Reproductive and morphological performances of stallions in District of Karo, North Sumatera, Indonesia

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Abstract. The objective of this study was to investigate reproductive and morphological performances of stallions in District of Karo, North Sumatera, Indonesia. Body measurements and semen were taken on 12 stallions from four villages in District of Karo, North Sumatra, Indonesia. There were two villages in Merdeka Sub-district i.e. Jaranguda and Merdeka; and two villages in the Berastagi Sub-district, i.e., Gundaling and Berastagi. Data were entered in Microsoft excel, checked, organized and processed for further analyses. Means with standard errors (SE) for different traits were subjected to the standard analysis of variance technique. The results showed that semen quality of stallions performed in macroscopic and microscopic examination were in good quality with colour of semen was white grey, neutral pH, 74% dilute, 73.3% motility, 13.40 x 10^7 concentration with their semen abnormalities observed were normal. The morphology characteristics of stallions in District of Karo showed an appearance with a variation coefficient value below 10% which means the measurement value of horizontal horse morphology in good condition. The results support horse breeders to cross-breed periodically their stallions with local horses in District of Karo because their variation coefficient showed good quality semen with uniform value.

1. Introduction
Horse (Equus caballus), a non-ruminant equine species among livestock, has played significant role in the human civilization especially in developed countries. In these countries, farmers exercised traditional knowledge on horse rearing that was used mainly for pulling cart, transportation, land tillage and sports purposes for their livelihood [1]. In North Sulawesi, Indonesia, for example, horse plays an important role in the rural area which are mainly used in agriculture, light attraction, riding and leisure activities [2]. Besides these roles, horse milk is minor importance in milk production in comparison to cow and goat milk. Resemblance with human milk in many respect make horse milk have been traditionally important and claimed to have special therapeutic properties. Overall, horse milk is considered to be highly digestible, rich in essential nutrient and possesses an optimum whey: casein protein ratio, making it suitable in paediatric dietetic. Nutritional and therapeutic properties are also beneficial for elderly diet. Around 30 million people consume horse milk regularly throughout the world. In Turks, Bashkirs, Kazaks, Mongol, Yakuts and Uzbeks, for example, they make lactic-alcoholic beverage called Koumiss. It is traditionally produced
through fermentation, it is also one of the most important basic foodstuffs for the human populations [3]. Administration of koumiss to cancer patients was able to decrease adverse effect of chemotherapy [4]. In Indonesia, Sumbawa horse milk is also claimed to cure some diseases such as asthma, hypertension, diabetes and gastrointestinal disorder. Sumbawa is one of the eastern island of Indonesia. Sumbawa horse milk not only contains beneficial protein and good microorganism but may also contain bioactive peptides yielding by enzymatic hydrolysis of bacterial protease [5]. Composition comparison of horse milk with other ruminants (cow, sheep, and goat) and human milk is presented in Table 1 [3].

Currently, development of horse breeding industry was commenced through horse racing events held all over the country. It were accelerated by development of Thorough breed-Indonesian local crossbreed horses in Indonesia [6]. Breeding management in animal production systems largely depends on the biological aspects appropriate to each species, but it is also linked to the population structure and the productive aptitude of each breed [7]. Many aspects of reproduction management in horses, such as the correct nutrition of stallions and mares, and the effect of nutrition on the occurrence of puberty, have nowadays been fully not well-known. Horses' optimal reproductive management has also been considered, but seldom in draught horses [8]. Assessment of breeding records for a stallion is a logical starting point when determining causes of subfertility, because critical analysis of these records will aid one in determining specific sources of a fertility problem (i.e., mare-related factors, management factors, and/or intrinsic stallion factors). In most commercial programs, each of these factors contributes to the perceived fertility of a given stallion [9]. Stallion fertility is of high economic importance for the horse industry. Among farm animals, horses have the lowest reproductive rate. This is reflected in lower per cycle pregnancy rates, which range from 43–60% [10] compared with 85–90% in boars [11] and 80–90% in rams [12]. Stallion fertility can be determined in different ways, including considering parameters reflecting breeding or reproduction success rates, such as pregnancy rate, foaling rate and non-return rate as well as may also be assessed using sperm characteristics [13]. For sustainable use of genetic resources characterization of horse breed is a first step in which almost no investigation has yet been carried out to evaluate the reproductive and morphology performance of stallion genetic recourses in North Sumatera, Indonesia. Therefore, it is necessary to conduct a research to measure the reproductive performance and morphology of the stallions in District of Karo, North Sumatera, Indonesia. This data would provide basic information required for designing any program aiming at conservation and sustainable use of indigenous horses in the region.

