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Modelling the voluntary dry matter intake in Murciano-Granadina dairy goats

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SUMMARY – Thirty six Murciano-Granadina dairy goats were selected from a commercial herd to model the dry matter intake (DMI). Six homogenous groups of 6 goats were allocated in pens. Homogenous groups were made according to the number of lactation, number of births, milk production in previous lactation and body weight. Milk yield and body weight were recorded once a week during a lactation period of 5 months. Voluntary intake was recorded daily as an average of each group. Goats were fed with a total mixed ration (92%DM; 16%CP; 32%NDF; 18 MJ GE/kg DM) and the total amount offered was 3 kg/d in two equal meals at 9:00h (after milking) and 15:00h. Feed intake (ad libitum access) and refusals were recorded for each group of goats daily. Water was freely available. Voluntary intake was expressed in kg DM/d, milk yield (kg/d) was standardized at 3.5% fat corrected milk (FCM) and metabolic body weight ($BW^{0.75}$) was calculated. These weekly data were used to obtain the parameters of the following model; DMI (kg/d) = [a x FCM + b x BW $^{0.75}$] x [1-e$^{(c \ x \ (week \ + \ d))}$]. The residual standard deviation was of 0.0814 kg DMI/d. The model showed a good prediction of the Murciano-Granadina DMI during lactation.

Keywords: Dairy goat, dry matter intake, prediction model.

RESUME – "Modélisation de l'ingestion volontaire de la matière sèche chez les chèvres laitières Murciano-Granadina". Afin de modéliser l'ingestion de la matière sèche (DMI) chez des chèvres, nous avons utilisé trente-six chèvres de race Murciano-Granadina, réparties en six groupes de six animaux chacun selon le numéro de lactation, le nombre de chevreaux de la dernière portée, la production laitière précédente et le poids vif. La production laitière et le poids vif ont été enregistrés hebdomadairement pendant une période de lactation de 5 mois. L'ingestion volontaire a été enregistrée quotidiennement dans chaque groupe. Les chèvres recevaient une ration complète mélangée (92% MS ; 16% MAT ; 32% NDF ; 18 MJ EB/kgMS). Chaque animal a reçu 1,5 kg de cette ration à 9 heures (après la traite) et à 15 heures. L'ingestion volontaire a été exprimée en kg MS/j, et la production de lait a été standardisée à 3,5% de taux butyrique (FCM). Le poids métabolique ($BW^{0,75}$) a été utilisé dans les calculs. Toutes ces données ont été utilisées pour aboutir à un modèle tel que DMI (kg/d) = [a x FCM + b x $BW^{0,75}$] x [1-e$^{(c \ x \ (week \ + \ d))}$]. Ce modèle a montré une bonne prédiction de l'ingestion de la matière sèche pendant la lactation.

Mots-clés : Chèvre laitière, ingestion de matière sèche, modélisation.

Introduction

The accurate measurement or prediction of DMI is essential for the formulation of balanced, economical diets and for diagnosis of milk yield losses. Inaccurate prediction of DMI limits the ability of current models to anticipate the technical and economic consequences of adopting different strategies for production management on individual dairy farms. Lack of precision in intake prediction may limit the advantages of using the currently available systems to evaluate dairy goat diets, such as INRA (1988) and AFRC (1993).

Because of the complexity of factors controlling feed consumption, accurate prediction of daily DMI is difficult. The objective of this study was to determine whether DMI of non-grazing lactating Murciano-Granadina dairy goats could be predicted satisfactorily by an equation based on easy measurable parameters.

Materials and methods

A commercial farm belonging to ACRIMUR (Asociación Española de Criadores de la Cabra

Murciano-Granadina [Murciano-Granadina Goat Breeder Association], entity responsible for the measurement of the Official Herd Book) was selected and thirty-six Murciano-Granadina dairy goats were taken into account in order to make homogenous groups. The 36 goats were chosen according to the number of lactation, number of births, milk production in previous lactation and body weight. Goats were allocated in groups of six and the experimental trial took a lactation period of approximately 5 months, and during this time, milk yield (MY) and body weight (Grupanor-Cercampo electronic scale) were recorded once per week (21 sets of measurements per group). In the present experiment we followed the Murciano-Granadina typical routine in this area, consisting in milking once daily (8:30); kids were weaned at 24-72 h after colostrums intake and reared by artificial feeding. In this case we use a portable milking machine (Flaco-J. Delgado).

