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Article

Monitoring vaginal electrical impedance in crossbred cows during post-partum period

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Abstract: Efficient and accurate detection of estrus and correct time of artificial insemination are essential for sustainable dairy farms. Therefore, this study was carried out to monitor oestrus by observing vaginal electrical impedance (VEI) in post-partum cows. Eighteen cows with 19-139 post-partum days were included for this study. Daily VEI values were measured with heat detector®. Lower vaginal electrical resistance (VER) values were recorded during oestrus. VER of 210-240 Ω might be indicative for oestrus in cows. The day difference between two successive lower values or higher values in "VER waves" ranged from 18 to 22 days in cows which might indicates the oestrous cycle length. Marked variation existed between VER values of two successive peaks in pregnant and non-pregnant cows, and increased ($P < 0.05$) VER values were observed in 2nd peak in pregnant cows. VER of 320-370 Ω at 19-22 days after AI could be considered for early pregnancy. The study suggests that the measurement of vaginal impedance could serve as an indicator of the oestrus in cows and daily impedance measurements are necessary to confirm the stages of the estrous cycle, correct time of AI and early pregnancy.

Keywords: cow; oestrus; post-partum; vaginal electrical impedance

1. Introduction

The main constraint of sustainable cattle production is prolonged postpartum anestrus in Bangladesh. It seems that first standing oestrus in the cows usually occur 40 to 50 days after parturition. Careful examination of ovaries reveals that the first ovulation usually occur 25 to 30 days post-partum in most dairy breeds (Toribio *et al.*, 1997). The major factor limiting reproductive performance in many dairy herds during post-partum is the failure to detect estrus in a timely and accurate manner. Detection of estrus is often difficult due to short periods of standing estrus, silent estrus, changing nutritional regimens, environmental temperatures, and estrus onset during the late night to early morning hours. In Bangladesh 40% cows remained undetected when they were in estrus (Shamsuddin *et al.*, 1999). A satisfactory conception rate can be achieved only if the insemination is performed at the correct time relative to ovulation. Efficient and accurate estrus detection is essential for successful AI and pregnancy. Therefore, it is very important to monitor reproductive system when animal is in oestrus. Various noninvasive *in vivo* methods have been used to study reproductive events in female mammals (Bollwein *et al.*, 2000; Singh *et al.*, 2003). Now-a-days, oestrus or heat detector is used to monitor estrus and oestrous cycle. Estrous detectors are evolutionary and relatively new technology designed for optimum productivity in breeding. The onset of estrous is characterized by increasing levels of estrogen. Increased

oestrogen level leads to increase activity of metabolic pathway, which in turn increases adrenocorticotropic hormone and aldosterone. One effect of these hormones is to increase the levels of sodium chloride (NaCl) in the vaginal mucous resulting in a significantly lower level of electrical resistance than usual (Fehring, 1997). Differences in VEI readings resulted from the estrous cycle correspond to its phases, providing vital information for efficient and effective breeding. There is no study on vaginal electrical impedance in cows, using heat detector in Bangladesh. Therefore, the study was designed to monitor VEI to detect estrus and estrus cycle length in cows during post-partum. Optimization of VEI values in estrus and early pregnancy in cows is also considered.

2. Materials & Methods

Eighteen cross breed dairy cows with 19-139 days post-partum were selected at Dairy Farm, Bangladesh Agricultural University, Mymensingh-2202. The cows with ≥3 BCS were selected for the study. Their ages were in between 3 to 9 years and their parity ranged between 1 and 6. The animals were fed with paddy straw, concentrate mixture, cut-and-carry grass and milling by-product according to their body weight and milk production. Vitamin premixes (Powder Renavet-DB®, Renata Animal Health, Bangladesh) were also supplied to the cows with concentrate. All the selected cows were dewormed by using Nitroxyline (Bolus Nitronex®, Renata Animal Health, Bangladesh) 7 days before beginning of experiment.

Daily VEI values of all cows were recorded up to 37-42 days. No synchronization protocol was followed in this study. Stages of estrous cycle were not considered during monitoring of VEI and values were taken at 9.00am. When cows were observed as in estrus, AI was performed with frozen-thawed semen. Among them, 7cows became pregnant after AI. Pregnancy diagnosis was performed by observing embryos with transrectal ultrasonography using real-time B-mode ultrasound (MU1V®, Veterinary Mobile Ultrasound, Bionet, South Korea) equipped with a 7.5 MHz linear probe, between days 40-45 after insemination. Prior to using the probe of the estrous detector was washed in 1% potassium permanganate (PPM) solution. No gel or oily substance was used as this change the reading of VEI. Care was taken to insert the probe into the vagina at same length each time. Therefore, a red band was used to mark the same length on the probe. The probe was placed aside either left or right to take reading from the vaginal wall. The reading was visible on the screen.

