Abstract W135

Semen Quantity and Quality of Dairy Bulls Raised in Tropical Central Thailand

T. Kongnoi[*], S. Koonawootrittriron[*], M.A. Elzo[†], T. Suwanasopee[*] and A. Hirunwong[‡]

[*] Department of Animal Science, Faculty of Agriculture, Kasetsart University, Bangkok 10900, Thailand
[†] Department of Animal Sciences, University of Florida, Gainesville, FL 32611-0910, USA
[‡] Department of Statistics, Faculty of Sciences, Kasetsart University, Bangkok, 10900, Thailand

SUMMARY

The dataset contained 5,127 records from 57 bulls for semen volume (VOL), semen appearance (APP), semen concentration (CON), abnormal sperm (ABN), active motile sperm (MOT), and active motile sperm after freezing for 24 hr (M24) collected from October 2001 to April 2007. Bulls were grouped by H fraction into BG1 (0.96 to 1.0 H), BG2 (0.91 to 0.95 H), BG3 (0.86 to 0.90 H), BG4 (0.81 to 0.85) and BG5 (0.75 to 0.80 H). All bulls received the same nutrition and management. Semen was collected and evaluated using standard procedures from the Dairy Farming Promotion Organization of Thailand. The statistical model contained year-month of semen collection, ejaculation number (1 to 2), age of bull (339 to 2,988 d), ambient temperature at collection time (11 to 31 °C), and breed group as fixed effects, and residual as a random effect. All factors in the model were important for all traits ($P < 0.01$), except for ambient temperature, which affected only CON, ABN and MOT ($P < 0.01$). Older bulls had higher VOL, APP, CON, and MOT, and lower ABN and M24 than younger bulls ($P < 0.001$). Semen collected at higher ambient temperatures had higher CON, higher MOT, and lower ABN ($P < 0.01$). Least squares means (LSM) indicated that BG5 was as good as or better than any other breed group for all traits ($P < 0.05$; VOL = 6.18 ± 0.11 ml; APP = 2.83 ± 0.05 score; ABN = 11.50 ± 0.15 %; CON = 1,173.83 ± 13.26 × 10^6 cells/ml; MOT = 45.43 ± 0.56 %), except for M24 (51.75 ± 0.17 %) where it was second to BG1 (52.41 ± 0.15 %). Breed groups 1 to 3 tended to have similar LSM, and BG4 yielded the worst results of all breed groups ($P < 0.05$).

INTRODUCTION

Thailand is a tropical country in Southeast Asia (5º 35´ to 20º 30´ North latitude and 97º 20´ to 105º 40´ East longitude) that has high temperature (17 to 36 ºC) and high humidity (64 to 84 %). Holstein (H) and high percent H sires have been used to increase milk production in this country. As part of this mating strategy, semen production within Thailand has been promoted by the government. The two main organizations (Department of Livestock Development of Thailand and Dairy Farming Promotion Organization) raise dairy AI bulls in the central part of Thailand and produce frozen semen to serve dairy producers across the country. ***Thus, the objective of this study was to determine factors that affect semen quantity and quality traits in dairy bulls raised under tropical conditions in Central Thailand.***

MATERIALS AND METHODS

Animals and Data. The dataset consisted to 5,127 records of semen quantity and quality from 57 dairy bulls, that were collected from October 2004 to April 2007. All bulls were raised and semen collected in a bull station of the Dairy Farming Promotion Organization (DPO) located in Muaklek, Saraburi. Dairy bulls were grouped by Holstein (H) fraction into BG1 (0.96 to 1.00 H), BG2 (0.91 to 0.95 H), BG3 (0.86 to 0.90 H), BG4 (0.81 to 0.85 H) and BG5 (0.75 to 0.80 H).

Housing, Nutrition and Management. Each bull was kept in an open 4 x 22 m^2 stall. Each stall had 2 sections: a raised area and an exercise area. The raised area was 4 x 6 m^2, with concrete floor and tile roof (2.5 to 3 m high). The exercise area was 4 x 16 m^2, ground floor and no roof. Feed and water bunks were located in the front of the stall. Bulls were kept in their stalls at all times, except when their semen was collected.

All bulls received the same nutrition, management and health care. Feeding was based on roughage (ad libitum) and concentrate. Fresh roughage consisted of Guinea (*Penicum maximum*) and Ruzi (*Brachiaria ruziziensis*) produced by the DPO. Concentrate (16% Protein) was purchased from a local company, and between 6 and 7.5 kg/d given to each bull according to their weight (6 kg/d for bulls with 400 kg body weight, 6.2 kg/d for bulls with 600 kg body weight, and 7.5 kg/d for bulls with 800 kg body weight). In the dry season (November to March), when fresh grass was limited, bulls were fed Guinea (*Penicum maximum*) and Ruzi (*Brachiaria ruziziensis*) hay and silage produced by the DPO. A free-choice mineral supplement was available throughout the year. Bulls were vaccinated for Food and Mouth Disease and Tuberculosis twice a year. De-worming was done every six months.

