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GENETIC EVALUATION OF MILK YIELD UNDER DIFFERENT MILK RECORDING SCHEMES

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SUMMARY

This study was carried out to evaluate the effect of using four different schemes of milk recording on the prediction of the transmitting ability of dairy cattle. Schemes to calculate 305-day milk yield were based on composite test day samples (weighing two milking within 24 hours, i.e. am and pm), am samples only, pm samples only and alternative am-pm samples. Yields calculated from each of the four schemes were considered as four different traits.

A total of 6595 lactations of 2892 cows progenies of 322 sires in a single herd were used. The MTDFREML programs were used to calculate the phenotypic and genetic correlations among the four traits. Heritabilities and predicted transmitting abilities (PTA) were also calculated. Phenotypic correlations were +0.98, +0.96 and +0.94 between composite and each of alternative, am and pm yields, respectively. It was +0.94 and +0.93 between alternative yield and am and pm yields, respectively. It was +0.9 between am and pm yields. Genetic correlations showed the same trend being +0.85, +0.76 and +0.71, respectively. Phenotypic correlations of +0.7 or less were found between am, pm and alternative yields. Heritabilities estimates were 0.21, 0.11, 0.14 and 0.18 for 305-d , am, pm and alternate yields, respectively. Product moment correlations between PTA ranged from +0.72 to +0.95 for all animals and from +0.77 to +0.96 for sires and from +0.73 to +0.94 for cows. Rank correlation between PTA calculated from different schemes ranged from +0.68 to +0.94 with rank correlation of +0.95 between sires' predicted transmitting ability based on 305-d yield and yield from alternating am and pm.

In conclusion, alternate recording of am and pm samples scheme can be applied to milk recording system without altering the genetic evaluation of sires and dams. However, an investigation of the effect of this scheme on estimating transmitting abilities for milk constituents is required.

Keywords: *Milk recording schemes, 305-day milk yield, genetic correlations, phenotypic correlations, predicted transmitting, heritability.*

INTRODUCTION

Milk yield records are important for one or more purposes: herd management decisions, cow selection and sire progeny testing. Accumulated morning and evening (am-pm) daily milk weights provide a precise measure of a cow's total milk yield, but it does incur costly efforts and time. Making milk recording more practical and cost effective would be achieved when milk weights are sampled less frequent. Only single am or pm sampling or alternating between am and pm instead of composite samples (am-pm) would be a way of lesser sampling. Several studies considered the implementation of single or alternating schemes of milk recording to estimate 305-day milk yield (Hargrove, 1994, Palmer *et al.*, 1994, Cassandro *et al.*, 1995, Schaeffer and Jamrozik 1996, Liu *et al.*, 2000 and Van Dyk *et al.*, 2002).

Breeding values for milk yield are traditionally predicted based on estimated 305-day milk yield from test day samples composite samples. Using only single, either morning or afternoon samples or using alternating schemes in calculating the total 305-day milk could result in a different trait from the actual total milk yield. Van Dyk *et al.* (2002) reported a high genetic correlation between the breeding values predicted from composite and single samples, i.e. am or pm. Everett and Wadell (1970) and Delorenzo and Wiggans (1986) stated that bias from taking only am or pm samples could be reduced by alternating between am and pm samples.

The objectives of this study were to 1) estimate the phenotypic and genetic correlations between actual milk yield, estimated yield from am single samples, pm single samples and alternating samples, and 2) investigate the effect of different sampling schemes on predicting breeding values and estimating heritability of milk yield.

MATERIAL AND METHODS

Data utilized were 2892 first lactation records, 2105 second lactation records and 1598 third lactation records of 2892 Holstein cows, daughters of 322 sires. Only records of cows, which started their first lactation after 24 months or before 36 months of age and number of days in milk were more than 180 days were included. Further, a linear regression of am on pm was fitted to detect outliers. Residuals from this regression over three standard deviation units were considered to be evidence of outliers and the whole record was discarded (Cassandro *et al.*, 1995). Therefore, 253 records were eliminated. Cows calved from October 1993 to August 1997 in a single herd owned by a commercial farm, Eastern Province, Kingdom of Saudi Arabia. A total of 8 year-seasons were formed by specifying two seasons of freshening, November to April and May to October. Daily a.m. and p.m. milk weights were recorded. These weights were used to calculate 305-days milk yield in four ways: 1) total milk yield based on composite samples (trait 1 - composite), 2) milk yield based on am samples only (trait 2 am), 3) milk yield based on pm samples only (trait 3 pm), and 4) milk yield based on alternating am and pm samples (trait 4 - alternating).

