Turk J Vet Anim Sci
29 (2005) 17-22

Research Article

Effect of Certain Factors on Productive and Reproductive Efficiency Traits and Phenotypic Relationships Among These Traits and Repeatabilities in West Anatolian Holsteins

Mustafa TEKERLİ
Department of Animal Science, Faculty of Veterinary Medicine, Afyon Kocatepe University, ANS Campus, Afyon - TURKEY

Mustafa GÜNDOĞAN
Department of Reproduction and Artificial Insemination, Faculty of Veterinary Medicine, Afyon Kocatepe University, ANS Campus, Afyon - TURKEY

Received: 20.06.2002

Abstract: The present investigation was undertaken to study certain factors affecting production efficiency, milk production and reproduction and to estimate the repeatabilities and phenotypic correlations of these traits in Holsteins maintained at different farms in western Anatolia over 3 years (1990 - 1993). The data consisted of 506 first and 232 second lactations of 525 cows. Three production efficiency traits (milk yield per day of lactation length (MYPDLL), milk yield per day of calving interval (MYPDCI) and milk yield per day of age at second calving (MYPDASC)), one production trait (lactation yield (LY)), and one reproduction trait (calving interval (CI)) were studied. The means of MYPDLL, MYPDCI, MYPDASC, LY and CI were 19.04 kg, 15.44 kg, 4.91 kg, 6404.77 kg, and 418.86 days, respectively.

The analyses of variance indicated that the effects of the region-year factor were significant ($P < 0.05$) for all traits, whereas none of the traits was influenced by the parity order. The calving months were significant ($P < 0.05$) for MYPDASC, LY and CI. Least-squares means illustrated that these traits were lower for summer calvers. Age also had an important effect ($P < 0.05$) on MYPDLL, MYPDCI and LY. The positive phenotypic correlation (0.55) between milk yield and calving interval suggested that the higher yielding cows had longer calving intervals. Fertility was also severely depressed when the lactation yield was higher than 7000 kg. The repeatabilities for MYPDLL (0.51), MYPDCI (0.41) and LY (0.43) were high, and low for calving interval (0.10).

Key Words: Milk production, production efficiency, reproduction, phenotypic correlation, repeatability, Holstein

Batı Anadolu Holştaynlarının Üreme ve Üretim Etkinliği Özelliklerine Bazı Faktörlerin Etkisi, Bu Özellikler Arası Fenotipik İlişkiler ve Tekrarlama Dereceleri

Özet: Bu araştırma bazı faktörlerin Holştaynlarda bazı üretim randımanı göstergeleri, süt üretimi ve üremeye etkilerini ortaya koymak ve bu özellikler arasındaki fenetopik korelasyonları ve tekrarlama derecelerini tahmin etmek amacıyla yapılmıştır. Araştırma materyalini TÜRK-ANAFİ süt sığırcılığını geliştirme projesi kapsamında Batı Anadolu'da yetiştirilen 525 ineğin 1990 - 1993 yılları arasında tutulmuş 506 birinci ve 232 ikinci laktasyon kaydı oluşturmuştur. Üç üretim randımanı (laktasyon süresinde günlük süt verimi (LSGSV), buzağılama aralığında günlük süt verimi (BAGSV), ikinci buzağılama yaşında günlük süt verimi (İBYGSV)), bir üretim özelliği (laktasyon verimi (LV) ve bir üreme özelliği (buzağılama aralığı (BA) incelenmiştir. LSGSV, BAGSV, İBYGSV, LV ve BA için ortalama değerler sırasıyla 19,04 kg, 15,44 kg, 4,91 kg, 6404,77 kg ve 418,86 gün bulunmuştur.

Varyans analizleri, bölge – yıl faktörünün tüm özellikleri önemli derecede ($P < 0{,}05$) etkilediğini, buna karşılık laktasyon sırasının hiçbir özellik üzerinde önemli etkiye sahip olmadığını göstermiştir. Buzağılama ayı ise sadece İBYGSV, LV ve BA özelliklerini önemli ($P < 0{,}05$) düzeyde etkilemiştir. En küçük kareler ortalamaları bu özelliklerde en düşük değerlerin yaz aylarında buzağılayanlarda olduğunu göstermiştir. Yaş faktörünün de LSGSV, BAGSV ve LV özellikleri üzerinde etkisi önemli ($P < 0{,}05$) bulunmuştur.

