Use of daily robotic progesterone data for improving fertility traits in Finnish Ayrshire

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Abstract

Currently, cow's ability to return to cyclicity after calving is mostly evaluated using the first insemination measurements, which are highly influenced by management decisions. However, if consecutive progesterone measurements are used the first heat can be identified accurately even if the cow does not show the clear signs of heat. The data from 14 Finnish dairy herds using DeLaval Herd Navigator™ (HN) system were used to study cow's ability of returning to cyclicity after calving. 1230 Ayrshire cows from parities 1-3 were included in the analysis. The HN system takes milk progesterone samples automatically during milking and apply biological models to calculate the time of oestrus and probability for pregnancy if the cow is inseminated. In this study, the data of the first heat identified by the HN system (CFH) based on progesterone concentrations between 1-100d after calving was used. Commencement of luteal activity (C-LA) was also studied. For first parity cows the mean number of days were 49.9, 38.1, 78.9 and 30.5 for CFH, C-LA, interval from calving to the first insemination (CFI) and interval from first to last insemination (IFL), respectively. Most of the cows in the data had been inseminated for the second heat identified by the HN system. When phenotypic estimates were compared with those from previous studies CFI was 4.5d shorter and IFL 10.3d shorter in HN herds for the first parity Ayrshire cows. Heritability estimates for first parity cows were calculated using DMU software and the linear animal model being 0.27±0.13, 0.23±0.12, 0.07±0.07 and 0.03±0.06 for CFH, C-LA, CFI and IFL, respectively. Genetic correlation between CFH and C-LA for the first parity cows was high, being 0.95±0.06. Because of the small number of animals in the data most of the estimates had high standard errors. However, the magnitudes of the estimates are in line with previous studies where higher heritability estimates have been found for endocrine fertility traits than traditional fertility traits. Results suggest that using milk progesterone information to detect heats shortened CFI in first parity cows and IFL in parity 1-3 cows.

Keywords: progesterone, heat detection, dairy, ayrshire.

Introduction

Fertility is one of the major factors affecting the efficiency of dairy farming. In dairy breeding schemes a large emphasis has been put to selection on high milk yield in past years and many studies have revealed a negative genetic correlation between milk production and fertility traits (e.g. Berry *et al.* 2014). Failure in heat detection also reduces fertility. Poor fertility is associated with high production costs and is one

of the most common reasons for culling. The efficient heat detection program and correct timing of service are crucial to achieve high conception rates. Currently, cow's ability to return to cyclicity after calving is mostly evaluated using the first insemination measurements (CFI), which are highly influenced by management decisions and have low heritabilities (e.g. Berry *et al.,* 2014). There can be large differences between herds on the length of the voluntary waiting period and the visual checks of heats.

Progesterone (P4) is a hormone which is produced by the corpus luteum and the reproduction status of the cow can be determined from P4 concentration. DeLaval Herd Navigator™ (HN, DeLaval International, Tumba, Sweden) management program samples and analyses milk P4 concentration automatically during milking. If consecutive P4 measurements are used, heats can be identified accurately even if cows are not showing the clear signs of heat. Several studies have also revealed that endocrine fertility traits have higher heritabilities than traditional fertility traits (Royal *et al.*, 2002, Berry *et al.,* 2012).

The objective of this study was to estimate genetic parameters of endocrine (P4) fertility traits measured by HN system and compare those traits with the traditional fertility traits in Finnish Ayrshire cows.

Materials and methods

The data from 14 Finnish dairy herds using HN system were used to study cows' ability of returning to cyclicity after calving. Progesterone data were provided by Lattec I/S (Hillerød, Denmark). Data from a period of 2014-2017 were available although some herds had joined later (6 in 2015 and 3 in 2016). 1230 Ayrshire cows from parities 1-3 were included in the analysis. Herd Navigator starts to sample and analyze P4 concentrations 20 d after calving. Raw P4 measurements are smoothed using an extended Kalman filter and a biological model is used to predict the reproductive status of the cow (Friggens & Chagunda 2005, Friggens *et al.,* 2008). The model classifies cows to three different reproductive categories (0 = postpartum anestrus, 1 = oestrus cycling and 2 = potentially pregnant) and calculates the time (d) to the next sample (DNS) (Friggens *et al.,* 2008). Two P4 traits, days from calving to the first heat identified by HN system (CFH) and days from calving to luteal activity (C-LA), were studied. C-LA was calculated as a reproduction status change from 0 to 1 or 2.

