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Laishram Brajagopal Singh

College of Veterinary Sciences
and Animal Husbandry, Central
Agricultural University, Selesih,
Mizoram, India

Dibyajyoti Talukdar

College of Veterinary Sciences
and Animal Husbandry, Central
Agricultural University, Selesih,
Mizoram, India

Dipan Rudra Paul

College of Veterinary Sciences
and Animal Husbandry, Central
Agricultural University, Selesih,
Mizoram, India

Pankhi Priya Bora

College of Veterinary Sciences
and Animal Husbandry, Central
Agricultural University, Selesih,
Mizoram, India

Ajoy Ghosh

College of Veterinary Sciences
and Animal Husbandry, Central
Agricultural University, Selesih,
Mizoram, India

K Lalrintluanga

College of Veterinary Sciences
and Animal Husbandry, Central
Agricultural University, Selesih,
Mizoram, India

Fazal Ali Ahmed

College of Veterinary Sciences
and Animal Husbandry, Central
Agricultural University, Selesih,
Mizoram, India

TC Tolenkhomba

College of Veterinary Sciences
and Animal Husbandry, Central
Agricultural University, Selesih,
Mizoram, India

Corresponding Author:

Dibyajyoti Talukdar

College of Veterinary Sciences
and Animal Husbandry, Central
Agricultural University, Selesih,
Mizoram, India

Estimation of blood biochemical and hormonal profile during different days of reproductive cycle of Manipuri COW

Laishram Brajagopal Singh, Dibyajyoti Talukdar, Dipan Rudra Paul, Pankhi Priya Bora, Ajoy Ghosh, K Lalrintluanga, Fazal Ali Ahmed and TC Tolenkhomba

Abstract

Dairy cow fertility control depends heavily on nutrients, which are necessary for the growth and development of reproductive organs. Any deficiency may impair the reproductive organ's cellular metabolism and enzymatic function, perhaps leading to concurrent reproductive issues. The goal of the current study was to evaluate the correlation between the blood biochemical and hormonal profiles of indigenous non-descript female cattle in Manipur at various stages of their reproductive cycles. From ten experimental animals, a total of thirty blood samples were collected at days 0, 10, and 18 of the oestrous cycle. Several biochemical indicators, including glucose, cholesterol, calcium (Ca), phosphorous (P), zinc (Zn), estrogen, and progesterone were measured from the serum. Blood glucose, zinc, estrogen, and progesterone levels varied significantly ($p < 0.01$) between the various oestrous cycle days, according to the current study. Blood cholesterol, calcium and phosphorus levels at various oestrous cycle days did not significantly differ according to analysis of variance.

Keywords: Cow, reproductive cycle, blood, biochemical, hormone

Introduction

The original nature of Manipuri local cattle (Meetei San) is of semi wild type. Their rearing is under intensive type management system. Although some grazing areas are available but it is not sufficient for them, animals were housed in cement concrete byres with half raised walls. They were fed with concentrate feed along with green fodder and water in the morning and evening. During Dry season the animals were fed with Paddy straw, tree leaves and shrubs. Early weaning at birth is not practiced and calves were allowed to suck their mother's milk. Dairy cow fertility control depends heavily on nutrients, which are necessary for the growth and development of reproductive tissues (Boro *et al.*, 2022a) [2]. Deviation of blood biochemical constituents during different days of reproductive cycle may alters the appropriate function of the reproductive organs (Talukdar *et al.*, 2016; Das *et al.*, 2024) [6, 19]. A lack of certain nutrients can impair the reproductive organ's cellular metabolism and enzymatic function, which can lead to concurrent reproductive issues such anoestrus and repetitive breeding (Talukdar *et al.*, 2015; Talukdar and Talukdar, 2017) [17, 20] thus an economic loss to dairy farmers. Furthermore, hormones control the homeostasis and augment reproductive traits in cow, as well as fertility, growth, development and health (Talukdar *et al.*, 2013) [18]. Breed improvement requires investigating hepatic metabolism and hypothalamus-pituitary-gonad function, which are essential for controlling physiological and behavioral changes associated with the oestrous cycle (Boro *et al.*, 2022b) [3]. The goal of the current study was to clarify the connection between the blood biochemical and hormonal profiles of indigenous non-descript female cattle from Manipur at various stages of the reproductive cycle.

