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Evaluation of lactation curve parameters and lactation persistency from number of Iranian Holstein cows

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ABSTRACT

*To evaluate the lactation curve parameters of number of Iranian Holstein dairy cattle, the incomplete gamma function and computational methods of lactation persistency including P_{FIN},P_{CAN} and P_{NLD} has been used. Gamma function parameters estimated in four calving seasons(spring, summer, autumn, winter)by using of SAS statistical software.The results showed that the highest and the lowest amount **a** is related to cows which calve in summer and winter and the highest and the lowest amount **b** is related to cows which calve in spring and winter and the highest and the lowest amount **c** is related to cows which calve in spring and winter. And also the relations in computational methods of lactation persistency showed that the relations between second and third lactation period had the highest correlation in computational methods and the relations between first and third lactation period had the lowest correlation in computational methods.The correlation between lactation curve parameters indicated that correlation among **a** parameter and **b** and c is negative and inverse which states this fact the more milk production in early lactation is the lower slope toward production peak and the faster its reduction after lactation peak. Meanwhile, correlation between **b** and **c** parameters was positive which indicates that the faster lactation curve reaches its peak the faster reaches its end too.*

Keyword: Lactation curve,incomplete gamma function,lactation persistency, Holstein cow

INTRODUCTION

In dairy cows nurturing, the amount of milk, fat and protein production is the main source of rancher income therefore it is obvious that the amount of milk and its compounds is the first category in selection and breeding livestock. Milk production in dairy cows begins after calving and continues until months before the next calving then it reaches its peak point and gradually decreases until the end of lactation period. The fluctuations of milk production within lactation period is called lactation curve which is chart description of relationship between milk production variations and time. Every lactation curve includes an increasing stage and a decreasing stage. The speed of milk production in increasing stage denotes the ramp of decreasing stage and production height in the peak region denotes the produced milk in a lactation period[1-2]. Shimzoa and Emord[3] introduce typical and atypical lactation curve this way: if estimated a, b and c, which respectively are production at the beginning of lactation and the slope of lactation curve toward its peak and the slope of lactation curve from peak point toward the end of lactation, are positive the lactation curve is typical and if they are negative the lactation curve is atypical [4]. The percentage of atypical curves decreases by increase in number of calving and the most percentages of atypical curves are among first calf heifers. Well body condition at the time of calving and effective nurturing plan after that causes increase in production in the peak region in addition, it extends the time of reaching peak of lactation which both factors result in total production increase in a lactation period. Due to close relationship of production peak and total production in a lactation period, production in the peak region (the height of curve)play a significant role in amount of milk production in a lactation period[5, 6].

The percentage of milk production decrease in every month in comparison with previous month is calculated which shows the persistency of lactation[7-8].In other words, production decrease after peak production until end of lactation, ability of cows to maintain the production level after production peak or the percentage of maintained milk from peak of lactation to end of lactation period is called lactation persistency. In cows which speed of production decrease after production peak is high, persistency is low and vice versa.

Totally, heifers and elderly cows after production peak have a production decrease of 0.2 percent per day and 0.3 percent per day respectively[2, 9]. The first estimations of lactation persistency shows that milk production has a 9 % reduction per month in comparison to the last month and this decrease varies from 8% per month for expectant cows to 6% per month for niexpectant cows.

Lactation persistency in the first lactation period is higher than later lactations and the cause is continuing livestock growth, promote breast system and using body storages. High production peak has a negative correlation with lactation persistency which states this fact the higher milk production at the beginning of lactation is, the faster its reduction after lactation peak and probably, because production peak increases by the increase in number of calving the lactation persistency inversely decreases[10]. In cows with high lactation persistency as production in first 100 to 120 days of lactation is low so the negative balance of energy is low and pregnancy of cows is more probable. Therefore, by selection cows with high lactation persistency we could lower the expanse of negative balance by reducing production peak and by preventing decomposition of body storages of cows we could increase the level of pregnancy. Thomas and et al. reported that by every 0.1% promotion in lactation persistency, milk production will increases to 150 kg. The objective of this study is estimation of lactation curve parameters of Iranian Holstein cattle by using incomplete gamma function and specifies correlation between different computational methods of lactation persistency in various periods of lactation.

MATERIAL AND METHODS

In this study, to estimate amounts of lactation curve parameters using incomplete gamma function (wood function) which is the most common and the most obvious mathematical function to describe lactation curve, from 14458 test day record of milk production related to 1725 first birth of Holstein cows including 140 sub-groups of recording date related to 54 cattle of country has been used.

