Comparison among actual and estimated milk yields in dairy goats

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Abstract
In dairy goats milk production can be affected by remarkable daily variations in consequence of the incidence of environmental, seasonal and sanitary factors. Usually during lactation animals milk yields are estimated through monthly functional tests operated by the National Breeders Association using specific calculation algorithms. Main limit of this procedure is that lactation milk yields are estimated through few data. Therefore, despite the introduction of special correction factors, milk productions can be over- or underestimated inducing evaluation errors in flock management.
At the experimental farm of the University of Milan 24 Saanen dairy goats (lactation: 1-3; DIM: 10 ± 5) were milked between February and October 2007, and individual milk yields were recorded at each a.m. and p.m. milking session by electronic milk meters (AfiFree™ S.A.E. AFIKIM) and a flock management software (Afigoats™ S.A.E. AFIKIM). Daily milk yields were used to calculate actual milk yields at 100, 210 and 227 days in milking (end of experimentation).
Moreover, for the same group of animals and for the same lactation stages milk yields were estimated following the procedures provided for dairy goats by the regulations of functional controls operated by the National Breeders Association (ICAR AT4 protocol and Fleischmann estimation method).
A comparison among real and estimated milk yields was carried out.
Estimated milk yields showed an underestimation at 100 DIM (-3%) and an overestimation respectively at 210 and 227 DIM (+5% and +2%) in comparison with actual milk yields
Measuring actual animals milk yields through electronic milk meters instead of estimating them through calculation algorithms enable breeders to improve flock management (instantaneous sensing of animals milk yields, proper feed plans formulation, grouping animals on real production levels during milk sessions).

Keywords: milk meter, milk yield, lactation curve, dairy goat.

Introduction
In dairy goats milk production can be affected by remarkable daily variations in consequence of the incidence of environmental, seasonal and sanitary factors. On equal terms, however, milk production can be described by a lactation curve with a quite regular profile.

Usually during lactation milk yields are estimated through functional tests performed monthly by field officers of the National Breeders Association. Many official milk recording methods (A4, AT4, B4, E) are used in ICAR member Countries and among these methods the alternate morning and evening testing scheme (AT method), that is based on weighing and sampling one milking alternated between a.m. and p.m. on monthly basis, has been regarded as an efficient way to achieve good accuracy at convenient cost. But when the yield of a single milking is recorded and animals are milked twice a day, daily and total milk yields have to be estimated. In dairy science several mathematical models have been proposed to

predict milk yield and the factors affecting it (Smith and Pearson, 1981; Wiggans, 1981; Lee and Wardrop, 1984; Delorenzo and Wiggans, 1986; Grossmann and Koops, 1988; Gipson and Grossman, 1990; Cassandro et al., 1995; Lee et al., 1995; Pool and Meuwissen, 1999; Basdagianni et al., 2005) although when only the yield of a single milking is recorded on the test-days, total lactation milk yields can be over- or underestimated inducing evaluation errors in herd or flock management.

Current technologies allow the automatic measurement and recording of milk production at every milking reducing costs and human errors related to the milk recording procedures. Presently various automatic milk recording systems are available on the market for dairy goats (Afimilk, 2007; DeLaval, 2007; WestfaliaSurge, 2007), but only few commercial farms have implemented them due to high costs of the equipment required for automatic animal identification (ID) and for recording of milk volume or milk flow (Ait-Saidi et al., 2008).

Aim of the study was to compare actual milk yields, recorded through electronic milk meters, with milk yields estimated by the Fleischmann's method at different lactation stages in dairy goats.

Materials and methods

A total of 24 Saanen dairy goats (lactation: 1-3; days in milking: 10 ± 5), located at the experimental farm of the University of Milan (North Italy) were used. Goats were milked twice a day at 5 a.m. and 5 p.m. between February and October 2007 in a rapid exit parallel milking parlor (16+16 stalls) equipped with a low milk pipeline, 16 milking units on each side, automatic cluster removers (ACRs), electronic milk meters and automatic head lockers. The milking machine was set up to provide 90 pulsations/min in a 50:50 ratio with a vacuum level of 42 kPa.

Goats were random split into two groups of 12 animals. One group was milked with an ACR switch point of 70 g/min and a delay time of 10 s while the other one was milked disabling the ACR. Reattachment of milking units to goats was discouraged.

Individual milk yields were recorded at each a.m. and p.m. milking session through electronic milk meters (AfiFree™ S.A.E. AFIKIM) and a flock management software (Afigoats™ S.A.E. AFIKIM).

Calculation of actual milk yields

Actual milk yields at 100, 210 and 227 days in milking (end of experimentation) were calculated using individual milk yields recorded at each a.m. and p.m. milking session by electronic milk meters and flock management software. Erroneous milk yield records (equal to 0 kg or greater than 6 kg/milking session) due to failed or incorrect measurements operated by milk meters were not used in the calculation of actual milk yields and an average value between the previous and the next record was considered.

Estimation of milk yields

During the experimental period milk recording was performed monthly by field officers of the National Breeders Association using the ICAR AT4 method. Under such scheme, morning milk yields were recorded in one month then the evening yields were recorded in the following month and so on up to the end of the field test.

