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Importance of indigenous cattle and peculiarity of their reproductive cycle: A review

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Abstract
India is one of the most biodiversity rich countries in the world. India has a huge cattle wealth and indigenous cow breeds of India have cultural, ethical and economic importance. But population of indigenous cows is showing a decreasing trend and some breeds are showing even endangered levels. So it is imperative to protect our country's natural wealth. Indigenous cows have very unique reproductive physiology and studies related to indigenous cattle reproduction are very rare. Therefore, there is a need of proper investigation in field of reproductive physiology of indigenous cattle for proper up-liftment and propagation of indigenous cattle population.

Keywords: Indigenous cow, reproductive cycle, estrus, endocrinology

1. Introduction

India has a large population of humped cattle (Bos *indicus*) estimated to be 142.11 million (Livestock census, 2019) and there are so far 43 registered native cattle breeds in India broadly classified into dairy, draft and dual purpose breed depending upon their utility either in dairying or in agriculture work. There is a vast diversity in the phenotypic, utility pattern and adaptability of the cattle populations reared and adapted in varying agro-climatic conditions and production systems of India (Srivastava *et al*., 2019) [29]. The genetic diversity among the cattle breeds is due to the process of domestication over the centuries, mutation, selective breeding, adaptation to local environment, isolation and genetic drift (Groeneveld *et al*., 2010) [11]. The indigenous breeds of cattle posses various unique characteristics such as the presence of unique genetic variation in HSP70 gene family, carry a 'thermometer gene' which makes them more thermotolerant thus less negative impact of hot humid climatic conditions on milk production as compared to cross breed and exotic population (Li *et al*., 2011; Sodhi *et al*., 2013) [13, 28]. Also due presence of A2 allelic variant in indigenous cow milk (Mishra *et al*., 2009) [14], it is known for less incidence of cardiovascular and other metabolic diseases. The A1 β-casein gene is more prevalent in cow milk of exotic breeds, while the A2 allelic variant in cow milk is predominant in Indian Zebu cattle breeds with the highest frequency of 0.987 (Mishra *et al*., 2009) [14]. A1 milk is related with higher incidence of cardio vascular disease and Type-1 diabetes. Majority of indigenous cattle posses homozygous A2 A2, the desirable genotype, rest of the indigenous cattle are supposed to be carrier for A2 allele (Sharma *et al*., 2014) [25]. Conversely, the exotic cattle (Bos taurus) have A2 allele in low frequency, worldwide. Most of the indigenous breeds are undergoing genetic degradation due to indiscriminate cross breeding and irregular mating among the breeds situated in each other's vicinity. As a result several indigenous breeds with many desirable traits are threatened with extinction, while others are in the process of getting replaced completely by certain high producing cross breed animals. Several breeds of Indigenous cow are having low population or showing declining trends which need attention for the conservation. Sharma and Niranjan (2016) [26] reported that Vechur, Punganur, Krishna valley, Bargur, Ponwar, Binjharpuri, Red Sindhi, Sahiwal, Tharparkar and Amritmahal are showing decreasing population trends. The exotic / crossbred population has been increased by 26.9% during the period of last census in 2012 while population of indigenous cattle has been decreased by 6.0% during the same duration (Livestock census, 2019). But these high producing cross breed are not as adapted as indigenous breeds to Indian agro-climatic condition, also disease resistance of cross breeds are not at par with indigenous breeds. Some of the indigenous breeds are well known for their high milk and fat production and can survive and produce milk on poor feed and fodder resources.

However, the production potential of these animals has deteriorated over a period of time due to lack of selection. Also indigenous breeds need to be conserved for genetic insurance in future, scientific study, as a part of our ecosystem, cultural and ethical requirements.
Therefore up-liftment and propagation of this population can be undertaken by using available reproductive technologies, but there is a lacuna in the information on successful utilization of assisted reproductive technologies in these indigenous cattle breeds.