CFH is defined as a second heat after calving. Cows tend to have constant low P4 concentrations after calving, therefore first heat is difficult to detect by the P4 curve. In addition, cows are rarely inseminated to the first heat. The model detects when P4 concentration changes from high to low, issue a heat alarm to the user, record that a heat has occurred and will be searching for new heat from around 17 - 18 days later.

Insemination, test day and pedigree data were provided by Faba Coop (Vantaa, Finland) for all cows in those 14 HN farms described above. Four traits were studied, days from calving to the first insemination (CFI), days from calving to the last insemination (CLI), days from first to last insemination (IFL) and the number of inseminations (NI). Two different datasets were created, data 1 had observations for CFH and traditional fertility traits (restricted by CFH = 100 d and CFI = 230 d) and data 2 had observations for CFH and C-LA (restricted by CFH = 100 d).

For statistical analysis DMU software (Madsen & Jensen 2013) and linear animal model were used. Genetic analysis were performed for parity 1 except for C-LA where parities 1-3 were also analyzed together. Herd, calving year, calving month and calving age were included as fixed effects and an animal effect as a random factor. Interactions were not included because of the small data size.

Results and discussion

Descriptive statistics for parity 1 for datasets 1 and 2 are shown in Tables 1 and 2. The mean number of days in univariate analysis were 49.3 (n=763), 50.9 (n=715) and 52.9 (n=465) for CFH and 39.8 (n=752), 37.7 (n=689) and 40.5 (n=460) for C-LA for parities 1, 2 and 3, respectively. Most of the cows in the data were inseminated to the second heat identified by the HN system (First 17.3%, Second 31.2%, Third 18.5%). The mean number of days from calving to the first insemination (CFI) varied between 78.9-86.5 and interval from first to last insemination (IFL) between 30.5-38.7d depending on the parity. Phenotypic estimates from HN herds in parity 1 were 4.5d shorter for CFI and 10.3d shorter for IFL compared to those from previous studies (Kargo *et al.,* 2014, Muuttoranta *et al.,* 2015). CFI was 1d and 5.7d longer and IFL was 6.6d and 4.9d shorter in HN herds for parities 2 and 3, respectively. The mean number of inseminations in HN herds was around 2 for all parities, which are similar with the estimates from previous studies. According to Kargo *et al.* (2014) the average cost of CFI is 0.51 Euros/day and IFL is 2.56 Euros/day for the red dairy breed in Finland. The improvement in herd economic results after HN system is installed could therefore depend on the herd size and herd age structure. HN also reduces farmer's working time in visual checks of heats.

Table 1. Descriptive statistics for CFH and traditional fertility traits for first parity cows (dataset 1).

Trait (days)	n	Mean	SD	Min	Max
CFI	676	78.9	15.8	46.0	184.0
CLI	676	109.4	43.0	52.0	296.0
IFL	676	30.5	40.4	0.0	234.0
CFH	676	49.9	17.7	22.0	100.0

CFI= calving to first insemination, CLI=calving to last insemination
IFL= interval from first to last insemination
CFH= first heat identified by Herd Navigator

Table 2. Descriptive statistics for CFH and C-LA for first parity cows (dataset 2).

Trait (days)	n	Mean	SD	Min	Max
CFH	723	48.4	17.1	22.0	100.0
C-LA	723	38.1	15.7	20.6	89.6

CFH= first heat identified by Herd Navigator, C-LA= commencement of luteal activity

Table 3. Heritabilities (±SE) for commencement of luteal activity (dataset 2).

