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Water intake of dairy goats in intensive systems

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Abstract. Data on water intake of dairy goats are scarce, especially in temperate climates. The aim of this work was to update previous results concerning the factors of variation of water intake linked to the level of intake (DMI), to composition of the diet or milk production. A data base was built with 505 records obtained during digestibility trials on 140 lactating goats receiving one of the 48 different diets differing for their chemical composition (%NDF = 45.0 ± 8.7%; %CP = 17.7 ± 3.1) or their composition in ingredients (% hay = 26.7 ± 31.1). Total water intake (TWI) was directly proportional to DMI (3.32 l/kg) as well as to the water drunk (2.49 l/kg). There was a substitution between water drunk and water taken in with the feed. Dietary crude protein content and percentage of hay are positively correlated to the ratio TWI/DMI, but the dietary NDF content was not correlated with this ratio. These data pointed out the ability of goats kept in temperate climates to use water more efficiently than other ruminants: low TWI/DMI ratio and total substitution between water taken in with the feed and water drunk.

Keywords. Goats – Water intake – Intensive systems – Diet composition.

Ingestion d'eau par des chèvres laitières élevées dans des systèmes intensifs

Résumé. *Les données concernant les facteurs de variation des ingestions d'eau par des chèvres laitières, en particulier sous des climats tempérés, sont rares. L'objet de ce travail était d'actualiser des résultats sur ce thème en faisant varier le niveau d'ingestion (MSI), la composition de la ration ou la production laitière. Une base de données a été constituée avec 505 mesures obtenues lors d'expériences de digestibilité, sur 140 chèvres recevant l'un des 48 régimes qui différaient par leur composition chimique ((%NDF = 45,0 ± 8,7%; %MAT = 17,7 ± 3,1) or leur composition en ingrédients (%foin = 26,7 ± 31,1). La quantité d'eau ingérée (Eau) est directement proportionnelle à celle de MSI (3,32 l/kg), comme la quantité d'eau bue (2,49 l/kg). Il y a eu substitution entre les quantités d'eau apportée par la ration et bue. Le ratio eau/MSI a augmenté avec les pourcentages de MAT ou de foin, mais n'a pas été corrélé avec le% NDF. Ces résultats ont montré la capacité de la chèvre élevée en milieu tempéré de mieux valoriser l'eau que les autres ruminant: ratio eau/MSI faible et substitution totale entre eau apportée par la ration et eau bue.*

Mots-clés. *Chèvres – Ingestion d'eau – Systèmes intensifs – Composition de la ration.*

I – Introduction

Water requirements of goats have been seldom studied, especially in temperate countries. Nevertheless, it is of importance to know the factors of variation of this parameter as with global warming water will become scarcer, even in temperate countries.

Water requirements are related to feed intake and composition, to level of production and to heat losses (Jarrige *et al.*, 1978).

Some results have been published on this topic (Giger-Reverdin and Gihad, 1991). The aim of this work was to precise the requirements of lactating dairy goats living in a temperate country on the basis of a greater number of measurements.

II – Material and methods

1. Animals and diets

A data base was built with 505 records obtained during 18 digestibility trials carried out between 1978 and 2008 on lactating goats (Alpine or Saanen breeds) housed in digestibility crates (Giger and Hervieu, 1980). A record corresponded to the mean value of measurements obtained on 5 consecutive days. The 140 goats involved in this data base belonged to the INRA AgroParisTech flock of Alpine and Saanen goats kept first at Palaiseau and afterwards at Grignon, near Paris. All measurements were performed between March and mid-July, and about two thirds between March and May. Very different fodders were offered to the animals (alfalfa hay, corn silage, brewer's grain, pressed sugar beet pulps) associated with different types of concentrates which were either rich in starch or in different types of cell walls. A total of 48 diets were tested.

2. Measurements

Water intake is the sum of water drunk and water estimated to have been taken in with the feed. Animals were weighed each week at the beginning of the afternoon. They were milked twice a day, except for 12 animals in the last experiment which were only milked once a day. Feeds, orts and faeces were recorded daily and weekly samples were analysed for dry matter, crude protein (CP) and fibrous constituents (NDF, ADF or ADL). NDF was estimated by the Van Soest method (Van Soest and Wine, 1967) modified by Giger *et al.* (1987).

3. Statistical interpretation

The data were analysed by calculating the mean value of the considered parameter for a diet and weighing it by the number of observations used to obtain it. Thus, it was possible to take into account the between-diets effects and to exclude the within-diet variations between animals. This procedure is similar to a meta-analysis (Sauvant *et al.*, 2008).

For each equation, the statistical information concerned the number of observations (n), the number of diets (ndiets) and the root mean squared error (rmse).