2. Reproductive Physiology of Indigenous cattle breeds

Indigenous cattle attains puberty at an older age and heavier body weight as compared to cross breeds and exotic cattle species (Sartori *et al*. 2016) [20]. The mean estimated age at puberty for Indigenous breeds is 25 months which is 6 to 12 months later than exotic counterparts (Abeygunawardena and Dematawewa. 2004) [1]. Independent of nutrition, there also seems to be a genetic factor associated with puberty in Zebu cattle and indigenous cattle attains puberty later than exotic cows. Generally, Zebu heifers are less precocious than B. taurus heifers and when precocious heifers are compared with nonprecocious, nonprecocious heifers are heavier and older than precocious heifers at puberty (Ferraz *et al*. 2014). There are clear differences in age at puberty between B. taurus and B. indicus cattle. Moreover, smaller breeds like of indigenous cows normally reach puberty at an older age and heavier body weight than larger exotic cow heifers. Appreciable differences are observed in reproductive physiology of Indigenous and exotic cattle species. The average ovarian antral follicle count (AFC) in indigenous cow is twice the number observed for B. taurus. At wave emergence the number of 2 to 5 mm follicles present in the ovaries was 42.7 (ranging from 25–100) in indigenous cow and 19.7 (ranging from 5–40) in exotic cattle (Batista *et al*., 2014). Greater AFC has been associated with greater circulating anti-Müllerian hormone (AMH) in indigenous cattle as compared with exotic. Even the average antral follicle count is higher in indigenous cattle species but the size of largest follicle at deviation is smaller than exotic cattle species (Sartori *et al*., 2005). In Holstein cattle the diameter of the future ovulatory follicle at the time of deviation was between 8.3 and 9.8 mm (Sartori *et al*., 2005) but deviation occurs when the largest follicle reached 5.4 to 6.2 mm in case of indigenous cattle (Sartori *et al*. 2005). But time taken between ovulation and next follicular deviation in indigenous cows is similar as in exotic cows and it can be due to slower growth rate of the follicles in indigenous cattle as compared with exotic. Different studies has indicated predominance of three wave cycles in addition to two, four and even fives waves cycles in some animals. (Gambini *et al*., 1998) [9]. The diameter of the ovulatory follicle is 11 to 14 mm in indigenous cows (Sartori *et al*. 2016) [20], which is smaller than 13 to 19mm for exotic cows. Similarly, the CL diameter of indigenous cows ranged from 17 to 22 mm whereas, the CL diameter of exotic cows is larger and is in range of 20 to 30 mm (Sartori *et al*. 2016) [20].

2.1 Estrous cycle and estrus signs

The length of the oestrous cycle in indigenous cattle is same as that in exotic cattle, varying between between 18 and 22 days with a mean of 21-28 + 0-06 days (Asdell, 1964) [4]. Copious quantities of clear elastic mucus flow from the vulva; swelling and reddening of vulva at oestrus, restlessness along with homosexual behavior are prominent signs of estrus in indigenous cattle but homosexual activity in indigenous cattle is not as pronounced as in exotic cattle (Layeek *et al*., 2011). Average time of estrus behavior reported for Bos indicus breeds ranges between 13.6± 1.0 to 14.61± 0.99 hours and is shorter when compared with exotic ones with higher incidence of estrus during nights in indigenous cattle thus making detection of estrus difficult in case of indigenous cattle (Barros & Nogueira, 2001; Fernandes *et al*., 2001; Baruseli *et al*., 2004; Layeek *et al*., 2011) [6, 8]. Luteal tissue volume is lower in indigenous cattle but the amount of circulating steroid hormones is higher than exotic conterparts (Sartori & Barros., 2011) [19].

2.3 Endocrinology and hormonal profile in indigenous cattle

Higher circulating steroid hormone concentration in case of indigenous cattle even with lower luteal volume as compared to exotic cow is a fascinating fact and this inverse proportionality can be attributed to higher cholesterol levels which is precursor for biosynthesis of hormones in case of indigenous cattle compared to exotic cattle kept on same plane of nutrition (Gandra *et al*., 2011) [10]. Also Sartori *et al*. in 2016 [20] reported reduced metabolic clearance rate of steroid hormones in indigenous cattle. There is higher amount of circulating levels of insulin and IGF1 in case of indigenous cattle (Sartori & Guardieiro., 2010; Sartori *et al*., 2013) [21].