Data were analyzed using the MTDFREML programs of Boldman *et al.* (1995) based on the following multiple-trait animal model:

$y = Xb + Z_1a + Z_2p + e$

where:

y is a vector of observations of the four traits;

b is an unknown vector of year-season, days in milk and parity fixed effects;

a and p are unknown vectors of additive genetic and permanent environment random effects, respectively;

Z_1 and Z_2 are known incidence matrices for random effects; and

e is a nonobservable random vector of errors.

It was assumed that:
$E(y) = Xb$, $E(a) = E(p) = E(e) = 0$ and

$$V\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \end{bmatrix} = \begin{bmatrix} A\sigma^2_{a1} & \sigma_{a1a2} & \sigma_{a1a3} & \sigma_{a1a4} \\ \sigma_{a2a1} & A\sigma^2_{a2} & \sigma_{a2a3} & \sigma_{a2a4} \\ \sigma_{a3a1} & \sigma_{a3a2} & A\sigma^2_{a3} & \sigma_{a3a4} \\ \sigma_{a4a1} & \sigma_{a4a2} & \sigma_{a4a3} & A\sigma^2_{a4} \end{bmatrix}$$

and A is the additive genetic relationship matrix for animals. σ^2_{a1}, σ^2_{a2}, σ^2_{a3}, and σ^2_{a4} are the direct genetic variance for the four traits. The off diagonal elements represent the direct genetic covariance between the four traits.

$$V\begin{bmatrix} p_1 \\ p_2 \\ p_3 \\ p_4 \end{bmatrix} = \begin{bmatrix} I\sigma^2_{p1} & \sigma_{p1p2} & \sigma_{p1p3} & \sigma_{p1p4} \\ \sigma_{p2p1} & I\sigma^2_{p2} & \sigma_{p2p3} & \sigma_{p2p4} \\ \sigma_{p3p1} & \sigma_{p3p2} & I\sigma^2_{p3} & \sigma_{p3p4} \\ \sigma_{p4p1} & \sigma_{p4p2} & \sigma_{p4p3} & I\sigma^2_{p4} \end{bmatrix}$$

where σ^2_{p1}, σ^2_{p2}, σ^2_{p3}, and σ^2_{p4} are the variance due to permanent environmental effects for the four traits. The off diagonal elements represent the permanent environmental covariance between the four traits and I is an identity matrix.

$$V\begin{bmatrix} e_1 \\ e_2 \\ e_3 \\ e_4 \end{bmatrix} = \begin{bmatrix} I\sigma^2_{e1} & \sigma_{e1e2} & \sigma_{e1e3} & \sigma_{e1e4} \\ \sigma_{e2e1} & I\sigma^2_{e2} & \sigma_{e2e3} & \sigma_{e2e4} \\ \sigma_{e3e1} & \sigma_{e3e2} & I\sigma^2_{e3} & \sigma_{e3e4} \\ \sigma_{e4e1} & \sigma_{e4e2} & \sigma_{e4e3} & I\sigma^2_{e4} \end{bmatrix}$$

where σ^2_{e1}, σ^2_{e2}, σ^2_{e3}, and σ^2_{e4} are the error variance for the four traits. The off diagonal elements represent the error covariance among the four traits. I is an identity matrix.
In addition, cov (a,p) = cov (a,e) = cov (p,e) = o.

The product moment and rank correlations were calculated to investigate the relationships among predicted transmitting abilities for the four studied traits using SAS (1996).

RESULTS AND DISCUSSION

As stated before, the records obtained by the four recording schemes were considered as four different traits. Genetic and phenotypic correlations between composite, am, pm and alternative yield estimates and heritabilites of these measurements are presented in table 1. Estimates of heritability were reported to vary according to the size of data, model and method of analysis (Chauhan and Hyes, 1991). In the present study, heritability estimates were similar to those reported in literature. However, estimate for composite yield was higher than the estimates for other traits under investigation. Heritability estimate for alternative yield was near to the estimate for composite yield, 0.18 and 0.21, respectively. The lowest heitability estimate, 0.11, was for am yield. Phenotypic correlation between composite yield and alternate or am or pm yields were high (+0.98, + 0.96 and +0.94, respectively; $P<0.001$). Phenotypic correlations between alternate yield and am or pm yields were high (+0.94 and +0.93, respectively; $P < 0.001$). Yield from am was highly correlated with pm yield (+0.9; $P < 0.001$). These correlations were similar to those reported by Cassandro *et al.* (1995), Everett and Wadell (1970) and Jasiorowski, *et al.* (1966). The high correlation implies that 305-d yield could be estimated from am or pm or alternating am and pm yields.

