Abstract W185

Genetic parameter estimates for rump traits and teat length in a multibreed dairy cattle population in Thailand

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SUMMARY

Hip width (**HW**, cm), pin width (**PW**, cm), hip to pin length (**HP**, cm), hip height (**HH**, cm) and teat length (**TL**, cm) of cows are important for reproduction and production efficiency of a dairy business. Most dairy cattle in Thailand and other Asian tropical countries are multibreed where Holstein is a major component breed (mean = 87 %; SD = 9 %) and both purebred and crossbred animals are regularly selected as parents of the next generation. ***The objective of this study was to estimate genetic parameters for rump traits (HW, PW, HP and HH) and TL in a multibreed dairy cattle population in Thailand.*** The dataset consisted of pedigree and phenotypic information for **HW**, **PW**, **HP**, **HH**, and **TL** from 868 cows located in 122 farms across Thailand. The data were analyzed using a multiple-trait animal model that accounted for the fixed effects of herd, Holstein fraction, and age of cow, and the random effects of animal and residual. An average information-restricted maximum likelihood procedure was used to estimate variance components. Estimates of variance components were subsequently used to compute heritabilities and genetic correlations. Means and SD were 55.13 cm and 4.91 cm for **HW**, 18.49 cm and 2.40 cm for **PW**, 51.74 cm and 3.27 cm for **HP**, 134.07 cm and 5.52 cm for **HH**, and 5.07 cm and 1.43 cm for **TL**. ***Heritability estimates were high for HW (0.42 ± 0.10), medium for PW (0.23 ± 0.09) and HP (0.25 ± 0.10), and low for HH (0.11 ± 0.08) and TL (0.12 ± 0.09). Most genetic correlations ranged from medium (0.35 ± 0.28 between HP and PW) to high (0.91 ± 0.45 between PW and HH). The only low correlations were between TL and PW (0.14 ± 0.39) and between TL and HH (0.19 ± 0.54). These estimates of heritability and genetic correlations indicated that it would be feasible to develop a genetic improvement program for rump traits and teat length in this multibreed population.***

INTRODUCTION

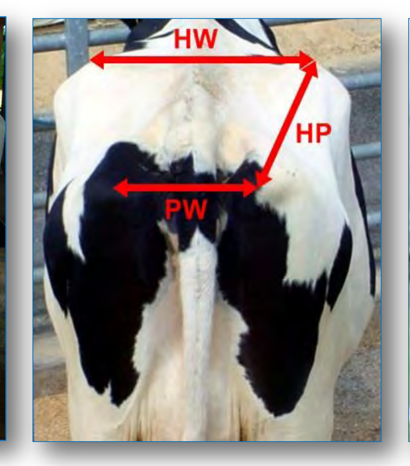
Rump traits (i.e., hip width, pin width, hip to pin length, and hip height) and teat length of cows are economically important traits because they are associated with reproduction and production efficiency. These traits are also used as indicators of growth and maturity for females. Dairy production in Thailand and other tropical Asian countries has been greatly increased through crossbreeding programs aiming at upgrading native and crossbred cattle from various breeds to Holstein. However, nutritional, management, health, and climate conditions have determined that crossbred dairy cows that are less than 100% Holstein are the most productive. Further, both purebred and crossbred Holstein cattle have been used as parents of subsequent generations, creating a multibreed dairy population with a wide range of breed compositions. Effective genetic evaluation and selection programs for rump traits and teat length require variances and covariances estimated under the tropical environmental conditions in these regions. ***Thus, the objective of this research was to estimate genetic parameters for rump traits and teat length in a multibreed dairy cattle population in Thailand.***

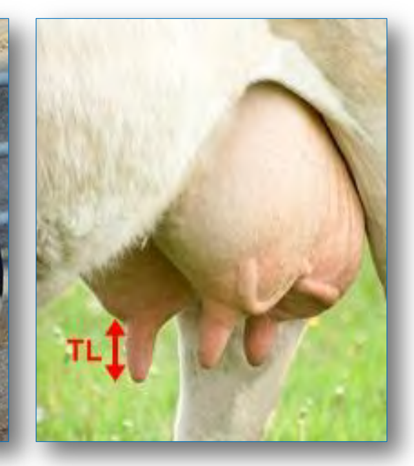
MATERIALS AND METHODS

Animals and Data. The dataset consisted of ***hip width (HW; the distance between left and right hip bone), pin width (PW; the distance between left and right pin bone), hip to pin length (HP; measured from hip bone to pin bone), hip height (HH; measured from hip bone to ground), and teat length (TL; the length of the teat)*** from 868 cows recorded from 1997 to 2011 in 122 farms. Ages of cows were classified into 6 groups: age < 3 (G1), 3 ≤ age < 5 (G2), 5 ≤ age < 7 (G3), 7 ≤ age < 9 (G4), 9 ≤ age < 11 (G5) and age > 11 (G6). The range of Holstein fractions in this population was from 37.5% to 100%.