Semen collection. Young bulls were trained for semen collection when they were 1 to 1.5 years of age. Semen was collected and used to produce frozen semen when bulls were older than 1.5 years. Semen collection was done once a week for 1 to 1.5 yr old bulls, and twice a week if bulls were older than 5 yr of age. Semen collection was done until each one of them had produced 25,000 doses of frozen semen.

At each semen collection, bull ID, collection date and time, ejaculation number, ambient temperature (ºC), and collector's name were recorded. The collected semen was evaluated for semen volume (ml), semen appearance (score; 4 = creamy, 3 = milky, 2 = yellow, 1 = yellow and watery, 0 = watery, -1 = brown, and -2 = bloody), semen concentration (x10^6 cells/ml), abnormal sperm (%), active motile sperm (%), and active motile sperm after freezing for 24 hr (%) using standard procedures of the DPO.

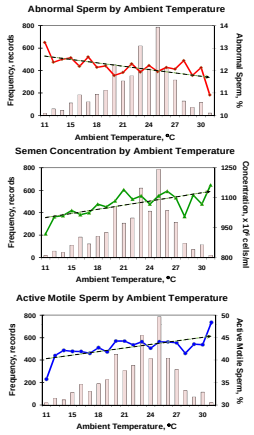
Data Analysis. The model for VOL, APP, CON, ABN, MOT, and M24 contained year-month of semen collection, ejaculation number (1 to 2), age of bull (339 to 2,988 d), ambient temperature at collection time (11 to 31 °C), and breed group as fixed effects, and residual as a random effect. Procedure GLM of SAS was used for computations. Least square means (LSM) were computed for each breed group (BG1 to BG5). Phenotypic correlations between VOL, APP, CON, ABN, MOT, and M24 were computed using procedure CORR of SAS.

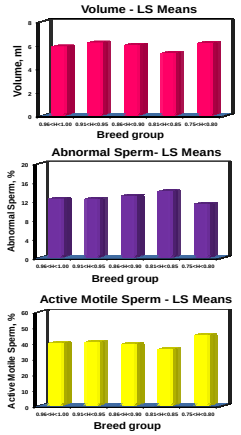
RESULTS AND DISCUSSION

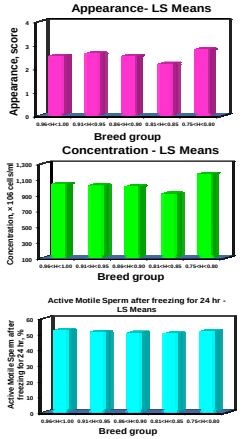
Dairy bulls in this study produced an average of 5.54 ml (SD = 2.26 ml) for VOL, 2.72 scores (SD = 0.94 scores) for APP, 12.08 % (SD = 2.98 %) for ABN, 1,088.00 ×10^6 cell/ml (SD = 293.29 ×10^6 cell/ml) for CON, 43.42 % (SD = 11.26%) for MOT, and 52.78 % (SD = 2.56 %) for M24. All factors in the model were important for all traits ($P < 0.01$), except for ambient temperature, which affected only CON, ABN and MOT ($P < 0.01$).

Year-month subclass. Semen quantity and quality were significantly affected by year-month subclass ($P < 0.001$). Least square means (LSM) ranged from 5.21 ± 0.40 ml (2006-April) to 6.78 ± 0.30 ml (2005-January) for VOL, from 2.07 ± 0.10 scores (2003-May) to 3.01 ± 0.13 scores (2007-April) for APP, from 11.69 ± 0.39% (2005-January) to 15.03 ± 0.63% (2006-April) for ABN, from 872.76 ± 37.39 × 10^6 cells/ml (2007-April) to 1,609.45 ± 48.53 × 10^6 cells/ml (2004-September) for CON, from 36.19 ± 1.23% (2003-April) to 46.37 ± 1.94% (2007-April) for MOT and from 49.53 ± 1.63% (2003-September) to 53.56 ± 0.52 % (2007-July) for M24. Year-month LSM tended to increase for APP (0.005 ± 0.001 scores/year-month; $P < 0.0001$), MOT (0.041 ± 0.123 %/year-month; $P < 0.001$) and M24 (0.025 ± 0.006 %/year-month; $P < 0.001$), but tended to decrease for VOL (-0.006 ± 0.002 ml/year-month; $P < 0.01$) from 2001 to 2007. Improvements in bull reproductive management and nutrition as well as improvements in semen collection and freezing protocols and personnel training during these yeas may account for these trends.

Ejaculation number. The first ejaculation had higher LSM than the second ejaculation ($P < 0.001$) for APP (2.75 ± 0.02 vs. 2.37 ± 0.04 scores), ABN (11.95 ± 0.05 vs. 13.69 ± 0.14 %), MOT (44.21 ± 0.19 vs. 36.93 ± 0.53 %), CON (1,118.85 ± 4.57 vs. 954.11 ± 12.66 x10^6 cells/ml), and M24 (51.66 ± 0.07 vs. 51.04 ± 0.23 %), but not for VOL (5.35 ± 0.04 vs. 6.53 ± 0.11 ml). Most bulls (90%) were collected only once. Only bulls that had unsuccessful thrusting and ejaculation were collected for a second time (10%). The larger volume of the second ejaculation was likely due to incompleteness of the first ejaculation. The quality of the first ejaculation was better than the second one as found temperate environments (Everett and Bean, 1982; Fuerst-Waltl et al., 2006).