Table 1. Heritability (diagonal), genetic correlations (below diagonal), phenotypic correlations (above diagonal) among composite, am, pm and alternative estimated yield

Trait	Composite yield	am yield	pm yield	alternate yield
composite yield	0.21	0.96	0.94	0.98
am yield	0.71	0.11	0.90	0.94
pm yield	0.76	0.55	0.14	0.93
alternate.am-pm yield	0.85	0.67	0.70	0.18

Estimates for genetic correlations revealed the same trend as the phenotypic coreelations. They were +0.85, +0.71 and +0.76 between composite milk yield and alternative, am and pm yields, respectively. This means that 85% of the genetic variability in the total milk yield will be accounted for by utilizing alternate am-pm milk-recording scheme. Genetic coreelations were 0.7 or less between pair of am, pm and alternative yields. As pointed out by Cassandro *et al* (1995), collection of only am or only pm might severely reduce accuracy compared with that with alternative method. Dickinson and McDaniel (1970) stated that imperfect correlation between am and pm could result in high variability for estimating lactation yield based on single milking scheme.

Table 2 shows the product moment and rank correlations between predicted transmitting abilities (PTA) of the four studied traits for all animals, sires and cows. Table 2 shows high to moderate positive product moment correlations between the four traits. The highest product moment correlations, 0.95, 0.96 and 0.94, were between composite yield and alternate yield, for all animals, sires and cows. The rank correlations between those two traits were also the highest, 0.94, 0.95 and 0.93, for all animals, sires and cows. Genetic and rank correlations would display a clear evidence of the possibility of using the alternative method instead of the composite method as a milk-recording scheme. The other values of the product moment and rank correlations showed similar trend but with lower magnitude.

Table 2. Product moment correlations (above diagonal) and rank correlations (below diagonal) among predicted transmitting abilities of composite, am, pm, and alternative yields

Trait	composite yield	am yield	pm yield	alternate yield
All animals:				
composite yield	-	079	0.85	0.95
am yield	0.72	-	0.72	0.75
pm yield	0.81	069	-	0.81
alternate am-pm yield	0.94	071	0.79	-
Sires:				
composite yield	-	0.81	0.83	0.96
am yield	0.75	-	0.77	0.81
pm yield	0.85	0.72	-	0.84
alternate am-pm yield	0.95	0.73	0.82	-
Cows:				
composite yield	-	0.78	0.84	0.94
am yield	0.73	-	0.73	0.74
pm yield	0.80	0.68	-	0.82
alternate am-pm yield	0.93	0.70	0.78	-

CONCLUSIONS

Results from this study showed a near perfect positive genetic correlation between total 305-d milk yield and yield based on alternating am-pm samples in addition to the high rank correlation between PTA for both traits. This indicates that the same genes are possibly responsible for both traits, therefore, could be considered as the same trait. This investigation indicated the possibility of using the alternative am-pm scheme instead of the composite samples in calculating breeding values for milk yield in Holstein cattle. Further research may be needed to investigate the impact of the studied schemes on estimating milk constituents.

REFERENCES

Boldman K.G., L.A. Kriese, L.D. Van Vleck, C.P. Van Tassell and S.D. Kachman, 1995. A manual for use of MTDFREML. A set of programs to obtain estimates of variances and covariances [DRAFT]. U.S. Department of Agriculture, Agricultural Research Service. USA. pp: 137-145.

Cassandro M., P. Cariner, L. Mantovani, B. Contiero, G. Bitante and G. B. Jansen, 1995. Bias and accuracy of single milking testing schemes to estimate daily milk and lactation milk yield. J. Dairy Sci. 78: 2884-2893.

Chauhan V. P. S. and J. F. Hayes, 1991. Genetic parameters for first lactation milk production and composition traits for Holsteins using multivariate restricted maximum likelihood. J. Dairy Sci. 74: 603-611

Delorenzo, M. A. and G. R. Wiggans, 1986. Factors for estimating daily milk yield, fat, and protein from a single milking for herds milk twice a day. J. Dairy Sci. 69: 2368-2394.

Dickinson F. N. and B. T. McDaniel, 1970. Single-milking yields versus 24-hour yields for estimating lactation milk production by test interval method. J. Dairy Sci. 53:200-209

Everett, R. W. and L. H. Wadell, 1970. Sources of variation affecting ratio factors for estimating total daily yield from individual milkings. J. Dairy Sci. 53: 1430-1435.

Hargrove G. L. 1994. Bias in composite milk samples with unequal milking intervals. J. Dairy Sci. 77: 1917-1921.