Table 1. Composition comparison of horse milk with other ruminants (cow, sheep, and goat) and human milk

| Component         | Value | Mare     | Cow     | Sheep   | Goat     | Human   |
|-------------------|-------|----------|---------|---------|----------|---------|
| Fat (g kg⁻¹)      | Mean  | 12.1     | 36.1    | 75.0    | 41.0     | 36.4    |
|                   | (Min-Max) | (5-20) | (33-54) | (50-90) | (30-60) | (35-40) |
| Crude protein     | Mean  | 21.4     | 32.5    | 54.5    | 34.0     | 14.2    |
|                   | (Min-Max) | (15-28) | (31-39) | (45-70) | (30-36) | (9-17)  |
| Lactose (g kg⁻¹)  | Mean  | 63.7     | 48.8    | 49.0    | 47.0     | 67.0    |
|                   | (Min-Max) | (58-70) | (44-49) | (41-59) | (42-50) | (63-70) |
| Gross energy (kcal kg⁻¹) | Mean | 41.0 | 34.0 | 47.0 | 7.7 | 677 |
|                   | (Min-Max) | (30-60) | (30-36) | (42-50) | (7-8) | (670-690) |
| Ash (g kg⁻¹)      | Mean  | 4.2      | 7.6     | 8.5     | 7.7      | 2.2     |
|                   | (Min-Max) | (3-5) | (7-8) | (8-9) | (7-8) | (2-3) |
| Gross energy (kcal kg⁻¹) | Mean | 480 | 674 | - | 670 | 677 |
|                   | (Min-Max) | (390-550) | (650-712) | - | (660-690) | (650-700) |
2. Materials and methods
The study was carried out in District of Karo, North Sumatera province started from June to August 2017 in four villages in District of Karo, North Sumatra, Indonesia (Figure 1). There were two villages in Merdeka Sub-district i.e. Jaranguda and Merdeka Village; two villages in the Berastagi Sub-district, i.e., Gundaling and Berastagi. Those districts are located in the Karo highlands surrounded by active volcanoes of Sinabung and Sibayak with altitude between 900 and 1,200m above sea level and therefore categorised as coldest area with temperature around 16 – 17°C. The four villages within two districts were selected according to data on the availability of horses and their use in these areas. District of Karo are categorized as agriculture region and more than 90% of the population work as farmers. 12 stallions were used in the present study. The age of the stallions ranged from two to five years old. Data on reproductive and morphology traits of individual horses were collected from 12 horse-owning households and they have cross-bred from Thorough-breed-Indonesian horses. The reproductive traits of semen horse were colour, viscosity, pH, motility, concentration and abnormality. The observed morphological traits of horse were head length, head width, neck length, shoulder height, chest depth, chest girth, chest depth, body length, hip height, hip width, and scrotum circumference were measured on spot using measuring taps. Data were entered in Microsoft excel, checked, organized and processed for further analyses. Means with standard errors (SE) for different traits were subjected to the standard analysis of variance technique [14].

Figure 1. Research location in four villages in sub-districts in Karo District, North Sumatra, Indonesia.