Climate, Nutrition and Management. Seasons were classified into summer (March to June; hot and dry), rainy (July to October; hot and humid) and winter (November to February; cold and dry). Feeding of milking cows was mainly roughage (30 to 40 kg/d), supplemented with concentrate (10 to 12 kg/d). Roughage consisted mainly of fresh grasses (e.g., *Penicum maximum, Brachiaria ruziziensis, Pennisetum purpureum*, and *Brachiaria mutica*). During the dry season (November to June), when fresh grass was limited, farmers fed rice straw and agricultural by-products (e.g., cassava residuals, brewer grain, soybean meal, corn cop, etc.) to their cows. All cows were raised in open-barns and milked twice a day; once in the morning (5 am) and once in the afternoon (3 pm). Mating was conducted all year round using artificial insemination. Sires were chosen based on high milk yield and availability of semen.

Data Analysis. Least squares means (LSM) were estimated using a model that included the fixed effects of herd, age group, and regression on Holstein fraction. The LSM for levels of subclass fixed effects were compared using Bonferroni t-tests. Variance and covariance components were estimated with a multiple-trait animal model using an average-information REML procedure. The model included herd, age group, and regression on Holstein fraction as fixed effects, and animal and residual as random effects. Estimates of variance components were then used to compute heritabilities and genetic correlations between all traits.





RESULTS AND DISCUSSION

Overall means and standard deviations for cows in this population were 55.13 and 4.91 cm for **HW**, 18.49 and 2.40 cm for **PW**, 51.74 and 3.27 cm for **HP**, 134.07 and 5.52 cm for **HH** and 5.07 and 1.43 cm for **TL** (Table 1). Cows in this population were taller than those cows reported in other Thai dairy cattle populations (129.89 ± 5.58 cm; Sintala et al 2004), but shorter than cows in dairy populations from other countries (Brown Swiss, Holstein, Red & White; 139 to 143 cm; De Haas et al., 2007).

Least Squares Means. All rump traits and teat length traits were influenced by herd and age (P < 0.01). Holstein percentage only influenced **PW** (0.0230 ± 0.0095; P < 0.0166). There was a sizable degree of variation among cows due to herd effects in this population. Herd LSM ranged from 40.28 ± 2.64 to 60.03 ± 1.88 cm for **HW**, 13.43 ± 2.10 to 23.56 ± 2.12 cm for **PW**, 42.08 ± 1.92 to 57.52 ± 1.37 cm for **HP**, 112.04 ± 2.79 to 142.17 ± 3.43 cm for **HH**, and 3.96 ± 1.30 to 8.09 ± 1.30 cm for **TL.**

Rump traits and teat length LSM increased with age only from G1 (age < 3) to G2 (3 ≤ age < 5) when cows reached mature size. Changes in LSM from G1 to G2 were 44.66 ± 0.51 to 52.13 ± 0.36 cm for **HW**, 15.67 ± 0.29 to 17.93 ± 0.21 cm for **PW**, 47.38 ± 0.37 to 50.71 ± 0.26 cm for **HP**, 129.25 ± 0.93 to 133.28 ± 0.66 cm for **HH**, and 4.58 ± 0.18 to 6.07 ± 0.42 cm for **TL**.

Differences in rump traits and teat length of cows across herds in this study were likely related to personal preferences of famers concerning the physical appearance of cows, incomplete explanation of cow breed effects (up to seven breeds represented per animal), and utilization of specific lines of Holstein sires for genetic improvement within particular farms, especially sire germplasm imported from Canada and the US.

Table 1. Descriptive statistics for rump traits and teat length

Trait	n	Mean	Standard Deviation	Minimum	Maximum
Hip width (cm)	868	55.13	4.91	33.0	72.0
Pin width (cm)	868	18.49	2.40	11.0	29.0
Hip to pin (cm)	868	51.74	3.27	36.0	63.0
Hip height (cm)	867	134.07	5.52	116.0	167.0
Teat length (cm)	868	5.07	1.43	1.0	11.0