Age. Older bulls produced higher VOL (5.95 0.55 x10^{-4} ml/d), APP (2.83 0.23 x10^{-4} score/d), CON (770.92 65.68 x10^2 cells/ml/d), and MOT (22.76 2.75 x10^{-4} %/d), and lower ABN (-2.65 0.73 x10^{-4} %/d) and M24 (-7.24 0.97 x10^{-4} %/d) than younger bulls ($P < 0.001$). Superior reproductive capacity and degree of maturity of reproductive organs in older bulls were likely responsible for their advantage over younger bulls. Results here agreed with those from temperate climates where mature bulls (4 to 6 yr age) had larger quantities and better quality of semen than younger bulls (Everett and Bean, 1978; Mathevon et al., 1998).

Temperature. Ambient temperatures at collection time ranged from 11 to 31 ºC. Semen collected at higher ambient temperatures tended to have higher CON (760.33 ± 172.39 x10^4 cells/ml/ºC; $P < 0.01$), higher MOT (23.23 ± 7.22 x10^{-2} %/ºC; $P < 0.01$), and lower ABN (-5.17 ± 1.92 x10^{-2} %/ºC; $P < 0.01$) than semen collected at lower ambient temperatures. Semen collection at warmer ambient temperatures resulted in semen of superior quality to collections at cooler temperatures. This suggests that these bulls were well adapted to the hot and humid conditions in Thailand. This may also be an indication that the optimum range of temperature for semen production in these bulls was higher than that for bulls in temperate regions (5 to 15 ºC; Fuerst-Waltl et al., 2006).

Breed group. Range of LSM was from 5.33 ± 0.11 ml (BG4; 0.81 to 0.85 H) to 6.23 ± 0.07 ml (BG2; 0.91 to 0.95 H) for VOL, from 2.21 ± 0.05 scores (BG4) to 2.83 ± 0.05 scores (BG5; 0.75 to 0.80 H) for APP, from 11.50 ± 0.15 % (BG5) to 14.15 ± 0.15 % (BG4) for ABN, from 920.65 ± 13.31 ×10^6 cells/ml (BG4) to 1,173.83 ± 13.26 ×10^6 cells/ml (BG5) for CON, from 36.45 ± 0.56 % (BG4) to 45.43 ± 0.56 % (BG5) for MOT, and from 50.33 ± 0.23 % (BG4) to 52.41 ± 0.15 % (BG1; 0.96 to 1.0 H) for M24.

Breed groups 1 to 3 tended to have similar LSM for all traits, and BG4 yielded the worst results of all breed groups ($P < 0.05$). Bulls in BG5 had LSM as good as or better than any other breed groups for all traits ($P < 0.05$; VOL = 6.18 ± 0.11 ml; APP = 2.83 ± 0.05 score; ABN = 11.50 ± 0.15 %; CON = 1,173.83 ± 13.26 × 10^6 cells/ml; MOT = 45.43 ± 0.56 %), except for M24 (51.75 ± 0.17 %) where it was second to BG1 (52.41 ± 0.15 %). The superiority of BG5 over all other breed groups suggests that a small fraction of adapted genes from the local founding Bos indicus breeds was required to produce the best quality semen under the hot and humid conditions of Central Thailand.

Phenotypic correlations. Phenotypic correlations between VOL and other traits were close to zero (-0.07 to 0.04). Similar associations were found between M24 and other traits (0.01 to 0.08). Higher phenotypic correlations existed between APP and ABN (-0.29; $P < 0.001$), APP and CON (0.47; $P < 0.0001$), APP and MOT (0.46; $P < 0.0001$), ABN and CON (-0.55; $P < 0.0001$), ABN and MOT (-0.77; $P < 0.0001$), and CON and MOT (0.69; $P < 0.0001$). Bulls that had semen with good APP would also have high CON, less ABN and high MOT. Quantity and quality of fresh semen were less associated with active motile sperm after 24 hr freezing.

FINAL REMARKS

- ***Semen quantity and quality were influenced by year-season, ejaculation number, age at collection time, ambient temperature at collection time, and breed group (H fraction)***
- ***Older bulls had higher semen quantity and quality than younger bulls***
- ***Semen collection at higher temperatures had higher CON and MOT but lower ABN***
- ***Crossbred dairy bulls with 0.75 to 0.80 H produced as good as or better VOL, APP, ABN, CON and MOT than all other breed groups***
- ***A small fraction of adapted Bos indicus genes yielded better semen quantity and quality under Thai tropical conditions***
- ***Quantity and quality of fresh semen were less associated with sperm motility after freezing for 24 hr.***

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