2.1. Statistical analysis

Data were presented in two groups; non -pregnant and pregnant cows, after descriptive analysis. Individual VEI values of each cow were presented as graph to demonstrate daily VEI value changes during estrus cycle and early pregnancy. T test was performed to observe variations in the VEI values of successive two values in pregnant and non-pregnant cows using statistical software SPSS 16. Differences were considered significant at $P < 0.05$.

3. Results

Daily VER values of individual animals were considered to establish precise VER values for estrus cycle and early pregnancy. It is the first and preliminary study on VER of dairy cows by heat detector in Bangladesh. Individual VER values of estrus and estrous cycle of non- pregnant cows are presented in Figure 1a,b,c,d,e,f,g,h,i,j &k. Daily VER values of pregnant cows are presented in Figure 2a,b,c,d,e, & g. In general, lower resistance (ranged from 210 Ωto 290 Ω in cows) were observed when animal was in estrus.

Presence of swollen and reddish vulva and mucus strand supports this finding. Resistance remained high near the next heat and then it dropped again. The day difference between two successive lower peaks in VER waves ranged from 18-22 days which might indicate the estrous cycle in dairy cows.

During this study, we summarized VEI values of two successive lower peaks in both pregnant and non-pregnant cows and data are shown in Table 1.

Table 1. Mean ±SD of VEI values of two successive lower peaks in VEI wave.

Group		Vaginal electrical impedance (VEI)		
		(Mean ±SD)	Minimum values	Maximum values
Non-pregnant	1st peak	241±29.5[a]	210	290
	2nd peak	229±12.0[a]	210	250
Pregnant	1st peak	218.6±7.0[a]	210	230
	2nd peak	342.9±20.6[*b]	320	370