Süt verimi ve buzağılama aralığı arasındaki fenotipik korelasyon (0,55) yüksek verimli ineklerin daha uzun bir buzağılama aralığına sahip olduğunu göstermiştir. Ayrıca süt verimi 7000 kg düzeyini aştıktan sonra döl veriminin baskılanmaya başladığı belirlenmiştir. Tekrarlama derecelerinin LSGSV (0,51), BAGSV (0,41) ve LV (0,43) için yüksek BA (0,10) için ise düşük olduğu saptanmıştır.

Anahtar Sözcükler: Süt üretimi, üretim randımanı, üreme, fenotipik korelasyon, tekrarlama derecesi, Holştayn

Introduction

The reproductive activity of cows in dairy operations is an important factor in milk production. The more frequently a dairy cow calves the greater is the amount of milk produced in her lifetime (1). The calving interval should not be longer than 1 year for obtaining lower costs, profitability and optimum viability of the dairy enterprise (2,3).

In the past, dairy animals have been mainly selected on the basis of their milk yield without giving consideration to other traits. The real merit of dairy animals, however, depends on many traits that need to be considered simultaneously for performance evaluation. Reproductive traits such as age at first calving and calving interval should be taken into consideration in a selection program (4). In several studies some antagonistic genetic and phenotypic correlations between reproductive performance and lactation yield were reported (5-8). To obtain a simultaneous improvement in productive and reproductive traits by overcoming this antagonism, it will be useful to use a practical measure that combines these traits and shows the overall efficiency of a cow. Milk yield per day of calving interval and milk yield per day of age at second calving may be thought of as combinations of production and reproduction. Moreover, the productive and reproductive traits of dairy animals are also affected by various environmental factors like farm operation, age, parity and season (2,4,9-26).

The objective of this investigation was to determine the effects of some environmental factors on production efficiency, milk production and reproduction, and to estimate the repeatabilities and phenotypic correlations of these traits in Holstein cows kept in western Anatolia, Turkey.

Materials and Methods

The data for the present study were collected from 506 first and 232 second lactation records of 525 Holstein cows calving in the Balıkesir, Çanakkale, Aydın, Denizli, İzmir, Manisa, Muğla, Uşak, Burdur and Isparta provinces of the Marmara, Agean and Mediterranean regions of western Anatolia as part of the TURK-ANAFI dairy cattle improvement project from 1990 to 1993. Only the records including lacatation lengths longer than150 days and calving intervals between 300 and 700 days were included.

In the study, 3 production efficiency traits (milk yield per day of lactation length, milk yield per day of calving interval, and milk yield per day of age at second calving), 1 production trait (lactation yield), and 1 reproduction trait (calving interval) were considered. The lactation yields were divided by lactation lengths (days) and calving intervals (days) to get milk yield per day of lactation length (MYPDLL) and milk yield per day of calving interval (MYPDCI), respectively. Similarly, milk yield per day of age at second calving (MYPDASC) was worked out by dividing the first lactation milk yield by age at first calving (days) plus first calving interval.

The effects of region-year (herds were grouped according to breeding regions and years because of small herd size), calving month (1-12), parity order (1-2) and age at calving were determined by the method of least squares (27).

The model:

$y_{ijkl} = \mu + RY_i + CM_j + PO_k + b\,(AGE) + e_{ijkl}$

where

y_{ijkl}: the lth observation in the kth parity, jth calving month and ith region-year.

μ: the overall mean;

RY: the effect of ith region-year group (i: 1,......,12);

CM: the effect of jth calving month (j: 1,......,12);

PO: the effect of kth parity order (k 1, 2);

b (AGE): The partial regression of y_{ijkl} on age at calving;

e_{ijkl}: random error component assumed to be normally distrubuted with mean zero and variance σ^2.

The analyses for MYPDASC were carried out after excluding the parity order and regression of age in the model. The data were corrected for the significant ($P < 0.05$) effects. The influence of lactation milk yield on the production efficiency and calving interval was revealed using 6 milk production categories (< 4000 kg, ≥ 4000 - < 5000 kg, ≥ 5000 - < 6000 kg, ≥ 6000 - < 7000 kg, ≥ 7000 - < 8000 kg and ≥ 8000 kg) and one-way ANOVA. Regression coefficients of production efficiency and calving interval on lactation yield, Pearson correlation coefficients among the traits and repeatabilities were also calculated. The repeatabilites were estimated from the variance components using intraclass correlation and repeated records of the same animal (28-31).