3. Results and discussion
The reproductive performance of both macroscopic and microscopic of semen horses is presented in Table 2. The reproductive performance of semen horse, i.e. colour, viscosity, pH, concentration and abnormality were found to be white grey–yellowish white, dilute–viscous, 65-80, 12.8-14 x 10^7, and normal,
respectively. While the average head length, head width, neck length, shoulder height, chest depth, chest girth, chest depth, body length, hip height, hip width, and scrotum circumference were found to be 56.35±1.87; 19.08 ± 0.67; 67.42 ± 3.06; 142.50 ± 7.66; 151.08 ± 8.83; 61.58 ± 5.48; 98.58± 4.62; 141.17 ± 7.77; 42.33 ± 3.11; 33.58 ±1.83 cm respectively.

Table 2. Reproductive performance and morphological indices of the quantitative traits of stallions reproductive performance

| No. Horse | Macroscopic of Semen Horse | Microscopic of Semen Horse |
|----------|----------------------------|----------------------------|
|          | Colour                     | Viscosity                  | pH  | Motility (%) | Concentration (ml) | Abnormality |
| 1        | White grey                 | Dilute                     | 7   | 70           | 13 x 10⁷           | Normal      |
| 2        | White grey                 | Dilute                     | 7   | 80           | 14 x 10⁷           | Normal      |
| 3        | White grey                 | Dilute                     | 7   | 65           | 13.8 x 10⁷         | Normal      |
| 4        | White grey                 | Dilute                     | 7   | 70           | 13.6 x 10⁷         | Normal      |
| 5        | White grey                 | Dilute                     | 6   | 75           | 13 x 10⁷           | Normal      |
| 6        | White grey                 | Viscous                    | 7   | 65           | 13 x 10⁷           | Normal      |
| 7        | White grey                 | Viscous                    | 6   | 75           | 13.2 x 10⁷         | Normal      |
| 8        | Yellowish white            | Dilute                     | 7   | 80           | 14 x 10⁷           | Normal      |
| 9        | Yellowish white            | -                          | 6-7 | 65-80        | 12.8-14 x 10⁷      | Normal      |
| 10       | White grey                 | Dilute                     | 7   | 75           | 13.6 x 10⁷         | Normal      |
| 11       | White grey                 | Dilute                     | 7   | 75           | 13 x 10⁷           | Normal      |
| 12       | White grey                 | Dilute                     | 7   | 70           | 13.8 x 10⁷         | Normal      |
| Total    | White grey                 | (91.7%) - Viscous          | 6-7 | 65-80        | 12.8-14 x 10⁷      | Normal      |
|          | (83.3%) - (16.7%)          | (6.83)                     |     |              |                    |             |

Morphological characterization (n = 12)

| No. Horse | Head length (cm) | Mean ± SD | Variation coefficient |
|-----------|------------------|-----------|-----------------------|
| 1         | 56.35± 1.87      | 3.32      |
| 2         | 19.08 ± 0.67     | 3.50      |
| 3         | 67.42 ± 3.06     | 4.54      |
| 4         | 142.50 ± 7.66    | 5.37      |
| 5         | 151.08 ± 8.83    | 5.84      |
| 6         | 61.58 ± 5.48     | 8.91      |
| 7         | 98.58± 4.62      | 4.69      |
| 8         | 141.17 ± 7.77    | 5.50      |
| 9         | 42.33 ± 3.11     | 7.36      |
| 10        | 33.58 ±1.83      | 5.45      |

The majority colour of semen horse were white grey (91.7%) than yellowish white (8.3%), and therefore the average colour of semen horse were white grey. This results are in agreement with [15], who reported that semen horse is generally white grey compared with semen cow and pig which slightly creamy white and creamy white semen, respectively. In general, semen colour in animals are influenced by the presence of urine in semen (urospermia), presence of blood (hemospermia), presence of pus (pyospermia), and spermatozoa concentration [16]. The pH semen horse was relatively neutral in the range 6-7 with a mean of 6.83. This is in accordance with [17], who reported that fresh semen horse has a pH of 7.0 ± 0.1 and within the range of 6.7-7.2. This findings is also supported by [18], who reported that semen pH of horse is neutral.
within the range 7.0 - 7.8. The consistency of semen horse were dilute (83.3%) than viscosity (16.7%) and thus can be classified as dilute. This is in accordance with [18], who reported that semen horses and pigs are quite thin and light to grey. This findings is also supported by [17], who reported that the characteristics of horse semen consistency is dilute.