*presents significant variation (P<0.05) within group

a, b represent significant variation (P<0.05) between two groups

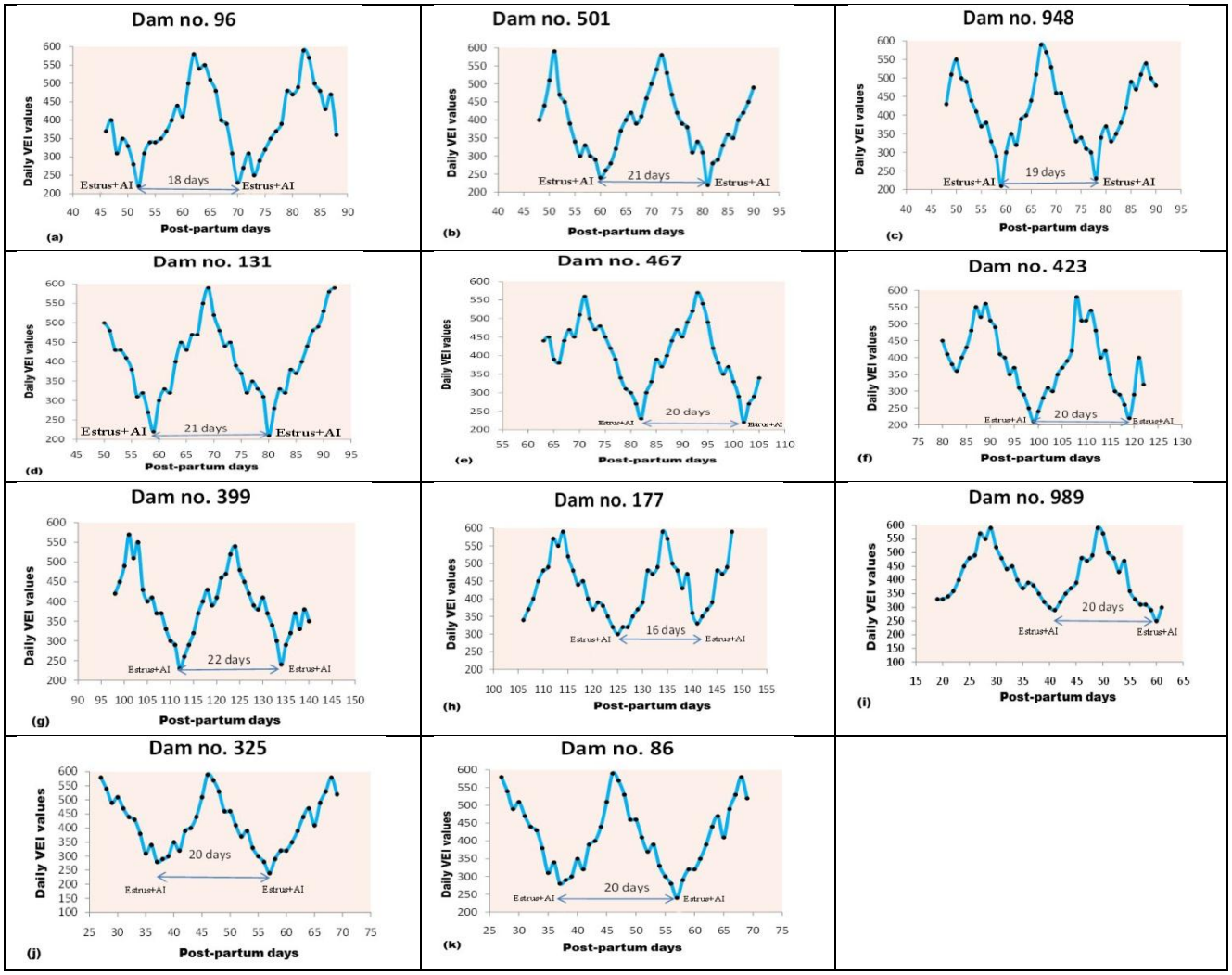

Figure 1. a, b, c, d, e, f, g, h, i, j & k present VER values of estrus and estrous cycle in non-pregnant cows during post-partum.

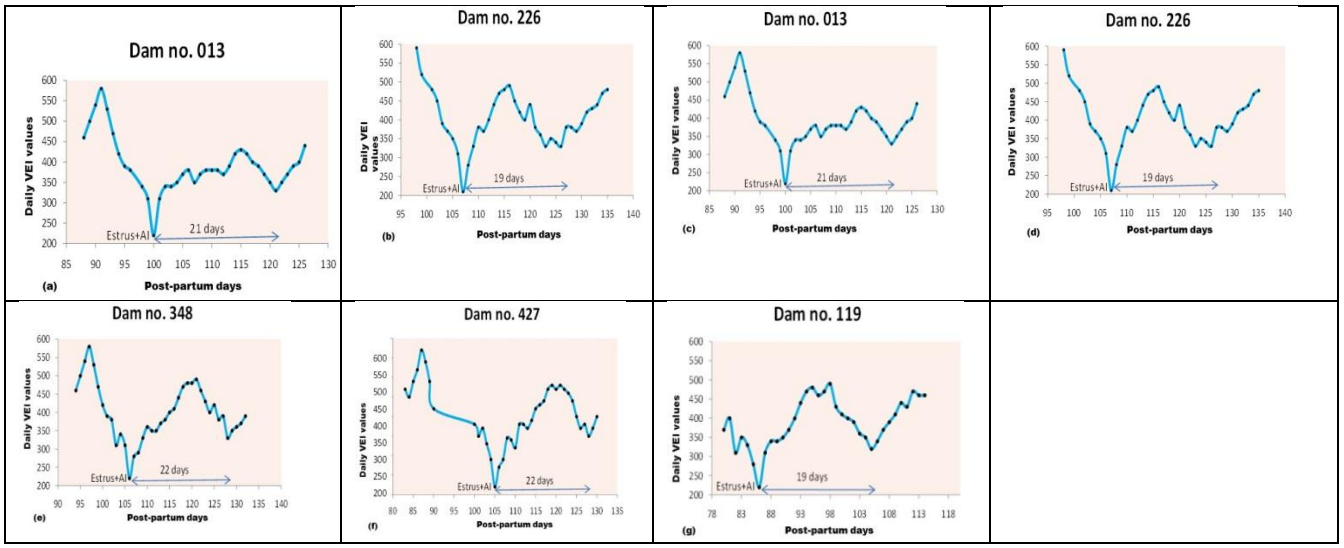

Figure 2. a, b, c, d, e, f, & g present daily VEI values of pregnant cows during post-partum.