Mathematical method used for data process was $y=at^{b}e^{-c}$ .in which y is the amount of produced milk in t^{th} month of lactation, b is the slope of the curve toward production peak or lactation peak, t is the lactation month, c is the slope of curve from lactation peak point to end of the lactation period and e is Nehperii number which is constant and equals 2.82817.Function parameters has been estimated by SAS statistical software[11]. The statistical model used for analysis of existing data was as follow:

$$Y_{ijklp} = M_i + TD_j + S_k + K_L + \sum_{n=1}^{2} b_n (\alpha ge_{ijklp})^n + \sum_{n=0}^{K} \beta_n \phi_n (\dim^*_{ijklp}) + \sum_{n=0}^{ka-1} a_{pn} \phi_n (\dim^*{}_{ijklp})$$
$$+ \sum_{n=0}^{kp-1} Y_{pn} \phi_n (\dim^*{}_{ijklp}) + \varepsilon_{ijklp}$$

Y_{ijklp} data of test day of milk production attribute

M_i effect of i^{th} constant number of milking per day sub group

TD_j effect of j^{th} constant date of data recording

S_k effect of k^{th} constant of calving season

K_L effect of L^{th} constant of calving year

b_n : n^{th} regression coefficient for age of calving

age_{ijklp} effect of calving age

$\dim^*_{ijklp}$ standardized lactation day

$\phi_n(\dim^*_{ijklp})$ n^{th} Legendre polynomial of lactation day

B_n n^{th} regression coefficient

a_{pn} n^{th} genetic random regression coefficient of p^{th} cow

y_{pn} n^{th} environmental permanent random regression coefficient of p^{th} cow

For the calculation based on random regression model, the DXMRR program included in DFREML software is used and all of the calculations estimated based on average information algorithm (AL-RELML).standardization of lactation day done based on $\dim_m = -1 + 2(\frac{\dim_i - \dim_{\min}}{\dim_{\max} - \dim_{\min}})$ in which $\dim_{min}$ and $\dim_{max}$ in this function are 5th and 305th days of lactation period[11]. Meanwhile, the i^{th} genetic value of animal in the m^{th} day of lactation estimated using $U_m = \sum_{j=0}^{ka-1} \phi_j(X^*_m) a_{ij}$ in which j^{th} polynomial Legendre estimated at the time of j^{th} increasing genetic regression coefficient related to i^{th} animal. In this study, three methods used for calculation of persistency lactation [11].the considerable criteria are:

a) Canadian method: 1/51 sum of genetic values estimated from days 255 to 305 minus 1/21 genetic values estimated from days 50 to 70.

$$P_{CAN} = \frac{1}{15} \sum_{i=255}^{305} EBV_i - \frac{1}{21} \sum_{i=50}^{70} EBV_i$$

b) Finnish model: 1/200 sum of estimated genetic values from days 101 to 300 minus estimated genetic value in 100th day.

$$P_{fin} = \frac{1}{200} \sum_{i=101}^{300} EBV_i - EBV_{100}$$

c) Dutch method: 1/245 sum of estimated genetic values from days 61 to 305 minus estimated genetic value in 60th day.

$$P_{NLD} = \frac{1}{245} \sum_{i=61}^{305} EBV_i - EBV_{60}$$

RESULTS AND DISCUSSION

An important application of mathematical models in livestock science is the description of milk production compared with time in ruminants. When a mathematical form is used to define a lactation curve then milk production could be estimated in every specific period of lactation. If such estimations would be available they can be used as a basis for decisions to remove or retain complained cattle[12-13].

According to the recording made on Holstein cows during four seasons the following results has been achieved. The highest and the lowest amount of a (milk amount in early lactation)related to cows which had calving summer and winter, the highest and the lowest amount of b(curve slope toward production peak)related to cows which had calving spring and summer, the highest and the lowest amount of c(curve slope from peak point to end of lactation)related to cows which had calving spring and autumn.

Fewer amount of c parameter indicates that the cow begins to reduce production slowly after maximum production so lactation persistency is higher[4, 14].The correlation between lactation curve parameters indicated that correlation among a parameter and b and c is negative and inverse which states this fact the more milk production in early lactation is the lower slope toward production peak and the faster its reduction after lactation peak is. Meanwhile, correlation between b and c parameters was positive which indicates that the faster lactation curve reaches its peak the faster reaches its end too. Tables (1) and (2) shows the correlation of lactation curve parameters in various seasons of the year.