Results

Mean squares from the analyses of variance are presented in Table 1. Region-year had significant (P < 0.05) effects on all traits. The effects of calving month on MYPDASC, lactation yield and calving interval were significant (P < 0.05). Linear regressions on age were also significant (P < 0.01, P < 0.05) for MYPDLL, MYPDCI and lactation yield. In addition, the least-squares means for the group effects of calving month and parity as well as linear regressions on age for milk production categories, regression coefficients on milk production for production efficiency and reproduction, phenotypic correlations among different traits and repeatabilities are shown in Tables (2-6).

Table 1. Analysis of variances for different traits.

Factors	D.F.		MEAN SQUARES				
			MYPDLL	MYPDCI	MYPDASC	LY	CI
Region-Year	11†	11‡	117.74**	65.71**	8.78**	13,345,875.73**	20,595.72**
Month	11	11	16.28	11.25	4.25**	7,335,481.74**	22,173.62**
Parity order	-	1	53..55	18.63	-	27,382.91	11,324.41
Regression on age		1	108.34**	67.82*	-	18,408,748.71*	998.11
Error	483	713	14.93	12.22	1.42	3,141,041.62	5990.28

* P < 0.05, ** P < 0.01.
† Degrees of freedom for MYPDASC. ‡ Degrees of freedom for MYPDLL, MYPDCI, LY and CI.

Table 2. Least squares means for different traits.

Effect	n		MYPDLL (kg)	MYPDCI (kg)	MYPDASC (kg)	LY (kg)	CI (days)
μ	506†	738‡	19.04	15.44	4.91	6404.77	418.86
Months							
January (1)	16	28	18.60a	15.66[a]	5.30[ab]	6885.22[a]	441.62a[b]
February (2)	45	66	18.51[a]	15.13[a]	5.01[abc]	6467.02[ab]	435.79a[b]
March (3)	69	90	19.61[a]	16.06[a]	5.28[ab]	6831.76[a]	426.88a[b]
April (4)	56	86	18.82[a]	15.17[a]	5.09[ab]	6662.18[a]	444.82[a]
May (5)	64	82	18.86[a]	15.44[a]	4.87b[c]	6376.11[ab]	418.26b[c]
June (6)	20	46	18.83[a]	15.10[a]	4.25 [d]	6180.38a[bc]	409.42b[c]
July (7)	23	46	18.29[a]	14.73[a]	4.22 [d]	5698.91[c]	388.88[c]
August (8)	46	62	18.90[a]	15.33[a]	4.60[cd]	5989.18b[c]	393.08[c]
September (9)	50	69	19.13[a]	15.57[a]	5.11[ab]	6403.13[ab]	416.53b[c]
October (10)	63	87	19.59[a]	15.46[a]	4.79b[cd]	6010.35b[c]	392.79[c]
November (11)	38	48	18.81[a]	15.03[a]	4.89[abc]	6496.04[ab]	437.05[ab]
December (12)	16	28	20.57[a]	16.60[a]	5.57[a]	6857.02[a]	421.14a[bc]
Parity order							
1	-	506	18.46[a]	15.09[a]	-	6418.08[a]	427.41[a]
2	-	232	19.63[a]	15.79[a]	-	6391.46[a]	410.29[a]
Regression ona ge			0.11	0.08	-	43.53	0.32

† First lactation number used for MYPDASC. ‡ Lactation numbers used for MYPDLL, MYPDCI, LY and CI.
a,b,c Means connected by the same letter are not significantly different in the same column.

Table 3. Least squares means for production efficiency and calving interval by milk production category.