There was no significant variation (P<0.05) in VEI values of 1st peak in cows of both groups. Whereas, VEI values increased significantly (P<0.05) during 2nd-peak in pregnant cows and marked variation existed between VEI values of 2nd-peak in pregnant and non-pregnant groups. This result could help us to determine the VEI values during early pregnancy.

4. Discussion

Longer post-partum is responsible for a long calving and is a major cause for economic loss to cow breeders. It is stated that high percentage of cows show silent oestrus and the longer period between calving and postpartum cyclicity. Poor oestrus detection is a common problem in cows even under good management. Hormonal variations during oestrus cycle produce variations in animal behavior and physiologic parameters. As a result, heat detection technique based on animal behavior can produce both false positives and false negatives (Miranda *et al.,* 2009). Most detection methods are not suitable in herd practice in Bangladesh. Detection method should combine cost and herd feasibility. For this reason, the experiments were performed to study VER with heat detector probe to monitor oestrus and pregnancy in cattle during post-partum.

The impedance technique is one of the tools that could be used for non-invasive monitoring of events occurring in cyclic animals (Miranda *et al.,* 2009). There is paucity of data regarding VEI values of cows in Bangladesh. Gupta and Purohit (2001) reported that AI at a low VEI distinctly improved the conception rate in buffaloes. Data obtained in cattle with electrodes implanted in the vaginal submucosa, 15 cm from the vulva, indicate that changes in vaginal impedance have a closer relationship to the timing of ovulation than to the timing of estrus (Smith *et al.,* 1989). During this experiment, typical changes in VEI of individual crossbred cows with a postpartum period of 40-96 days were observed daily up to 42 days to record the minimum level of resistance and the moment when a distinct rise in resistance occurred. It supports the statement of Aizinbud *et al.* (1980) who stated that daily impedance measurements are necessary to confirm the stages of the oestrous cycle. In this study, lower peak observed with lower VEI values during oestrus and then increased to a high level after oestrus. Resistance remained high near the next heat and then it dropped again. It is found that the difference between two successive lower peaks of "VEI waves" ranged from 18-22 days, which might indicate the oestrous cycle length in cows. Result corresponds well with the finding of Jainudeenand and Hafez (1993) who reported that the duration of the oestrous cycle in cows ranged from 18to 22 days with a mean of around 21 days. VEI in lower peak recorded during experiment supposed to be indicative of oestrus. In addition, physical signs i.e. changes in vulva color and mucus were more intensive at lower peak in cows. Estrous detector is responsive to the hormonal changes that coincide with estrous. For this, estrous detector as a much simpler tool can replace the more costly procedure of progesterone-based pregnancy detection. This is worthy to consider some physical factors such as, instability of the contact between the vaginal mucosa and electrodes due to the changes in the tone of the vagina, the entrapment of air in the vagina during insertion of an electrode-bearing probe or unequal hand pressure during taking impedance measure as described by Lehrer *et al.* (1991).The electrical impedance in the vagina, vaginal vestibule and vulva during different stages of the oestrous cycle shows significant changes that may vary among these reproductive organs, different locations in these organs and mammalian species (Rezácˇ, 2008). We found no significant variation (P<0.05) in VEI values of 1st peak in cows of both groups in this study. Whereas, VEI values increased significantly (P < 0.05) during 2nd-peak in pregnant cows.Marked variation existed between VEI values of 2nd peaks in pregnant and non-pregnant groups. This result could help us to determine the VEI values during early pregnancy. In this study, the vaginal length was not measured where detector was placed. There might be differences among VEI values taken from different anatomical site of female reproductive tract in cows, which need to focus in future. Moreover, hormonal profiles (oestrogen and progesteron level) were not measured to conclude if there is any relationship between VEI and hormones is existed. Future study should be directed to identify factors that may affect the variability of impedance values in the vagina during the oestrous cycle in cows. However, understanding and investigating VEI ''waves'' as a functional unit during the oestrous cycle, could facilitate the development of value indicating oestrus and influencing ovarian function in both cyclic and non-cyclic animals, leading to the improvement of reproductive efficiency in indigenous cow. Further study is in progress to detect definite range of VEI, which would, allows us to know the proper time of AI to improve fertility of cows.

5. Conclusions

This study suggests that the measurement of vaginal impedance could serve as an indicator of the oestrus in cows and daily impedance measurements are necessary to confirm the stages of the estrous cycle, correct time of AI and early pregnancy.

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Conflict of interest
None to declare.

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