Jasiorowski, H., J. Kossakowski, and M. Kurowska, 1966. Studies on the accuracy and the possibility of simplifying milk recording. Anim. Breed. Abstr. 34:2864.

Liu Z., R. Reents, F. Reinhardt and K. Kuwan, 2000. Approaches to estimating daily yield from single milk testing schemes and use of am-pm records in test day model genetic evaluation in dairy cattle. J. Dairy Sci. 83: 2672-2682.

Palmer R. W., E. L. Jensen and A. R. Hardie, 1994. Removal of within-cow differences between morning and evening milk yields. J. Dairy Sci. 77: 2663-2670.

SAS, 1996. Procedure Guide, Version 6.12. SAS Inst., Inc., Cary, NC, USA.

Shaeffer, L. R. and J. Jamrozik, 1966. Multi-trait prediction of lactation yields for dairy cows. J. Dairy Sci. 79: 2044-2055.

Van Dyk R., F. W. C. Neser and F. H. Kanfer, 2002. A comparison between single and composite milk sample for genetic evaluation of milk composition in dairy cattle. S. Afr. J. Anim. Sci. 31: 44-49.

التقييم الوراثى لإنتاج اللبن تحت نظم مختلفة لتسجيل اللبن

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أجريت هذه الدراسة لتقييم أثر استخدام نظم مختلفة لتسجيل إنتاج اللبن على التنبؤ بالقدرة المرورية فى ماشية اللبن. تم حساب محصول اللبن الناتج فى مدة ٣٠٥ يوم باستخدام أربعة طرق مختلفة للتسجيل: (١) باستخدام حلبة الصباح والمساء معا خلال ٢٤ ساعة، (٢) باستخدام حلبة الصباح فقط ، (٣) باستخدام حلبة المساء فقط ، (٤) باستخدام التبادل بين حلبة الصباح وحلبة المساء. تم اعتبار محصول اللبن الناتج باستخدام كل من الأربع نظم كصفات مختلفة.

استخدم فى هذه الدراسة بيانات ٦٥٩٥ موسم حليب ناتجة من ٢٨٩٢ بقرة، بنات ٣٢٢ طلوقة فى قطيع واحد. استخدم فى التحليل طريقة MTDFREML لحساب معاملات الارتباط المظهرية والوراثية بين الأربعة صفات وكذلك المكافئ الوراثى لكل صفة بالإضافة إلى قيم القدرة المرورية.

بلغ الارتباط المظهرى بين محصول ٣٠٥-يوم من حلبتى الصباح والمساء و المحصول الناتج كل من تبادل الحلبتين، حلبة الصباح فقط، وحلبة المساء فقط ٠,٩٨ ، ٠,٩٦ ، ٠,٩٤ ، على الترتيب. بينما كان الارتباط المظهرى بين محصول تبادل الحلبتين وكل من محصول حلبة الصباح ومحصول حلبة المساء ٠,٩٤ ، ٠,٩٣ ، على الترتيب. الارتباط الوراثى أظهر نفس اتجاه الارتباط المظهرى حيث بلغ ٠,٨٥ ، ٠,٧٦ ، ٠,٧١ بين محصول ٣٠٥-يوم من حلبتى الصباح والمساء وكل من محصول تبادل الحلبتين ، محصول حلبة الصباح فقط ، محصول حلبة المساء فقط ، على الترتيب. بلغت تقديرات المكافئ الوراثى ٠,٢١ ، ٠,١١ ، ٠,١٤ ، ٠,١٨ لكل من محصول ٣٠٥-يوم من حلبتى الصباح والمساء، محصول حلبة المساء، محصول حلبة الصباح، محصول تبادل حلبتى الصباح والمساء، على الترتيب.

تراوح معامل الارتباط بين القدرة المرورية المحسوبة للأربع صفات ٠,٧٢ ، ٠,٩٥ أما معامل ارتباط الرتب للقدرة المرورية فقد تراوح بين ٠,٦٨ ، ٠,٩٤

تراوحت قيمة معامل ارتباط الترتيب للقدرة المرورية المحسوبة لمحصول ٣٠٥-يوم ومحصول تبادل حلبتى الصباح والمساء بين ٠,٩٣ ، ٠,٩٥ مما يعكس إمكانية استخدام نظام تبادل حلبتى الصباح والمساء للتنبؤ بالقيمة المرورية لمحصول اللبن فى ماشية اللبن مما يتيح إمكانية زيادة عدد المزارع والحيوانات التى يمكن أن تنضم لنظام التسجيل مع تقليل التكلفة، ولكن لابد من دراسة أثر استخدام هذا النظام على التنبؤ بالقيمة المرورية لمكونات اللبن قبل تطبيقه.