Semen motility obtained was 65 - 80% with a mean of 73.3%. This results within the normal range of semen motility of 72.5 ± 2.9 reported by [19]. Normal horse spermatozoa have a motility degree of 3–4, and 48-75% of sperm in semen are active for less than 20 minutes after ejaculation [18]. This results are also supported by [17], who reported that the motility of fresh semen horse is 67.08 ± 9.08 within the range of 35 -75%. The percentage of motility can be categorized as excellent (> 70), good (55- 69), fair (40-54) and poor (<40) [20]. Several factors affecting spermatozoa are ambient temperature, collection equipment residue, pH and media osmolality, and collection intervals [21]. The semen horse concentration is 13.40 x 10^7/ml with a standard deviation of 0.0537 and 3.31% variation coefficient. The assessment of semen horse concentrations observed here was classified into oligospermia. According to [18], oligospermia or slightly sperm, when the distance has a whole sperm length with a concentration of less than 200 million per ml of semen. Our findings on concentration assessment of semen horse was lower than [17], who reported that the concentration of fresh semen horse was 21.19 ± 2.12 with a range of 18.0 – 26.5. The horse semen abnormalities observed were normal. This showed the state of semen in good condition. According to [1], spermatozoa abnormalities were assessed based on primary and secondary abnormalities. Spermatozoa are assessed as morphologically normal or not, in the head (primary abnormalities), neck and tail (secondary abnormalities).

The average head length, head width, neck length, shoulder height, chest depth, chest girth, chest depth, body length, hip height, hip width, and scrotum circumference were found to be 56.35± 1.87; 19.08 ± 0.67; 67.42 ± 3.06; 142.50 ± 7.66; 151.08 ± 8.83; 61.58 ± 5.48; 98.58± 4.62; 141.17 ± 7.77; 42.33 ± 3.11; 33.58 ±1.83 cm, respectively. These morphological characteristics of stallions at the present study were also totally different with Minahasa horses breed reported by [2]. This findings is in agreement with [22], who reported that differences in breed, age, sex and nutritional level are the main reasons behind such differences in the morphological characteristics of horses. In our study, aged of stallions were ranged from two to five years old and thus they were younger than two to seven years old reported by [2]. The variation coefficient of morphological measurements of stallions in our findings were ranged between 3.32–7.36 which below 10% and indicated that the level of morphological variation of horses is moderate, so that the morphology of stallions in District of Karo is uniform. This findings are in agreement with [23], who reported that stallions in North Sumatera showed a variation coefficient of measurement of stallions below 10%. The present findings are supported by [2], who reported that the low to medium coefficients of variation observed in all quantitative traits in horses and regions are attributable to the environmental sensitivity such as nutrition related conditions and temperature. In our study, four villages within two sub-districts in District of Karo located in the Karo highlands surrounded by active volcanoes of Sinabung and Sibayak with altitude between 900–1,200m above sea level and therefore categorised as coldest area with temperature around 16-17°C compared with Minahasa and Tomohon city are categorized as agriculture region with altitude is 600-700 m above sea level [2].

4. Conclusions
Semen quality of stallions performed in microscopic and microscopic examination showed good quality, with colour of semen is white grey, neutral pH, 74% dilute, 73.3% motility, 13.40 x 10^7 concentration and sample percentage is normal. The morphology characteristics of stallions in Karo Regency showed an appearance with a variation coefficient value below 10% which means the measurement value of horizontal horse morphology in good condition. It is suggested to breeders to cross-breed periodically their stallions
with local horses in District of Karo, North Sumatera, Indonesia because their variation coefficient showed good quality semen with uniform value.

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