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Effect of season and age on scrotal circumference, testicular parameters and endocrinological profiles in mithun bulls

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ABSTRACT

Mithun is a domesticated free-range bovine species primarily used as a meat animal and is a pride of North Eastern Hilly regions of India. The present study was conducted to measure the effect of seasons on scrotal & testicular biometrics and endocrinological profiles for different age groups at different seasons in mithun bulls. A total of 30 mithun males were selected from the mithun breeding farm, ICAR-NRC on Mithun, Medziphema, Nagaland, India and were equally distributed into five groups based on their age. Each group consisted of six animals and the groups were Gr A (0.1–1.0 year), Gr B (1.1–2.0 years), Gr C (2.1–3.0 years), Gr D (3.1–5.0 years) and Gr E (5.1–6.0 years). The seasons were grouped into winter, spring, summer and autumn based on the meteorological data such as temperature humidity index (THI) and sunshine hours. Scrotal circumference (SC) & testicular biometrics and endocrinological profiles such as follicle stimulating hormone (FSH), luteinizing hormone/interstitial cell stimulating hormone (LH/ICSH), testosterone, thyroxine (T4), cortisol and insulin like growth factor 1 (IGF 1) were estimated during different seasons for different age groups. Statistical results revealed that the SC & testicular biometrics and endocrinological profiles differed significantly ($p < 0.05$) among the different age groups for the same season whereas SC and endocrinological profiles significantly ($p < 0.05$) differed among the seasons for same age group. Significantly ($p < 0.05$) greater SC and testicular weight were observed in Gr E and D, lower in Gr A and B and intermediate in Gr C and increased as age advances. Significantly ($p < 0.05$) greater SC was observed in winter and spring and lowest was in summer season. The hormone profiles such as FSH, LH/ICSH, testosterone & thyroxine were significantly ($p < 0.05$) greater and IGF-1 & cortisol were significantly ($p < 0.05$) lower in spring & winter than in summer season. The hormones, FSH, LH/ICSH and thyroxine increased significantly in Gr A followed by reduced in Gr B and then increased to Gr D and E, whereas concentration of testosterone, cortisol and IGF-1 increased according to age advanced. It was concluded that the spring and winter seasons has significantly greater beneficial effects than summer season on reproduction and artificial breeding programme in semi-intensive management of mithun in the present location.

1. Introduction

Mithun is a unique domestic bovine species available in the Himalayan foothills of South/Southeast Asia. The massive unique beautiful animal is well adopted anatomically and physiologically at an altitude is ranging from 300 to 3000 m mean seas level (MSL). Mithun is a social animal; they are found in small groups usually containing one adult male and several females & its juveniles. The multifarious use of mithun is well recognized [1] especially for its delicious meat [2]. Although mithun is not yet endangered, but suffers from severe non-cyclical population fluctuations on a local/regional basis. A good understanding of the different aspects of reproduction in male, i.e. age at puberty, sexual maturity,

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biometrics of the reproductive system, semen production & its quality, endocrinological profiles and length of effective reproductive period are important factors to consider while taking efforts to preserve mithun germplasm.

Estimation of testicular and scrotal parameters is the key components in evaluation of breeding soundness, in analysis of the growth and development of scrotum & testis and its related semen quality parameters (SQPs) as well as endocrinological profiles of the breeding males in various livestock species [3–5]. Moreover, testicular and scrotal measurements are important parameters to predict the reproductive as well as spermatogenic capabilities in the post-pubertal breeding bull [6,7]. Additionally, the SC, volume & weight of the testis provide informations about the physical and physiological maturity of the breeding bulls, its semen production capability and the birth weight of its young ones [8].

The testes are highly sensitive to increasing ambient temperature, consequently degenerative changes are observed as in the form of reduction in testicular weight, size and change in its consistency [9], which finally affects the semen production and its quality. Heat stress decreases the secretion of LH/ICSH, of which (LH) is essential for spermatogenesis [10]. The testicular temperature should be at least 2–6 °C less than body temperature in mammals, i.e. testicular temperature of 33–34 °C is optimum for spermatogenesis in bovine species [11,12]. Another testicular parameter, scrotal circumference also varies with seasons [13]. External functional parameter such as seasonality also influences the sexual function either through day length/photoperiod [14] and/or through changes in ambient temperature [15]. In agreement, spermatogenesis is highly sensitive to increasing the scrotal temperature and affected even by shorter spiking of temperature as was observed in European cattle (*Bos taurus)* that were kept in artificial breeding centre in temperate regions [16]. Available research results showed that exotic bulls (*Bos taurus*) have minimum sperm output when exposed to midwinter and late summer and concomitantly highest percentages of total sperm abnormality was observed. At the same time, thermal tolerance capacity of indigenous cattle (*Bos indicus*) is significantly greater than exotic cattle (*Bos taurus*) as indicated by greater SQPs and lower total sperm abnormalities in former [17]. Species variation and their inherent capability to adapt and adjust to the tropical or subtropical environments is also another variable that determines whether ambient temperature and/or relative humidity affect the bull reproduction and its fertility [17]. Although, the seasonal changes had significant effects on *Bos taurus* cattle in a tropical environment, such effects were not reported in *Bos indicus* and *Bos frontalis* species under the same environmental conditions [17–19].