Goats were fed with a commercial total mixed ration (TMR) with the following characteristics: 92%DM; 16%CP; 32%NDF; 18 MJ GE/kg DM. The amount offered per day was 3 kg in two equal meals at 9:00 h (after milking) and 15:00 h. Feed intake (*ad libitum* access) and refusals were recorded for each group of six goats daily. Free water was available all the time. TMR was elaborated by NANTA S.A. and the ingredients were alfalfa hay, barley, corn, dehydrated beet pulp, beet molasses, cottonseed and soybean meal. The composition of the diet was obtained using the recommended values of INRA (1988) and AFRC (1993) for energy, protein, fibre, calcium, phosphorus, sodium and chloride. The diet was supplemented with a vitamin-mineral premix (5 g/kg) provided by Trouw Nutrition S.A. All goats were housed in a building in which the environment was partially controlled (temperature varied between 16 and 20ºC). Throughout the trial, the goats were handled according to the principles for the care of animals in experimentation published by NRC (1998).

In this study the intake equation used for lactating dairy cows (NRC, 2001) was evaluated. This model is non-linear based on animal factor. The equation for DMI prediction was:

$$DMI \text{ (kg/d)} = [a \times FCM + b \times BW^{0.75}] \times [1 - e^{(c \times (week + d))}]$$

where *FCM* is fat corrected milk (3.5%), $BW^{0.75}$ is the metabolic body weight and *week* the week of lactation. For the calculation of the different parameters (a, b, c and d), an iterative procedure of non-linear regression was used, the Marquardt method (1963), and the model was fitted using the NLIN procedure of SAS (1997).

Results and discussion

In the approach used here to develop DMI prediction equation, DMI prediction is based on actual data with the inclusion of only animal factors, which would be easily measured or known. Equations containing dietary factors are best used to evaluate post consumption rather than to predict what will be consumed. Parameters and goodness of fit for the model are presented in Table 1. A three-dimensional representation of the model obtained is shown on Figs 1 and 2. Figure 1 shows DMI variation during lactation when FCM increases. We can observe that goats need approximately 5 weeks to achieve the maximum DMI. Figure 2 shows DMI variation during lactation when BW changes. The R^2 of the model was 0.32, explaining less that half of the variation in DMI. This low determination coefficient is found by others studies (Fuentes-Pila *et al.,* 1996; Roseler *et al.*, 1997) when predicting daily DMI across a wide range of management and environmental conditions. These authors indicate that the R^2 is improved by predicting population means instead of individual means. The correlation coefficient between DMI observed and predicted was of 0.57 (Fig. 3). Data adjustment to the model was consistent (measured as predicted minus actual intake), and the residual standard deviation (RSD) was 81 g DMI/d.

Few DMI prediction equations have been published and tested for accuracy (Fuentes-Pila *et al.*, 1996; Roseler *et al.,* 1997). These studies have been elaborated in Holstein cows. Published estimates of the voluntary feed intake of goats are very scarce: NRC (1981) in USA; Kearl (1982) in developing countries; Skjevdal (1982) in Norway; the French standards (Morand-Fehr and Sauvant 1988) and the review of AFRC (1997). In the British review the mean value of 119.6 g DM/kg $BW^{0.75}$ for the lactating goat was calculated. The main problem observed in these studies is the considerable contrast in the types of forage used. For example, maize silage and lucerne hay are common in France and grass hay (with some grass silage) is widely used in the UK.

Table 1. Estimated parameters for DMI (kg) and goodness of fit measurements

Model	Parameters[†]				Goodness of FIT[††]			
	a	b	c	d	R^2	MSE	RSD	RSS
NRC (2001)	0.022	0.107	-0.444	7.221	0.32	0.0066	0.0814	0.589

[†]a,b,c and d: parameters of the model.
[††]R^2 = coefficient of determination; MSE = mean square error; RSD = residual standard deviation; RSS = residual sum of square.
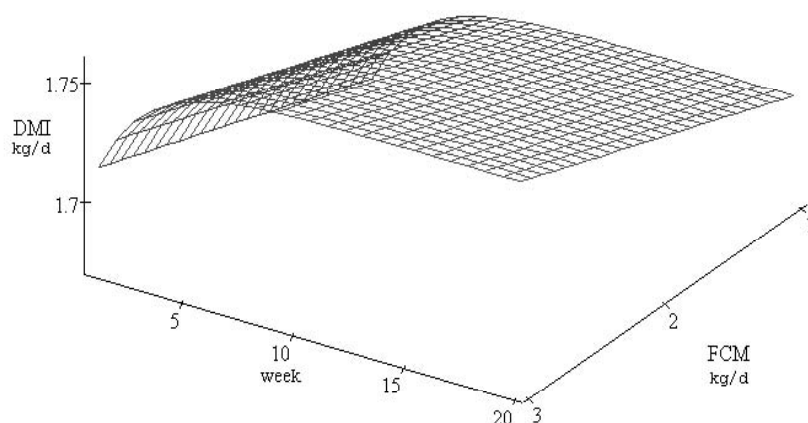