Materials and Methods

The experiment was carried out at the Livestock Farm Complex, College of Agriculture, Central Agricultural University, Iroisemba, Imphal, Manipur and adjoining private indigenous

cattle farms of Imphal west and Imphal east districts of Manipur. The farms are located at the plain areas and having optimum requirements. A total number of 10 Manipuri local cattle were included in this experimental process. The study was conducted for twelve (12) months from January, 2024 to December, 2024. To estimate the blood bio-chemical and hormonal profile at different days of reproductive cycle of local female cattle of Manipur, a total of 30 numbers of blood samples were collected from 10 experimental animals at day 0, 10 and 18 of oestrous cycle. Analysis was done on the serum levels of various biochemical markers, including zinc, calcium (Ca), phosphorus (P), cholesterol, and glucose. Ten (10) milliliters of blood were drawn for this purpose via jugular vein puncture and placed in a vacuum clot activator vial. Twenty minutes were spent with the vials standing. The clot activator vials were then centrifuged for ten minutes at 3000 rpm. Prior to analysis, the collected serum was stored at -20°C. Obtained serum were analyzed to estimate the level blood biochemical parameters by using commercial diagnostic kit using FUJI DRI-CHEM SLIDE in FUJIFILM (DRI CHEM 4000i) auto analyzer and serum level of estrogen and progesterone were also analyzed with ELISA kit (Sigma Alrich Chemicals Pvt Ltd., Jigani Link Road, Bangalore, Karnataka-560010).

To arrive at logical conclusions and significant findings, the gathered data was tallied, organized, and put through a number of suitable statistical tests. The information was statistically analyzed using Snedecor and Cochran (1995) [15].

Results and Discussion

Table 1 showed the serum levels of several biochemical markers calcium, phosphorus, zinc, glucose, and cholesterol including the hormones progesterone and estrogen,

Glucose

In cattle, follicular growth and reproductive hormone regulation are greatly influenced by nutrition. For several animal tissues, glucose serves as their main energy source. It is a vital metabolite for the development, upkeep, and metabolic processes of the animal body. In addition to being an essential nutrient, glucose coordinates the endocrine processes that govern homeorhesis (Lucy *et al.*, 2014) [10]. Gonadotrophins and metabolites like glucose interact and signal to promote follicular growth (Nishimoto *et al.*, 2006) [11]. Lower blood glucose levels in repeat breeder cows may be due to instability between hepatic output and peripheral glucose uptake or defects in the endocrine regulatory mechanisms that influence ovarian cyclicity. Abnormal hormone-producing organ function may affect glucose levels. The levels of blood glucose (mg/dl) in the present study were recorded as 92.10±4.71, 65.00±2.94, and 75.10±7.52 on day 0, 10 and 18 of the oestrous cycle, respectively. The blood glucose levels of the several oestrous cycle days were observed to differ significantly ($p < 0.01$) in the current investigation. The level was significantly high at day 0 i.e. oestrus phase and day 18 i.e. proestrus phase of subsequent cycle. Findings of the Talukdar and Talukdar (2017) [20] showed higher values than the present study. Blood glucose levels are positively correlated with energy balance; low energy levels impact follicular growth, leading to anestrus and follicular atresia. A higher blood glucose level increases the amount of insulin in the blood, which in turn causes the cow to release more GnRH and have more LH in the system, both of which are stimulatory to the ovary and promote an earlier

restart of cyclicity (Shakkarpude *et al.*, 2020) [14]. Cows' elevated glucose levels during oestrus may be caused by an increase in the animal's metabolic activity (Shakkarpude *et al.*, 2020) [14].

Cholesterol

The levels of blood cholesterol (mg/dl) were recorded as 164.40±12.77, 159.60±12.15 and 157.60±9.42 on day 0, 10 and 18 of the oestrous cycle, respectively. The overall level of blood cholesterol (mg/dl) was 77.40±3.65. Blood cholesterol levels at different days of the oestrous cycle did not significantly differ, according to analysis of variance. One of the most crucial components for the manufacture of steroid hormones is cholesterol (Jeremy, 2010) [8]. Cholesterol is a precursor to the steroid hormones progesterone and estrogens, which have a major impact on the onset of the oestrous cycle in cows.

