient is not as good as the former one, but still quite good (Figure 3).

The fourth step was the calculation of another regression equation between the actual NDF daily intake and the amounts predictable by equation (3):

$$y=0.2635 x + 3578.4 \quad R^2=0.263 \qquad (8)$$

where y=predicted NDF (g/d) and x=measured NDF intakes (g/d). The correlation coefficient is lowest and predictions definitely unreliable (Figure 4). This may be due to the relative non homogeneity of rumen capacity of Chianina cattle, not submitted to a serious selection for this trait. It is our opinion that a selection in this direction could improve the growth performance

Figure 1.   Regression between daily NE requirements predictable according to Giorgetti *et al.* (1995) and requirements predictable by means of equation (1), proposed in the present paper.
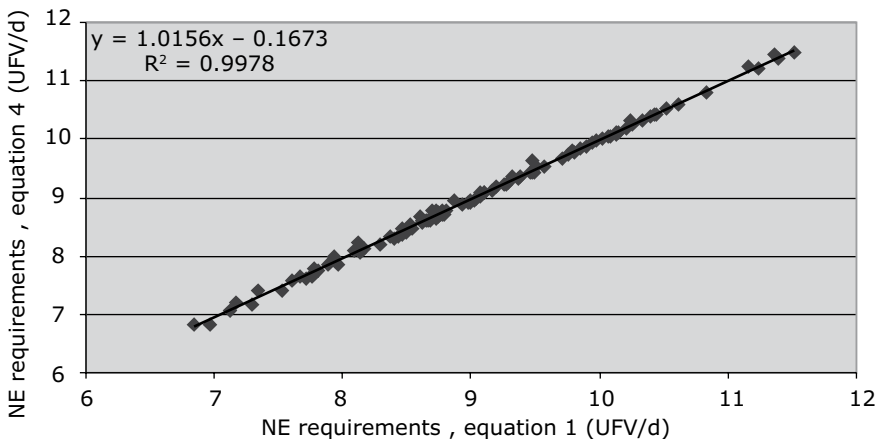
Figure 2.   Regression between actual NE intake and predicted intake by equation (1).
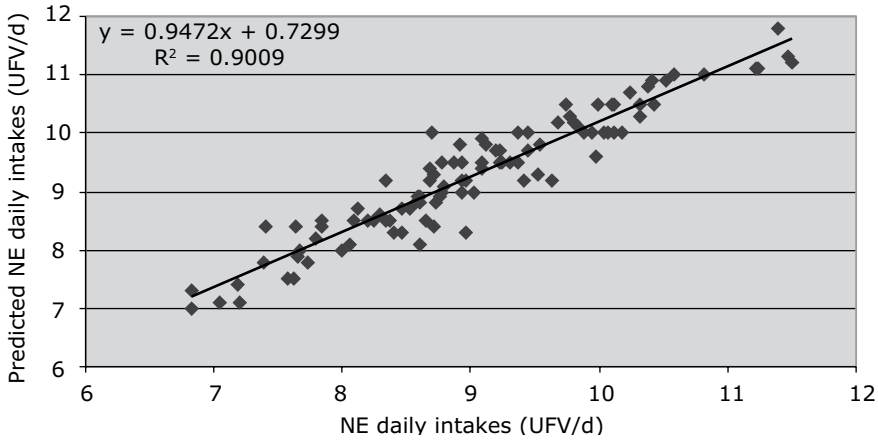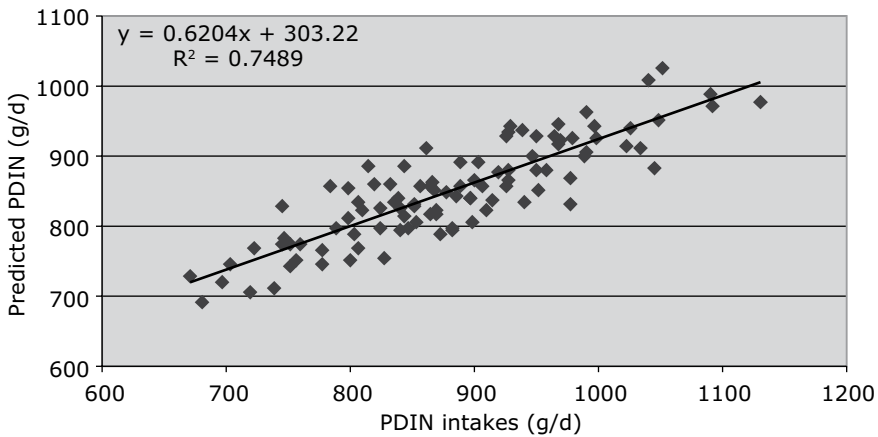

y = 0.9472x + 0.7299
R^2 = 0.9009

(x-axis: NE daily intakes (UFV/d), y-axis: Predicted NE daily intakes (UFV/d))