Production Category (kg)	N		MYPDLL	MYPDCI	MYPDASC	CI
<4000	29[†]	45[‡]	12.87[e]	10.15[f]	2.84[f]	362.63[e]
≥4000-<5000	84	104	15.774[d]	12.41[e]	3.74[e]	385.24[de]
≥5000-<6000	129	183	17.53[c]	13.94[d]	4.52[d]	398.00[cd]
≥6000-<7000	126	162	19.78[b]	16.04[c]	5.18[c]	413.30[c]
≥7000-<8000	70	120	20.67[b]	17.14[b]	5.77[b]	444.62[b]
≥8000	68	124	22.45[a]	19.09[a]	6.63[a]	499.47[a]

[†]First lactation number used for MYPDASC.
[‡] Lactation numbers used for MYPDLL, MYPDCI, LY and CI.
[a,b,c,d,e,f] Means connected by the same letter are not significantly different in the same column.

Table 4. Regression coefficients for production efficiency and calving interval on lactation yield.

MYPDLL (738[†])	MYPDCI (738)	MYPDASC (506)	CI (738)
0.001**	0.001**	0.001**	0.025**

**P < 0.01
[†] Figures in parentheses show the lactation record numbers.

Table 5. Phenotypic correlations among different traits.[†]

	MYPDLL	MYPDCI	MYPDASC[‡]	LY	CI
MYPDLL	-	0.89**	0.74**	0.64**	-0.14**
MYPDCI	-	-	0.80**	0.70**	-0.16**
MYPDASC	-	-	-	0.92**	0.32*
LY	-	-	-	-	0.55**

*P < 0.05
**P < 0.01
[†] The correlations were estimated from 738 lactation records of 525 cows.
[‡] Correlations related to the MYPDASC were calculated from only 506 first lactations.

Table 6. Repeatabilities* for different traits.

Traits	r	S.E.
MYPDLL	0.51	0.05
MYPDCI	0.41	0.05
LY	0.43	0.06
CI	0.10	0.07

* The repeatabilities were estimated from 213 cows having both first and second lactation records.

Discussion

In general, cows calving in hot months (summer) had lower milk yield and production efficiency and shorter calving interval. The results for calving interval seem to contradict the findings of Ray et al. (16), who reported that the fertility parameters were depressed in cows freshening in spring and summer in Arizona, USA. In this study, there was a sympathetic decrease in calving interval with the decrease in milk production. These results suggested that fertility might be more affected by milk production than hot weather in western Anatolia.

The least-squares means in Table 3 indicated that fertility was depressed more severely in cows producing more than 7000 kg of milk. Similarly, Faust et al. (14) reported that this level as 7250 kg in the North Carolina Holsteins. Further, the partial linear regression coefficients in Table 4 showed that production efficiency and calving interval were expected to increase by 1 kg and 25 days, respectively, for every 1000 kg increase in milk production. However, the relationships between these traits may not be linear.

A positive and significant ($P < 0.01$) correlation was found between calving interval and lactation yield. This result was similar to the findings of Olds et al. (5) and Mohiuddin et al. (32). The positive correlation between calving interval and milk yield per day of age at second calving was low but significant ($P < 0.05$). A similar result (0.071) was reported by Deshpande and Bonde (10) in Friesian x Sahiwal crossbreds. These findings indicated that cows having higher lactation yield and milk yield per day of age at second calving would have longer calving intervals. Phenotypic correlations between calving interval, milk yield per day of calving interval and milk yield per day of lactation length were negative but significant ($P < 0.01$) in a desirable way. These were in accordance with the findings (-0.15, -0.24) of Dhumal et al. (11) in Jersey x Red Khandri crossbreds. These results implied that the longer calving interval was associated with lower milk yield per day of calving interval and milk yield per day of lactation length. Lactation yield had positive and significant ($P < 0.01$) correlations with milk yield per day of calving interval, milk yield per day of lactation length and milk yield per day of age at second calving. Similar findings were reported by Deshpande and Bonde (10) in Friesian x Sahiwal crossbreds, and Umrikar and Despande (13) and Vij and Tivana (33) in Murrah buffaloes. Correlations between different production efficiency traits were also significant ($P < 0.01$) in desirable way. These results were in accordance with the findings of Deshpande and Bonde (10) and Dhumal et al. (11) in Friesian x Sahiwal, and Jersey x Red Khandri crossbreds.

Repeatabilities of milk yield per day of lactation length, lactation yield and milk yield per day of calving interval were higher than that of calving interval. Similar findings were also reported by Hatwar and Chawla (34) in Murrah buffaloes. These results suggested that there were higher possibilities of improvement in the first 3 traits, whereas an improvement in calving interval may be possible through better feeding and management practices.