2.3.1 Progesterone profile during estrus cycle

Progesterone is a 19-C steroid hormone produced by the CL synthesized from cholesterol. It is essential for maintenance and recognition of pregnancy. It is secreted at metestrus and continues throughout diestrus. Progesterone concentrations start to increase just after ovulation, as the CL develops and then stabilizes until about day 15 of the estrus cycle. Progesterone exert a negative feedback on hypothalamus and pituitary that results in the change in frequency and amplitude of GnRH and LH release, thereby decreasing LH blood concentrations. Plasma progesterone concentrations directly reflect the functional status of CL. The overall mean concentration of progesterone in the indigenous cows during estrous cycle on the day of estrus (day 0) and day 3, 6, 9, 12, 15, 18, 19, 20 of estrous cycle and subsequent estrus day 0 were 0.43±0.89, 1.89±0.89, 5.39±0.89, 6.24±0.89, 9.72±0.89, 10.67±0.89, 8.64±0.89, 5.22±0.89, 1.67±0.89 and 0.34±0.89 ng/ml, respectively (Singh *et al*., 2006; Naik *et al*., 2013). Progesterone concentration showed significant increase from day '0' to day 15 and then from day 18 a significant decreasing trend can be seen, finally coming down to the lowest concentration. Singh *et al*., 1998 observed plasma progesterone concentration of <0.5ng/ml reflects acycliclity or ovarian inactivity in indigenous cattle. Similar progesterone levels were recorded during another study in indigenous cattle by Singh *et al* in 2006 [26]. Rani *et al*., 2017 [18] recorded plasma progesterone concentrations of 1.18±0.40, 1.79±0.05 and 2.72±0.13 ng/ml in pregnant indigenous cows respectively on days 15, 28 and 45post-AI. It was also observed that plasma progesterone concentration was higher in pregnant cows as compared to non-pregnant on day 5 and 15 post-AI (Pandey *et al*., 2016) [17].

Table 1: Comparative reproductive parameters between Indigenous and Exotic cattle

Parameter	Indigenous cattle	Exotic cattle
Number of follicular waves	More	Less
Antral follicle count	More	Less
Anti-mullerian hormone	More	Less
Size of dominant follicle at deviation	5.4 to 6.2 mm	8.3 to 9.8 mm
Growth rate of dominant follicle	Less	More
Size of preovulatory follicle	11 to 14mm	13 to 19mm
Luteal tissue volume	Less	More
Circulating progesterone concentration	More	Less
Insulin concentration	More	Less
IGF1 concentration	More	Less
FSH concentration	Less	More
Cholesterol concentration	More	Less
Steriod hormone clearance rate	Less	More

2.3.2 Estrogen profile during estrus cycle in indigenous cattle

Estrogens are secreted from bovine adrenal, ovary, and placenta. Estrone, 17 β-estradiol, and 17 α-estradiol have been unequivocally identified in the cow. Only 17 β-estradiol has been tentatively identified in whole ovaries and follicular fluid. Estrone has been identified in bovine adrenals, bile, fetal cotyledons, feces, and urine. Urine and fetal cotyledons contain 17 α-estradiol, estrone, and 17 β-estradiol. The mean plasma Estradiol concentration (pg/ml) in indigenous cows during estrous cycle on the day of estrus (day 0) and the day 3, 6, 9, 12, 15, 18, 19, 20 of estrous cycle and subsequent estrus (day 00) were 20.24±1.17, 11.26±1.17, 14.25±1.17, 10.53±1.17, 15.24±1.17, 12.36±1.17, 17.83±1.17, 20.28±1.17, 21.47±1.17 and 22.25±1.17 pg/ml, respectively (Naik *et al.*, 2013).

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