Milk yields of each animal at 100, 210 and 227 days in milking were estimated using the Fleischmann's method:

$$\text{Milk yield [kg]} = L_1.\text{int}_1 + \sum_{i=2an}\left(\frac{(L_i + L_{i-1})}{2}.\text{int}_i\right) + L_n.14$$

where:

L_1	=	milk yield of the 1st monthly test;
L_i	=	milk yield of the ith monthly test (i = 1,…, n);
L_n	=	milk yield of the last test;
int_1	=	number of days from kidding to 1st monthly test;
int_i	=	number of days between monthly tests (i-1) and i (i = 1,…, n);
n	=	total number of monthly test for a specific animal.

Statistical analysis

Statistical analysis was performed using the Proc GLM of SAS (SAS, 2000). The following model was used:

$$Y_{ijk} = \mu + CR_i + LN_j + MM_k + CR*MM + \Sigma e_{ijk}$$

where:

Y_{ijk}	=	milk yield;
μ	=	general mean;
CR_i	=	effect of cluster remover (i = 0,1);
LN_x	=	effect of lactation number (j = 1,2);
MM_k	=	effect of measurement method (k = 1,2);
CR*MM	=	effect of cluster remover-measurement method
Σe_{ijk}	=	random error term with zero mean and variance.

The parameters NL, TM, CR were dropped from the model since they did not affect it.

Results

Milk yields at 100, 210 and 227 days in milking averaged respectively:

- 212,5 ± 17,3 kg, 427,2 ± 33,4 kg and 456,0 ± 35,3 kg, when calculated using individual milk yields recorded at each a.m. and p.m. milking session by electronic milk meters;
- 208,2 ± 17,3 kg, 447,0 ± 33,4 kg and 464,6 ± 35,3 kg, when estimated using the Fleischmann's method.

No differences ($P > 0.05$) were detected in actual and estimated milk yields at different lactation stages (Table 1). Anyway the calculation of milk yields by Fleischmann's method entailed a slightly underestimation at 100 days in milking (-2,0 %) and an overestimation at 210 and 227 days in milking (+4,6% and +1,9%) in comparison with actual milk yields (Figure 1).

Table 1. Comparison of estimated and actual milk yield in dairy goats

	Measurement method		SEM	*P*
	Fleischmann	Electronic milk meter		
MY-100[1] [kg]	208,2	212,5	± 17,3	> 0.05
MY-210[2] [kg]	447,0	427,2	± 33,4	> 0.05
MY-227[3] [kg]	464,6	456,0	± 35,3	> 0.05

[1] Milk yield at 100 days; [2] Milk yield at 210 days; [1] Milk yield at 227 days;

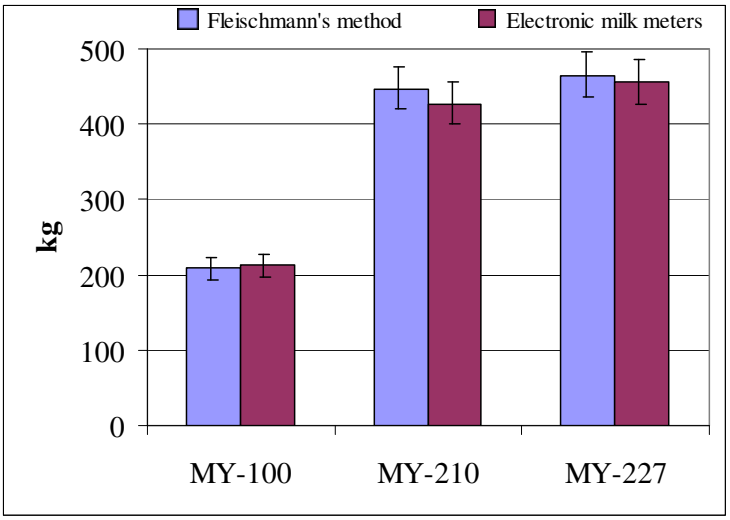

Figure 1 Estimated and actual milk yields at 100, 210 and 227 days in milking

Conclusions

The comparison between milk yields estimated by Fleischmann's method and actual milk yields calculated using individual milk yields recorded at each a.m. and p.m. milking session by electronic milk meters did not highlighted significant differences at anyone of the lactation stages considered. Although only slightly underestimation (-2%) and overestimation (+5% and +1,9%) of milk yield were observed respectively at 100, 210 and 227 days in milking, the main limit of Fleischmann's estimation method is that it considers a constant daily milk production between two records and equal to this two records mean, which doesn't describe the real variation of milk secretion during lactation (Pereira and Oliveira, 2006). On the contrary, measuring animals milk yield on a daily base through milk meters enable breeders to monitor constantly the individual milk production that is an important factor closely related with the health status of animals and their reproduction performance.

Automated systems to record individual milk weights of animals at each milking are widely used on many dairy cows farms in Europe and the US while they are not still common on dairy goats. With the regular use of milk meters, the farmer can select high producing animals for future breeding purposes or low producing ones for culling or that require

attention. By knowing animals milk production, the farmer is better equipped to assess supplementary feed requirements and to formulate proper feed plans. In addition, variation in daily milk yields can be used by management programs in efforts to detect health problems such as mastitis (Hogeveen et al. 1995). Individual milk yields can be used also in grouping animals during a milking session on the base of the actual production levels, improving the milking parlor throughput and reducing the unit cost of milking.

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