It was concluded that different environmental factors such as region-year and calving month had significant effects ($P < 0.05$) on production efficiency, milk production, and calving interval. The effects of these factors must be taken into consideration when evaluating dairy cows. Milk yield per day of lactation length and milk yield per day of calving interval have high repeatabilities and desirable correlations with lactation yield and calving interval. Therefore, these traits may be preferred by breeders as selection criteria, but further genetic correlation analyses with enough data would be useful for assessing real genetic merit. The correlation between milk yield per day of age at second calving and lactation yield was higher than the others. However, the positive and undesirable correlations between calving interval and this trait should be considered.

Acknowledgements

The authors are grateful to the Turkish Ministry of Agriculture and Rural Affairs for the facilities provided.

References

1. Raheja, K.L., Burnside, E.B., Schaeffer, L.R.: Relationship between fertility and production in Holstein dairy cattle in different lactations. J. Dairy Sci.,1989; 72: 2670-2678.
2. Kamdasamy, N., Lagaiathan, V.U., Krishnan, A.R.: Non-genetic factors affecting calving interval and dry period of Murrah buffaloes. Buffalo Bull.,1993; 12: 63-65.
3. Makuza, S.M., McDaniel , B.T.: Effects of days dry, previous days open and current days open on milk yields of cows in Zimbabwe and North Carolina. J. Dairy Sci., 1996; 79: 702-709.
4. Shafig, M., Khan, A., Rehman, A., Akhtar, P., Awan, M.A.: Effect of year and season of calving on some economic traits in Friesian-Sahiwal Halfbreds. Pakistan Vet. J., 1992; 12: 170-173.

5. Olds, D., Cooper, T., Thrift, F.A.: Relationships between milk yield and fertility in dairy cattle. J. Dairy Sci., 1979; 62: 1140-1144.

6. Berger, P.J., Shanks, R.D., Freeman, A.E.: Genetic Aspects of Milk Yield and Reproductive Performance. J. Dairy Sci., 1981; 64: 114-122.

7. Dong, M.C., Van Vleck, L.D.: Estimates of Genetic and Environmental Covariances for First Lactation Yield, Survival, and Calving Interval. J. Dairy Sci., 1989; 72: 678-684.

8. Schneeberger, M., Hagger, C.H.: Genetic Parameters for Days Open, Milk Yield, and Fat and Protein Content of Swiss Brown Cows. Livestock Prod. Sci., 1984; 11: 261-268.

9. Deshpande, K.S., Bonde, H.S.: Factors Affecting Milk Yield Per Day of First Calving Interval in Friesian X Sahiwal Crossbred Cows. Indian J. Dairy Sci., 1982; 35: 427-432.

10. Deshpande, K.S., Bonde, H.S.: Genetic Aspect of Milk Yield per day of Age at Second Calving in Friesian X Sahiwal Cross-breds. Indian J. Anim. Sci.,1983; 53: 189-191.

11. Dhumal, M.V., Sakhare, P.S., Deshpande, K.S.: Milk Yield per Day of Lactation Length and Milk Yield per Day of Calving Interval in Local (Red Kandhari) and Crossbred Cows. Indian J. Anim. Sci., 1988; 58: 1217-1220.

12. Hillers, J.K., Senger, P.L., Darlington, R.L., Fleming, W.N.: Effect of Production, Season, Age of Cow, Days Dry, and Days in Milk on Conception to First Service in Large Commercial Dairy Herds. J. Dairy Sci., 1984; 67: 861-867.

13. Umrikar, U.D., Deshpande, K.S.: Factors Affecting Milk Yield per Day of Calving Interval and Productive Life in Murrah Buffaloes. Indian J. Anim. Sci., 1985; 55: 782-785.

14. Faust, M.A., Mcdaniel, B.T. Robinson, O.W., Britt, J.H.: Environmental and Yield Effects on Reproduction in Primiparous Holsteins. J. Dairy Sci.,1988; 71: 3092-3099.

15. Parkash, A., Triphati, V.N., Tomer, S.S.: Genetic Analysis of Reproductive Traits of Murrah Buffaloes. Indian J. Dairy Sci., 1989; 42: 426-430.

16. Ray, D.E., Halbach, T.J., Armstrong, D.V.: Season and Lactation Number Effects on Milk Production and Reproduciton of Dairy Cattle in Arizona. J. Dairy Sci., 1992; 75: 2976-2983.