III – Results

1. Variations of the parameters measured

Statistical parameters of the main variables used in the database are given in Table 1. Intake was expressed in kg per day (kg/d) and water intake or milk production in litres per day (l/day).

This table pointed out the considerable variability in the composition of the diets, and the wide ranges in milk production and water intake.

2. Influence of dry matter intake on water intakes

Total water intake (TWI) was directly proportional to dry matter intake (DMI):

$$\text{TWI l/d} = 3.32 \text{ DMI kg/d} \qquad (n = 505, \text{ndiets} = 48, \text{rmse} = 2.77, r = 0.77)$$

Water drunk (WD) was also directly proportional to DMI:

$$\text{WD l/d} = 2.49 \text{ DMI kg/d} \qquad (n = 505, \text{ndiets} = 48, \text{rmse} = 5.45, r = 0.55)$$

Table 1. Statistical parameters of the variables used in a database of 505 records obtained in dairy goats

	Mean	Standard deviation	Minimum	Maximum
Milk production (l/d)	3.34	1.23	0.37	7.70
Body weight (kg)	60.8	10.2	38.9	106.8
Water drunk (l/d)	5.72	2.47	0.25	14.69
Water in feed (l/d)	1.95	1.32	0.17	5.67
DMI (kg/d)	2.31	0.50	1.11	3.65
%DM	59.4	19.0	24.2	89.6
%CP/DM	17.7	3.1	12.0	28.2
%NDF/DM	45.0	8.7	27.7	67.1
%ADF/DM	25.2	6.4	13.1	46.0
%ADL/DM	4.5	1.8	1.2	9.6

A great part of the root mean squared error (rmse) of this last equation can be explained by the quantity of water taken in with the feed (WF):

WD L/d = 3.42 DMI kg/d – 1.12 WF l/d (n = 505, ndiets = 48, rmse = 2.74, r = 0.91)

In this equation, the coefficient related to WF did not differ from 1, which means that there is a total substitution between water taken in with the feed and water drunk.

3. Influence of the composition of the diet on water intakes

As TWI was directly proportional to dry matter intake, the influence of the composition of the diet was tested on the ratio: TWI/DMI.

Crude protein (CP), expressed as % of dry matter, was the only chemical parameter which explained part of the variation of this ratio. The best relationship was obtained when the quadratic effect of CP was included in the model:

TWI/DMI = 0.314%CP – 0.00688%CP^2 (n = 505, ndiets = 48, rmse = 1.13, r = 0.50)

The percentage of hay in the diet explained also part of this variation:

TWI/DMI = 3.19 + 0.00533%Hay (n = 505, ndiets = 48, rmse = 1.17, r = 0.42)

The combination of these two variables explained a greater part of the variation:

TWI/DMI = 2.41 + 0.0458%CP + 0.00421%Hay (n = 505, ndiets = 48, rmse = 1.10, r = 0.54)

4. Effect of production parameters on water intakes

Water intake can also be expressed in function of body weight and milk production:

TWI l/d= 0.0892 BW kg + 0.673 Milk production l/d (n = 505, ndiets = 48, rmse = 3.53, r = 0.59)

IV – Discussion

Heat losses were not considered in this work, because data were obtained on animals kept in a temperate climate as experiments were most of the time performed between March and May. Moreover, goats seem to be more heat tolerant than other ruminants (Ghosh, 1987).

The ratio between water and dry matter intake confirmed previous data with less animals (Giger, 1987). This ratio is lower than the one generally observed with cattle in temperate climate (3.5 to 4) (Jarrige *et al.*, 1978), or with goats in tropical countries (4 to 4.5) (Devendra, 1967).

The substitution between water drunk and water taken in with the feed could be interpreted as a superiority of the goats in the efficiency of renal system as proposed by McGregor (1986).

The effect of crude protein on water intakes agrees with previous results with ewes (Forbes, 1968) and cows (Huber *et al.*, 1994). In fact, when the protein content of the diet increases, there is a need to excrete a greater volume of urine produced by the kidneys because there is a higher quantity of nitrogenous waste products.

There was no effect of cell wall content on the ratio TWI/DMI, but a positive effect of percentage of hay. These contradictory results might be explained by the difference between the physical fibre and the chemical one. The physical fibre (here estimated by the percentage of hay) increased rumination, and therefore also the water intake according to Holzer (1976). In our data, digestibility of NDF was highly variable (from 40 to 77%) and therefore does not predict the intensity of mastication.

The coefficients for milk production and body weight should be taken with care due to a significant correlation between these two variables.

V – Conclusion

These data confirm the ability of goats to use water in a more efficient way than other ruminants, as the ratio TWI/DMI is less than in other ruminants and as they are able to make a substitution between water taken in with the feed and water drunk. They also point out that this ability which was already known in tropical countries exists also in temperate climates.

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