Figure 3.   Regression between actual PDIN intake and predicted intake by equation (2).

y = 0.6204x + 303.22
R^2 = 0.7489

(x-axis: PDIN intakes (g/d), y-axis: Predicted PDIN (g/d))

of young bulls. In fact, when measured ADG (kg/d) were correlated with NDF concentration in the diet (g/kg DM), the following equation was obtained:

$$y = 0104.49\,x + 315.81 \quad R^2 = 0.8719 \qquad (9)$$

where y=NDF concentration in the diet (g/kg DM) and x=ADG (kg/d). The R^2 value is very promising. The higher the NDF was in the diet, the higher the expected weight gain (Figure 5). It confirmed the experience of the breeders of Chianina bulls, who know that their animals do not take advantage of high amounts of concentrates.

Conclusions

Information about the energy and protein requirements and voluntary feed intake

Figure 4.   Regression between actual NDF intake and predicted intake by equation (3).
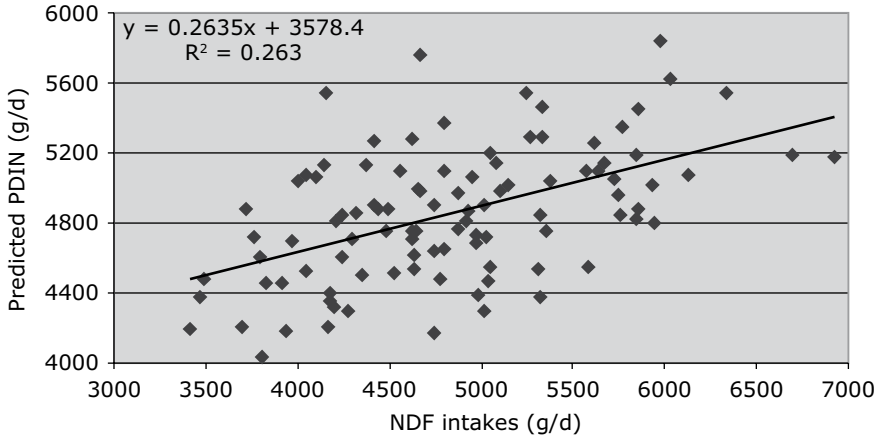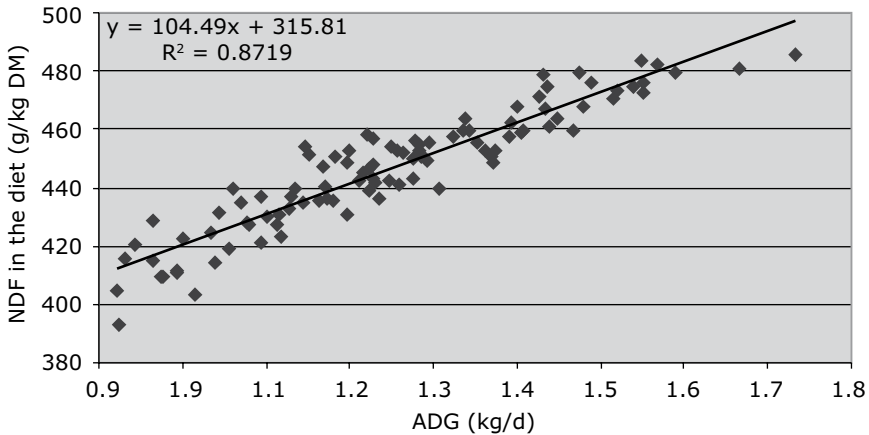

Figure 5.   Regression between actual average daily gains (ADG) and NDF concentration in the diet (g/kg DM).

of young Chianina bulls has been actually lacking to date.

Previous studies have been carried out in conditions that could be defined as "laboratory" conditions because the experimental procedure was conducted on experimental premises. On the contrary, the present work was carried out on a farm, in real "farm" conditions and over the rather long period of 7 years.

The only critical comment that can be made on the experimental design is with regard to the control of intake, which was not individual, but a group measurement of 10 animals, although it was as homogeneous and precise as possible.

Nevertheless, the proposed prediction equations appear to be reliable tools to adequately formulate the diet for the young bulls of this particular breed in order to achieve good performance. Particularly important is

the relationship between expected gains and NDF concentration of the diet, resulting in the recommendation to propose high fibre diets (48-50% NDF on the DM basis).

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