17. Sethi, R.K., Nagarcenkar, R.: Effect of Non-genetic Factors on Production and Reproduction Traits in Murrah Buffaloes. Indian J. Anim. Sci., 1992; 62: 1212-1215.

18. Narasimharao, A.V., Sreemannarayana, O.: Milk Production Efficiency As Influenced by Month and Season of Calving in Murrah Buffaloes in Andhra Pradesh. Indian Vet. J., 1994; 71: 341-344.

19. Chikara S.K., Singh N., Dhaka S.S., Yadav, R.S.: Effect of Certain Factors on Calving Interval of Murrah Buffaloes. J. Dairy., Food Home Sci., 1995; 14: 29-32.

20. Dhar, Y.M., Deshpande, K.S.: Factors Affecting Production Efficiency Traits in Murrah Buffaloes. Indian J. Dairy Sci., 1995; 48: 40-42.

21. Kinsel, M.L., Etherington, W.G.: Factors Affecting Reproductive Performance in Ontario Herds. Theriogenology., 1998; 50: 1221-1238.

22. Boztepe, S., Hodoğlugil, S., Kayış, S.A., Özbayat, H.I.: Reproduction Traits of Holstein and Brown Swiss Cattle. Indian Vet. J., 1999; 76: 395-398.

23. Reksen, O. Tverdal, A. Landsverk, K. Kommisrud, E. Boe, K.E., Ropstad, E.: Effect of Photointensity and Photoperiod on Milk Yield and Reproductive Performance of Norwegian Red Cattle. J. Dairy Sci.,1999; 82: 810-816.

24. Ageeb, A.G. , Hayes, J.F.: Genetic and Environmental Effects on the Productivity of Holstein-Friesian Cattle under the Climatic Conditions of Central Sudan. Trop. Anim. Hlth. Prod., 2000; 32: 33-49.

25. Tekerli, M., Akıncı, Z., Doğan, I., Akcan, A.: Factors Affecting the Shape of Lactation Curves of Holstein Cows from the Balikesir Province of Turkey. J. Dairy Sci., 2000; 83: 1381-1386.

26. Tekerli, M., Küçükkebapçı, M., Akalin, N.H., Koçak, S.: Effects of Environmental Factors on some Milk Production Traits, Persistency and Calving Interval of Anatolian Buffaloes. Livestock Prod. Sci., 2001; 68: 275-281.

27. Harvey, WR: User's guide for LSMLMW PC-1 Version, Mixed model least-squares and maximum likelihood computer program. Ohio State Uni., Columbus, USA. 1987.

28. Yalçın, B.C.: Cevre tesirlerinin istatistiki eleminasyonu. TÜBİTAK tarafından düzenlenen kurs notları (teksir). Ankara, Turkey. 1966.

29. Zar, J.H.: Simple Linear Correlation, Multiple Regression and Correlation, Biostatistical Analysis, second edition. Prentice-Hall Inc., Englwood Cliffs, New Jersey. 1984; 306-360.

30. Vanlı, Y., Özsoy, M.K., Baş, S: Araştırma Rakamlarının Düzeltilmesi, Populasyon ve Biyometrik Genetik. Yüzüncü Yıl Üniv. Ziraat Fakültesi yardımcı ders kitapları yayın no: 4., Van. 1993; 91-100.

31. Van Vleck, L.D.: Heritability, Genetic, Environmental and Phenotypic Correlations. Selection Index and Introduction to Mixed Model Methods. CRC Press Inc., Boca Raton, USA. 1993; 357-397.

32. Mohiuddin, G., Ahmad, Z. Khan, Akhtar, P., Ali, S.: Genetic, Phenotypic and Environmental Correlations Between Milk Yield and Some Other Economic Traits in Sahiwal Cattle. Pakistan Vet. J., 1991; 11: 113-116.

33. Vij, P.K. , Tiwana, M.S.: Phenotypic and Genetic Parameters of Some Production Traits in Buffaloes. Indian Vet. J., 1986; 63: 838-845.

34. Hatwar, R.K., Chawla, S.: Repeatability Estimates of Some Production and Reproduction Trait and Milk Constituents of Murrah Buffaloes. Indian Vet. J., 1988; 65:133-136.