Fig. 1. Dry matter intake (DMI) variation with the fat corrected milk (FCM) production.
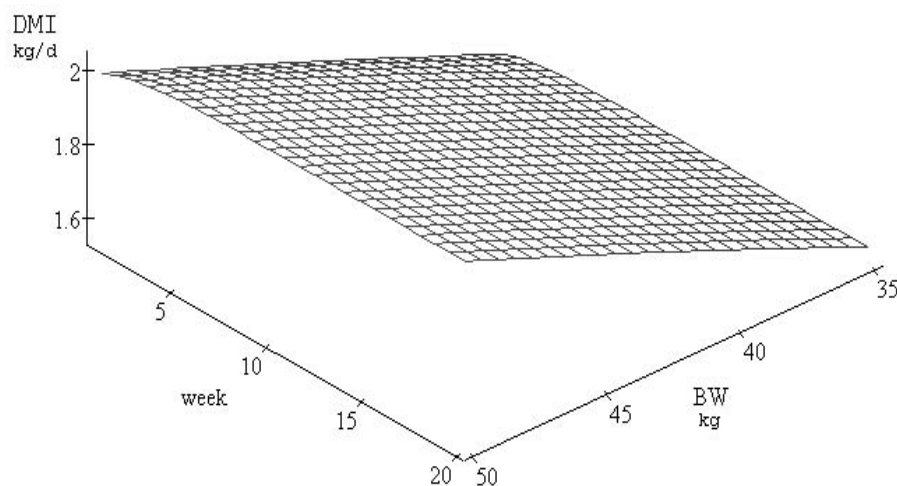

Fig. 2. Dry matter intake (DMI) variation with changes in body weight (BW).

The application of the model is shown in Fig. 4. It predicts DMI during 30 weeks of lactation for a 40 kg live weight goat producing 2 kg FCM/d. The model describes DMI consumption during 30 weeks of lactations successfully. In order to improve prediction accuracy a more quantitative understanding of factors that control eating, and a more descriptive and extensive database will be needed.
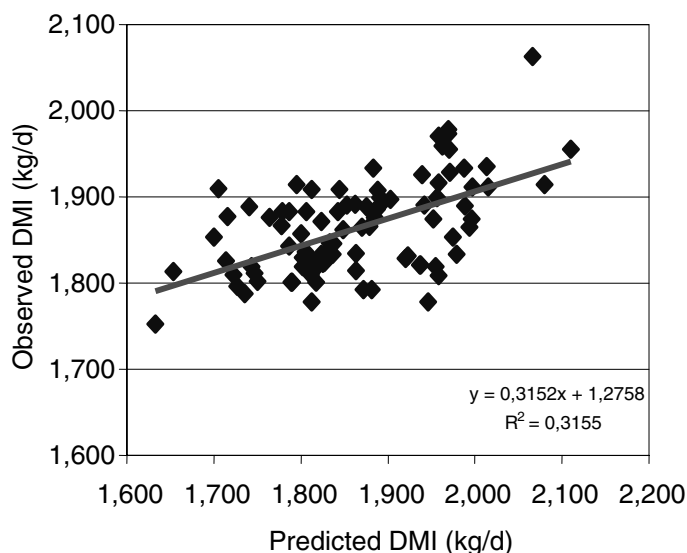
Fig. 3. Predicted (NRC, 2001) and observed dry matter intake (DMI) for dairy goats.
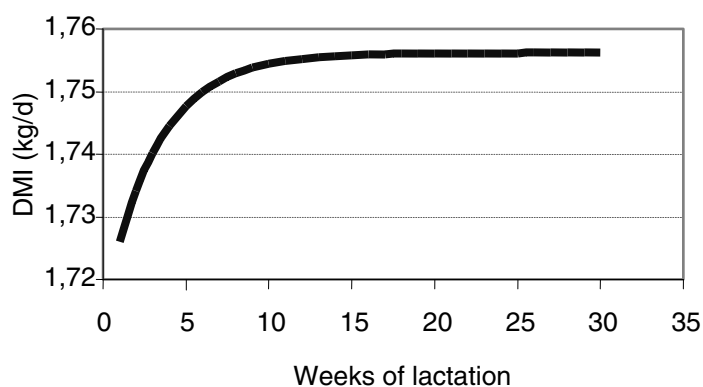

Fig. 4. Prediction or dry matter intake (DMI) (NRC, 2001) adapted for dairy goats (2 kg FCM/d; 40 kg live weight).

Conclusions

This equation is very useful to predict what dairy goats will consume during lactation. It is simple to use because it is based only on goat factors: FCM, body weight and week of lactation.

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