	C-LA	lnC-LA[1]
Parity 1, n=723	0.23 (0.12)	0.17 (0.10)
Parities 1-3, n=1933	0.22 (0.04)	0.23 (0.04)

[1]natural logarithm of commencement of luteal activity

Heritability estimates for first parity cows in data 1 were 0.27±0.13, 0.23±0.12, 0.07±0.07 and 0.03±0.06 for CFH, C-LA, CFI and IFL, respectively. Correlation between CFH and C-LA from data 2 for first parity cows was high as excepted since traits are quite similar, genetic correlation being 0.95±0.06 and phenotypic 0.90. In bivariate analysis (data 2), heritabilities were lower than in univariate analysis, being 0.20±0.12 for CFH and 0.14±0.11 for C-LA. Heritabilities for C-LA traits are shown in Table 3. These estimates are close to those in previous studies, e.g. Tenghe *et al.* (2015) reported heritabilities of 0.11±0.06 and 0.12±0.05 for CFI and lnC-LA, respectively. Because of the small number of animals in the data, most of the estimates had high standard errors. However, the magnitudes of the estimates are in line with previous studies where CFH and C-LA have found to have higher heritabilities compared to traditional fertility traits (Royal *et al.,* 2002, Berry *et al.,* 2012).

Conclusions

Results suggest that using milk progesterone information to detect heats shortens CFI in first parity cows and IFL in parity 1-3 cows. Progesterone traits (CFH, C-LA) had higher heritabilities than traditional fertility traits and the correlation between these traits were high. Some of the standard errors were high because of the small data size. However, these results suggest the data on endocrine fertility traits measured by automatic systems is a promising tool for improving fertility, specifically when more data is available. It is important that this kind of data from automatic devices is made available to recording and breeding organizations in the future.

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List of references

Berry, D.P., Bastiaansen, J.W.M., Veerkamp, R.F., Wijga, S., Wall, E., Berglund, B., and M. P. L. Calus. 2012. Genome-wide associations for fertility traits in Holstein-Friesian dairy cows using data from experimental research herds in four European countries. Animal 6, 1206–1215

Berry, D.P., Wall, E., and J.E. Pryce. 2014. Genetics and genomics of reproductive performance in dairy and breed cattle. Animal 8 (suppl. 1), 105–121

Friggens, N.C., and M.G.G. Chagunda. 2005. Prediction of the reproductive status of cattle on the basis of milk progesterone measures: model description. Theriogenology 64, 155–190

Friggens, N.C., Bjerring, M., Ridder, C., Højsgaard, S., and T. Larsen. 2008. Improved detection of reproductive status in dairy cows using milk progesterone measurements. Reproduction in Domestic Animals 43, 113–121

Kargo, M., Hjortø, L., Toivonen, M., Eriksson, J.A., Aamand, G.B., and Pedersen, J. 2014. Economic basis for the Nordic Total Merit Index. Journal of Dairy Science 97, 7879–7888

Madsen, P., and J. Jensen. 2013. A user's guide to DMU Ver. 6, rel. 5.2.

Muuttoranta, K., Tyrisevä, A.-M., Mäntysaari, E.A., Pösö, J., Aamand, G.P., Eriksson, J.-Å., Nielsen, U.S., and M.H. Lidauer. 2015. Genetic parameters for female fertility in Nordic dairy cattle. Interbull Bulletin 49, 32–35

Royal, M.D., Flint, A.P.F., and J.A. Woolliams. 2002. Genetic and phenotypic relationships among endocrine and traditional fertility traits and production traits in Holstein-Friesian dairy cows. Journal of Dairy Science 85, 958-67

Tenghe, A.M.M., Bouwman, A.C., Berglund, B., Strandberg, E., Blom, J.Y., and R.F. Veerkamp. 2015. Estimating genetic parameters for fertility in dairy cows from in-line milk progesterone profiles. Journal of Dairy Science 98, 5763–5773