Calcium

A minor shortage in calcium can interfere with ovulation and upset the pituitary-ovarian axis, which is essential for the gonadotropic regulation of ovarian steroidogenesis (Carnegie and Tsang, 1984) [4]. On day 0, 10 and 18 of the oestrous cycle, the level of blood calcium (mg/dl) was recorded as 9.85±0.21, 9.94±0.29, and 9.76±0.36, respectively. The overall level of blood calcium (mg/dl) was worked out to be 9.85±0.16. Blood calcium levels at various stages of the oestrous cycle did not significantly differ, according to analysis of variance. Observation of Talukdar and Talukdar (2017) [20] showed higher value than the present values in the local cattle of Manipur. Findings of Chandrarah *et al.* (2003) [5] showed similar results with the result of the present study.

Phosphorus

Phosphorus helps in energy conversion at the cellular level and is involved in the metabolism of phospholipids. Phosphorus also takes part in CAMP synthesis (Seifi *et al.*, 2005) [12]. The level of phosphorus (mg/dl) was recorded as 5.73±0.19, 4.99±0.19, and 5.30±0.35 on day 0, 10 and 18 of the oestrous cycle, respectively. The overall level of blood phosphorus (mg/dl) was 5.34±0.15. Phosphorus levels at various oestrous cycle days did not significantly differ, according to analysis of variance. Observation of the Talukdar and Talukdar (2017) [20] showed higher value than the findings in local cattle of Manipur.

Zinc

Zinc is believed to be a necessary element for proper sexual maturity, reproductive capacity, and—most importantly—the onset of estrus. Zinc is essential for the upkeep and repair of the uterine lining after parturition, which speeds up the return to regular estrous and reproductive activity (Goff, 1999) [7]. Zinc is one of the most important factors for the development of gonads and as well as the secondary sexual characteristics (Kumar, 2003) [9]. The level of Zinc (µg/dl) was recorded as 115.44±2.81, 89.11±4.65, and 103.20±5.12 on day 0, 10 and 18, respectively. The overall level of blood Zinc (µg/dl) was 102.58±3.12. Zinc levels at various oestrous cycle days varied significantly ($p < 0.01$), according to analysis of variance. Results of the Alvi-Shoushtari *et al.* (2012) [1] showed higher values than the present study. Similar results were reported by Das *et al.* (2024) [6] in local female cattle of Mizoram.

Estrogen

The level of estrogens (pg/ml) was recorded as 8.38 ± 0.30 , 2.14 ± 0.27 and 5.37 ± 0.47 on day 0, 10 and 18 of the oestrous cycle, respectively. The overall level of blood estrogen (pg/ml) was recorded as 5.29 ± 0.51 . Analysis of variance revealed that the levels of estrogen varied significantly ($p < 0.01$) between the various oestrous cycle days, with the highest levels occurring on days 0 and 18. Research on local female cattle in Manipur by Talukdar (2010) [21] revealed trends that are comparable to the current findings. The heifer or cow exhibits signs of oestrus due to the increased estrogen level generated by the dominant ovarian follicle. This means that the cow or heifer is "in heat," or sexually receptive, and will stand to be mounted or bred by other cows—a situation called "standing heat." Boosted activity and a clear mucous vaginal discharge are further symptoms of oestrus. She may also try to mount other cows and speak up more. "Day 0" of the estrous cycle is regarded as the start of oestrus. The large amount of estrogen produced by the dominant ovarian follicle not only causes the heifer or cow to exhibit signs of oestrus, but it also triggers the production of a spike in gonadotropin releasing hormone (GnRH) just prior to ovulation from the hypothalamus, a part of the brain. GnRH causes the brain's pituitary gland to release two other hormones, luteinizing hormone (LH) and follicle stimulating hormone (FSH), which are sent to the ovary through the bloodstream to control what happens to the follicles (Talukdar *et al.*, 2024) [16]. FSH triggers the formation of a fresh wave of ovarian follicles and is released during and soon after oestrus. An increase in LH leads the dominant ovarian follicle to rupture, delivering the egg approximately 24 to 32 hours later. This signifies the

change from the follicular to the luteal phases and is known as ovulation (Das *et al.*, 2024) [6].