Table 1: correlation among lactation curve parameters in spring and summer

parameter in Summer	a	b	c	parameter in Spring	a	b	c
a	1	-0/37	-0/21	a	1	-0/39	-0/19
b		1	0/92	b		1	0/92
c			1	c			1

Table 2: Correlation among lactation curve parameters in autumn and winter

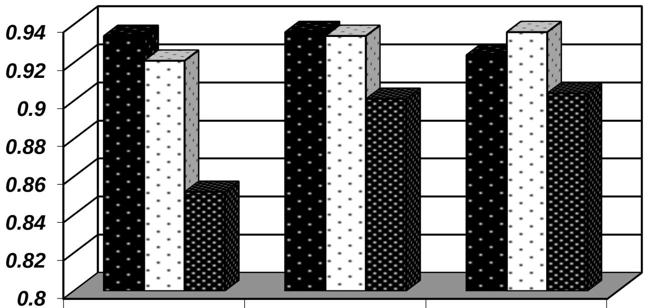
parameter in Winter	a	b	c	parameter in Autumn	a	b	c
a	1	-0/304	-0/19	a	1	-0/32	-0/16
b		1	0/91	b		1	0/94
c			1	c			1

The genetic value of every animal in whole period of lactation can be achieved by summation of estimated genetic values in everyday lactation so with sum of estimated genetic values from days 5 to 305 it is possible to calculate genetic value of every animal in the whole period of lactation. Jamrozik and et al [15] reported that cows with high lactation persistency have lower estimation of genetic value and cows with lower lactation persistency have higher estimation of genetic value. Considering that the amounts of genetic value stated as difference from average and the amounts of genetic value during lactation period after production peak are decreasing, in P_{can} which is difference of genetic values of 255th to 300th days from 50th to 70th days and P_{fin} which is difference of genetic value of 101th to 300th days from 100th day and P_{nld} which is difference of genetic values of 61th to 305th days from 60th[11, 16-17].According to the stated functions the lower amounts indicate higher lactation persistency.

Table 5: The genetic value for amount of produced milk (EBV) and amounts of P_{nld} ,P_{can} and P_{fin} for number of cows and bulls in some of the cattle

ID	EBV	rank	P_{NLD}	P_{CAN}	P_{FIN}	rank	ID	EBV	rank	P_{NLD}	P_{CAN}	P_{FIN}	rank
1127149	487.29	1	-1.1	-0.36	-0.5	1	902745	395.56	1	-1.53	-0.32	-0.097	1
1134547	329.36	4	-1.99	-0.25	-0.2	2	903251	317.36	3	-1.47	-0.29	-0.075	2
1112258	392.48	2	-1.92	-0.26	-0.09	3	901216	349.07	2	-1.43	-0.26	-0.061	3
1152487	385.66	3	-1.77	-0.22	-0.07	5	901498	269.45	5	-1.39	-0.22	-0.013	4
1141557	319.14	5	-1.7	-0.19	-0.06	4	701219	282.18	4	-1.35	-0.067	-0.011	5
1132876	292.18	6	-1.65	-0.17	-0.03	6	872214	235.36	6	-1.29	-0.050	-0.09	6

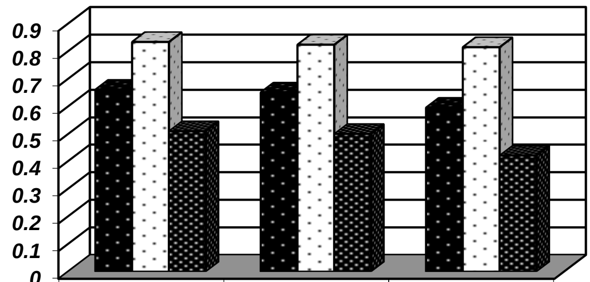
Table 5 indicates the differences among different animals from aspect of lactation persistency and variation of animal ranking for 305 days production and production persistency. For example animal with rank 4 in milk production in whole period of lactation gain rank 2 in lactation persistency. So lactation persistency as an economic character has different variations from produced milk in the cows and should be considered as an economic attribute in animal selection.



	first lactation	second lactation	third lactation
PCAN-PFIN	0.934	0.936	0.924
PCAN-PNLD	0.921	0.934	0.936
PFIN-PNLD	0.852	0.901	0.904

Fig. 1: Correlation between three different computational methods of lactation persistency in three lactation period