Table 2 shows variance components and heritabilities for rump traits and teat length. The additive genetic variance was 9.53 ± 2.46 cm^2 for **HW**, 1.07 ± 0.47 cm^2 for **PW**, 2.18 ± 0.92 cm^2 for **HP**, 2.79 ± 2.19 cm^2 for **HH**, and 0.22 ± 0.17 cm^2 for **TL**. ***Heritability estimates were high for HW (0.42 ± 0.10), medium for PW (0.23 ± 0.09) and HP (0.25 ± 0.10), and low for HH (0.11 ± 0.08) and TL (0.12 ± 0.09).*** These heritabilities were lower than those obtained elsewhere. DeGroot et al. (2002) reported heritabilities of 0.30 ± 0.09 for HP, 0.47 ± 0.09 for HH, and 0.29 ± 0.10 for TL in a US Holstein population. Similarly, Kadarmideen and Wegmann (2003) estimated heritabilities of 0.46 ± 0.04 for HW, 0.36 ± 0.02 for HH, and 0.35 ± 0.03 for TL in Swiss Holsteins, and Dal Zotto et al. (2007) computed heritabilities of 0.14 for HP, 0.32 for HH, and 0.32 for TL in Italian Brown Swiss. Heritability estimates for rump traits and teat length here indicate that a genetic evaluation and selection program for these traits is feasible in this multibreed population. Subsequent research would need to assess the relationships that exist between rump traits and teat length with economically relevant traits in Thailand such as fertility, milk yield, and milk quality traits. Information from this next step would help dairy producers in Thailand make appropriate selection decisions based on all economically relevant traits.

Table 2. Variance components and heritabilities for rump traits and teat length

Traits	Variance Components		Heritabilities
	Additive	Residual	h^2
Hip Width (HW)	9.53 ± 2.46	13.06 ± 2.23	0.42 ± 0.10
Pin Width (PW)	1.07 ± 0.47	3.68 ± 0.47	0.23 ± 0.09
Hip to Pin (HP)	2.18 ± 0.92	6.52 ± 0.90	0.25 ± 0.10
Hip Height (HH)	2.79 ± 2.19	22.46 ± 2.48	0.11 ± 0.08
Teat length (TL)	0.22 ± 0.17	1.55 ± 0.18	0.12 ± 0.09

Estimates of genetic and phenotypic correlations between rump traits and teat length are presented in **Table 3**. Values below the diagonal are estimates of genetic correlations and values above the diagonal are estimates of phenotypic correlations.

Estimates of genetic correlations among rump traits and teat length were all positive and ranged from 0.14 to 0.91. The strongest genetic correlation was between **PW** and **HH** (0.91 ± 0.45), followed by the genetic correlations between **HW** and **HP** (0.87 ± 0.13), **HW** and **TL** (0.74 ± 0.30), and **HP** and **TL** (0.70 ± 0.41). The weakest genetic correlation was between **HH** and **TL** (0.19 ± 0.54). These positive correlations agreed with previous research. Positive genetic correlations among HP, HH, and TL were found in Holstein (Short et al., 1991; DeGroot et al., 2002).

Dairy producers in Thailand currently have sire and cow genetic predictions available for milk production and reproduction traits under tropical conditions. Variable medium to low genetic correlations between rump traits and milk production and fertility traits have been reported (DeGroot et al., 2002; De Haas et al., 2007; Zink et al., 2011). If rump traits and teat length were to be considered for inclusion in national Thai genetic evaluation programs, research on their genetic correlations with production and reproduction traits would first need to be conducted. This research would need to information on sires and cows from all regions in Thailand.

Table 3. Genetic correlations (below diagonal) and phenotypic correlations (above diagonal) among rump traits and teat length

Trait	HW	PW	HP	HH	TL
HW	-	0.33 ± 0.03	0.61 ± 0.03	0.36 ± 0.03	0.23 ± 0.03
PW	0.54 ± 0.19	-	0.28 ± 0.30	0.24 ± 0.03	0.22 ± 0.03
HP	**0.87 ± 0.13**	0.35 ± 0.28	-	0.43 ± 0.03	0.11 ± 0.03
HH	0.62 ± 0.30	**0.91 ± 0.45**	0.62 ± 0.32	-	0.16 ± 0.03
TL	**0.74 ± 0.30**	0.14 ± 0.39	**0.70 ± 0.41**	0.19 ± 0.54	-

FINAL REMARKS

- ***Herd and age affected rump traits and teat length***
- ***Heritability estimates were high for HW, medium for PW and HP, and low for HH and TL***
- ***Genetic correlations among rump traits and teat length were all positive and most of them medium to high***
- ***Association between rump traits and teat length with fertility, milk yield, and milk quality traits in Thailand will need to be determined before utilizing these traits in a genetic evaluation and selection program***

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