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Heritability Estimates of Protein %, Fat %, Lactose %, Non Fat Solids and Total Solids of Dairy Cattle in Northern Thailand

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Abstract

Heritability is the ratio of additive genetic variance to phenotypic variance. The possible range of values for heritability is 0 to 1.0, because additive genetic variance is a part of phenotypic variance. Phenotypes are measured traits influenced by genetic and environmental effects. The higher the heritability the greater the genetic control on the trait, and the more rapidly selection will result in genetic progress. Fat, protein and milk yield as well as size of the individual have high heritabilities. Fertility has low heritability. This research estimated the heritability of protein%, fat%, lactose%, non fat solids and total solids in 530 dairy cows with the lactation days ranging from 1 - 400 in Chiangmai, Chiangrai and Lamphun Province. The animal model BLUP was used and the fixed effects were herd-year, season and % of Holstein Friesian while the covariable was days in milk.

The results revealed that mean, standard error of mean and variance of protein % were 3.22, 0.028 and 0.42; of fat % were 4.41, 0.098 and 5.07; of lactose % were 4.66, 0.017 and 0.15; of non fat solids were 8.55, 0.024 and 0.29 and of total solids as 12.96, 0.096 and 4.88 respectively. The additive genetic variances of protein %, fat %, lactose %, non fat solids and total solids were 0.041, 0.130, 0.022, 0.036 and 0.963 respectively. The residual variances of protein %, fat %, lactose %, non fat solids and total solids were 0.079, 0.212, 0.069, 0.238 and 2.736 respectively. And the heritability of protein %, fat %, lactose %, non fat solids and total solids were 0.342, 0.379, 0.238, 0.133 and 0.260 respectively.

Introduction

Heritability is the extent to which genetics influences a trait or characteristic. Unlike breeding values and predicted transmitting abilities, which are estimated for individuals, heritability is a population parameter. Strictly defined, heritability is the ratio of additive genetic variance to phenotypic variance (Falconer,1989). Additive genetic variance is the true variance among breeding values of animals in a population. Then heritability is a ratio of the variance of breeding values to the variance of phenotypes. The possible range of values for heritability is from 0 to 1.0, because additive genetic variance is a part of phenotypic variance. Phenotypes are observed or measured about a particular trait; phenotypes are influenced by genetic and environmental effects. In measuring heritability, phenotypic variances are taken to be the total of random sources of variation after adjusting for systematic sources of variability, such as herd-year, age, month of calving, or days in milk.

The extent of genetic control is different for each trait. The higher the heritability, the greater is the genetic control on the trait, and the more rapidly selection will result in genetic progress. In general, fat and protein percentages, stature, and size have higher heritabilities, and reproductive efficiency has lower heritability. Mastitis resistance has a heritability of about 0.10.

There are many methodologies (Falconer,1989) to estimates the heritabilities such as full sib and half sip and also by animal model (BLUP) this depends on data (fixed and random effects).

Materials and Method

Experimental animals: 530 Lactating dairy cows with the lactation days ranging from 1 - 400 in Chiang Mai, Chiang Rai and Lamphun provinces.

Method: Milk samples of cows were collected for analysis of protein %, fat %, lactose %, solids not fat and total solids.

Statistical Analysis: Animal model (BLUP), using restricted maximum likelihood (REML) by VCE 4 (Groeneveld, 1998). The model was as follows:

$$y_{ijklm} = \mu + Color_i + HF_j + HY_k + Season_l + Animal_m + b(X_{ijklm} - X) + Error_{ijklm}$$

Where

y_{ijklm}	is	Production traits
μ	is	Means
$Color_i$	is	Groups 1-10 according to % of white coloured skin areas: 0-10, 11-20, 21- 30, 31-40, 41-50, 51-60, 61-70, 71-80, 81-90, 91-100%, respectively
HF_j	is	Groups 1-5 according to % of Holstein Friesian breed in the cows: 50-60, 61-70, 71-80, 81-90, 90-100%, respectively
HY_k	is	Herd - Year (1997, 1998, 1999, 2000 and 2001)
$Season_l$	is	Calving season (winter, summer and rainy)
$Animal_m$	is	Animals
$b(X_{ijklm}–X)$	is	First calving age as covariate
$Error_{ijklm}$	is	Random residual effect

Results and Discussion

The average of fat %, protein %, lactose, total solid and solid not fat were 3.22, 4.41, 4.66, 15.51 and 8.54 respectively. The standard error of fat %, protein %, lactose, total solid and solid not fat were 0.028, 0.098, 0.01, 0.25 and 0.02 respectively. The variances of fat %, protein %, lactose, total solid and solid not fat were 0.42, 5.07, 0.15, 4.48 and 0.29 respectively as shows in table 1.

Table 1. Average, standard errors and variance of milk contents

	N	Protein %	Fat %	Lactose	Total solid	Solid not fat
Mean	530	3.22	4.41	4.66	15.51	8.54
S.E		0.028	0.098	0.01	0.25	0.02
Variances		0.42	5.07	0.15	4.48	0.29

The heritabilities of % protein, % fat, % lactose, total solid and solid not fat were 0.342, 0.379, 0.238, 0.260 and 0.133 respectively. The additive genetics variance of % protein, % fat, % lactose, total solid and solid not fat were 0.041, 0.130, 0.022, 0.963 and 0.036 respectively. The residual variance of % protein, % fat, % lactose, total solid and solid not fat were 0.079, 0.212, 0.069, 2.736 and 0.238 respectively as shows in table 2.

Table 2. Heritabilities, additive genetics variances and residual variances of milk contents

	N	Protein %	Fat %	Lactose	Total solid	Solid not fat
Heritabilities	530	0.342	0.379	0.238	0.260	0.133
Additive genetic variances		0.041	0.130	0.022	0.963	0.036
Residual variances		0.079	0.212	0.069	2.736	0.238

The calculated heritabilities of these traits are in the normal range. They are a little higher than the heritabilities reported by Wilcox et al. (2001) but similar to the ones reported by Tempelman et al. (2001), Ageeb et al. (2001) and Welper and Freeman (1992).

Conclusion

The heritabilities of the studied traits were in normal range. The heritabilities of % protein, % fat, lactose and total solid were higher than 0.20. This means that these traits can be

influenced by selection. For solid not fat it is lower than 0.20. This shows that there are many environmental effects which influence this figure.

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