The correlation among three different computational methods of lactation persistency in three periods of lactation showed that the most correlation in first and second period was among P_{fin} and P_{can} and in third period of lactation the most correlation was between P_{nld} and P_{can}. Higher correlation indicates the fact that these parts of lactation period are more affected with genetic differences among the animals and also include the start and finish of milk production decreasing stage which is compliance with results of P_{oso} et al [9].In different periods of lactation when P_{can} and P_{fin} is used the relations were similar but this relations was low for P_{nld} which means that P_{nld} compared with P_{can} and P_{fin} had lower stability among different periods of lactation and it maybe depend on the time of milk production peak. So cows with slower production peak have lower genetic value for 60 days lactation but include high amounts of genetic values for times of more than 60 days lactation which causes increase in P_{nld}. The relations between P_{fin} and P_{nld} in the first period of lactation were relatively low which maybe it is related to milk production peak which on average occurs in the 60th day of lactation.



	PCAN	PFIN	PNLD
first and second lactation	0.661	0.651	0.596
second and third lactation	0.834	0.824	0.815
first and third lactation	0.511	0.501	0.421

Fig. 2: sub correlation among different lactation periods for amounts of P_{can}, P_{fin} and P_{nld}

From three different computational methods of lactation persistency between first and second period of lactation, second and third lactation and first and third lactation the most correlation and the least correlation related to P_{can} and P_{nld} respectively. Relations between computational methods of lactation persistency in different stages of lactation indicate that relations between second and third period of lactation had lowest correlation among computational methods.

CONCLUSION

To fit lactation curves obtained from the records of milk production in dairy farms, the mathematical models to fit these curves to their best state is required. The exact fit of lactation curve helps the producers to use records to meet nurturing management and reasonable correction in dairy cattle.

REFERENCES

[1] Cole,J.B and Vanraden, P.M. *J.Dairy Sci*.**2006**; 89:2722-2728.
[2] Shanks, R. D., Berger, P. J, Freeman A. E, and Dickinson F. N. *J. Dairy Sci*. **1981**; 64: 1852 – 1860.
[3] Shimizu,H. Umrod,S. *Jpn.J. Zootech. Sci*. **1976**; 47:733-738.
[4] Wood, P. D. P. *Anim. Prod*., **1997**; 11: 307 – 316.
[5] Tomas, B. Prospects for improving lactational persistency. Dairy Science Group. Ag Research Ruakura Private Bag 3193. Hamilton, New Zealand. **1997**; 319 – 339.
[6] Yousefi-Golverdi A, Hafezian H, Chashnidel Y, Farhadi A. *Afr. J.Biotechnol*. **2012**; 11: 2429-2435.
[7] Dekkers, J. C. M, Jamrozik, J. Ten Hag, J. H. Schaeffer, L. R. and Weersink. A.Genetic and economic evaluation of persistency in dairy cattle proc. international work shop on genetic improvement of functional traits in cattle, **1996**; 12: 97-100.
[8] Solkner, J. Fuchs,W. *Livet. Prod. Sci*. **1987**; 26: 305 – 319.
[9] Keown, J. F., Everret. R. W, Empect N. B, and Wadell L. H. *J. Dairy Sci*.**1986**; 69: 769 – 781.
[10] Cole, J. B., VanRaden, P. M. A Manual for Use ofBESTPRED: A Program for Estimation of Lactation Yield andPersistency Using Best Prediction, Available: http://www.aipl.arsusda.gov/software/bestpred/docs/Best Prediction Manual.pdf.Accessed Nov. 1, **2007**.
[11] Poso, J. *Interbull Bulletin*, **2003**; 27.
[12] Tomas, B. Prospects for improving lactational persistency. Dairy Science Group. Ag Research Ruakura Private Bag 3193. Hamilton, NewZealand. **1997**; 319 – 339.
[13] Gengler, N., Keown, J. F and Van Vleck, L. D.*Braz. J. Genet*. **1995**; 18: 237 – 243.
[14] Vanderwerf, J. H. J and Schaeffer L. R. Random regression in animal breeding course notes. CGIL Guelph. June **1997**; 25-28. Available http://www.agbu.une.au/kmeyer/course notes/html.
[15] Jamrozik, J., Schaeffer, L. R, and Dekkers, J. C. M. *J. Dairy Sci*.**1997**; 80: 1217 – 1226.
[16] Jamrozik, J., Jansen, G., Schaeffer, L. R. and Liu Z. *Interbull Bulletin*, **1998**; 17: 62-64.
[17] Torshizi, M.E., Aslamenejad, A.A., Nassiri, M.R., Farhangfar, H. *South Afr. J. Anim. Sci*.**2011**; 41:104- 115.