Progesterone

Progesterone levels (ng/ml) were measured on days 0, 10, and 18 of the oestrous cycle and were 0.53 ± 0.08 , 11.02 ± 0.27 , and 4.17 ± 0.63 , respectively. The total amount of progesterone in the blood (ng/ml) was 5.24 ± 0.83 . Progesterone levels varied significantly ($p < 0.01$) at different days of the oestrous cycle, according to analysis of variance. Compared to days 0 and 18 of the oestrous cycle, the level was discovered to be substantially higher on day 10. Findings of Talukdar (2010) [21] reported similar trends with the present findings. The remains of the recently ruptured ovarian follicle develop into the corpus luteum during the luteal phase of the oestrous cycle, where they begin to generate progesterone, a steroid hormone necessary to support and maintain a potential pregnancy in the event that the egg is fertilized. The corpus luteum develops and enlarges over the first ten days of the oestrous cycle. Around mid-cycle (Days 9 and 10), the corpus luteum reaches its maximum size and produces the most progesterone. Under the influence of elevated progesterone, waves of ovarian follicles continue to develop and regress in the absence of a dominant ovarian follicle rupturing. A dominant follicle won't rupture again until the progesterone level falls in the next follicular phase. Low levels of progesterone during the estrous cycle impair oxytocin responsiveness in the late luteal phase of another oestrous cycle, which raises $\text{PGF2}\alpha$ release and interferes with the pregnancy stage (Shaham-Albalancy *et al.*, 2001) [13].

Table 1: Level of blood bio-chemicals and hormonal profiles at different days of oestrous cycle of local female cattle of Manipur (Mean \pm S.E), n=10

Parameter	Day 0	Day 10	Day 18	F-value	Overall
Calcium (mg/dl)	9.85 ± 0.21	9.94 ± 0.29	9.76 ± 0.36	0.091 ^{NS}	9.85 ± 0.16
Phosphorus (mg/dl)	5.73 ± 0.19	4.99 ± 0.19	5.30 ± 0.35	2.053 ^{NS}	5.34 ± 0.15
Zinc ($\mu\text{g}/\text{dl}$)	115.44 ± 2.81^b	89.11 ± 4.65^a	103.20 ± 5.12^b	9.322 ^{**}	102.58 ± 3.12
Glucose (mg/dl)	92.10 ± 4.71^b	65.00 ± 2.94^a	75.10 ± 7.52^a	6.424 ^{**}	77.40 ± 3.65
Cholesterol (mg/dl)	164.40 ± 12.77	159.60 ± 12.15	157.60 ± 9.42	0.092 ^{NS}	160.53 ± 6.45
Estrogen (pg/ml)	8.38 ± 0.30^c	2.14 ± 0.27^a	5.37 ± 0.47^b	74.248 ^{**}	5.29 ± 0.51
Progesterone (ng/ml)	0.53 ± 0.08^a	11.02 ± 0.27^c	4.17 ± 0.63^b	175.058 ^{**}	5.24 ± 0.83

** $p < 0.01$, ^{NS} Non significant

Means bearing different superscripts in a column differed significantly

Conclusion

The study demonstrates that serum levels of biochemical markers, including glucose, cholesterol, calcium, phosphorus, zinc, and hormones such as progesterone and estrogen, fluctuate throughout the oestrous cycle in cattle. Glucose and zinc levels showed significant variation across the cycle, which correlates with reproductive hormone regulation and metabolic activity. Cholesterol, calcium, and phosphorus levels, however, did not differ significantly. Elevated glucose and estrogen levels during oestrus, along with progesterone peaks during the luteal phase, highlight the intricate interaction between nutrition and endocrine functions that drive follicular growth, ovulation, and reproductive efficiency in cattle.

Conflict of Interest

Not available

Financial Support

Not available

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