Day length (photo period) and heat stress (temperature) are two major important factors determining the seasonality and secretory pattern of reproductive as well as metabolic hormones. Higher environmental temperature and longer day length cause decreased melatonin secretion (short day breeder) which inturn stimulate the prolactin secretion from anterior pituitary gland, inhibiting the secretion of gonadotrophin releasing hormone (GnRH) from hypothalamus and FSH & LH/ICSH from anterior pituitary in summer [20] than in winter season [21]. Improper secretion of these hormones leads to poor sex libido, higher reaction time, poor semen production & its quality and infertility or subfertility in male. Further, decrease in LH/ICSH production has cascading effects on androgen production, sperm maturity and sex libido in breeding males [21]. Existence of a correlation between plasma testosterone, body weight and scrotal circumference indicates that this can be used in the evaluation of testicular function and breeding soundness of the male [22]. Therefore, the objective of the present study was to ascertain the seasonal and age variation in scrotal circumference and its association with endocrinological profiles in mithun species.

2. Materials and methods

2.1. Area of the study

The present study was conducted at the mithun breeding farm, ICAR-National Research Centre on Mithun, Medziphema, Nagaland, India and is located between 25°54″30″ North latitude and 93°44″15″ East longitude and at an altitude range of 250–300 m MSL. The meteorological factors such as ambient temperature and relative humidity values were obtained from the meteorology station of ICAR Research Complex for NEH Region, Nagaland, India, located at the close proximity of the experimental station for calculation of temperature humidity index. The ambient thermal data were assessed to know the climatic condition of the research station where mithuns were kept for research. Season-wise THI was calculated for five whole calendar years and the year has been divided into four seasons such as spring (February to April), summer (May to July), autumn (August to October) and winter (November to January) (Table 1). Temperature humidity index was calculated by using the following formula: $THI = 0.72 (W + D) + 40.6$, where W stands for wet bulb temperature (°C) and D stands for dry bulb temperature (°C) [23]. During the study, the animals were handled as per Institutional Animal Care and Use Committee regulations.

2.2. Experimental animals

The present research was carried out on 30 mithun males of different age groups selected from the mithun breeding farm, ICAR-National Research Centre on Mithun, Medziphema, Nagaland, India and were maintained under the same feeding, housing and lighting and managemental conditions. The feeding schedule was followed as per the farm management for each experimental animal. The mithun males were distributed equally into five different groups based on their age and consisted of six animals per group and the groups were such as Gr A (0.1–1.0 year), Gr B (1.1–2.0 years), Gr C (2.1–3.0 years), Gr D (3.1–5.0 years) and Gr E (5.1–6.0 years).

2.3. Measurement of the scrotal and testicular parameters

The testicular biometrics and SC were measured as described by the Society of Theriogenology [24]. Testicular parameters and SC were measured using a caliper (Mitutoya Digimatic Caliper, Japan) and a measuring tape after proper restraining the mithun bull in the control crate. Testicular volume was estimated by using the following formula for volume of an ellipsoid as described by Love et al. [25] ($4/3\pi abc$, a = thickness/2; b = width/2 & c = length/2). Weight of the testes was calculated by multiplying 1.038 with volume as 1.038 is the approximate density of testicular tissue in bovine species [26]. Scrotal and testicular parameters were measured four times by the same operator at winter, spring, summer and autumn seasons for different age groups, average was calculated and presented in the form of line graphs.

2.4. Collection of blood and estimation of hormone profiles

The blood samples were collected by venipuncture of jugular vein in heparin tubes (20 IU of heparin/mL of blood) from the experimental mithun bulls at 0400 h interval throughout the day during the different seasons. The blood samples were centrifuged at 1200 × g for 15 min at 4 °C. The plasma samples were separated rapidly, labelled properly and preserved at −80 °C in deep freezer for further analysis.