Estrus detection in dairy cattle: Are vaginal detector probes species-specific to vaginal mucus?

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Abstract

Two separate estrous detector probes, labelled for bovine and swine, were intuitively used to study changes in electrical resistivity of vaginal mucus (ERVm) in 48 Sokoto Gudali cattle (SGC) that were synchronized with double intramuscular injections of prostaglandin F₂ alpha (PGF). The cattle comprised of 32 heifers and 16 cows were randomly assigned into groups A (11-day) and B (12-day) PGF injection intervals, with equal number of heifers and cows. The ERVm was measured between first day (d 0) of PGF injection and d 15. Each injection contained 500 µg Estrumate[®]. Results showed that the difference in the mean values of ERVm between bovine (267.07±20.81) and swine (256.64±39.41) probes was not significant ($p>0.05$). Similarly, the differences in ERVm between the bovine and swine probes at 48 h post 1st PGF in all cattle (239.20±5.09 and 231.60±13.53), as well as 48 h post 2nd PGF in 11-day (253.07±5.22 and 224.67±23.45) and 12-day (266.67±25.55 and 233.03±21.96) PGF injection groups were not significant ($p>0.05$), respectively. In all, 75% of cattle stood to mounting by pen mates and a 75:25 success to failure ratio for evaluating ERVm in cattle with the aid of a swine vaginal probe were obtained. The ERVm pattern also suggests that estrus occurred between 0-72 h post PGF with both probes. It can be concluded that there may be no difference in sensitivity to vaginal mucus between these two probes and that either may be used to evaluate ERVm in the SGC.

Keywords: Estrus detection, vaginal mucus resistivity, probes, Sokoto Gudali cows

Introduction

The delicate sequence between production and reproduction cycles is an indicator of performance efficiency in dairy industries. Some of the factors known to threaten this sequence of events include disease factors, poor genetics, malnutrition and poor reproductive management (Hudson *et al.*, 2012). According to Marinho *et al.* (2013), classical indicators of optimal reproduction in the dairy industry have nose-dived over the last 50 years or more. Some of these indicators include the rates of conception at first service and services per conception as well as the calving interval. One parameter that is central to all these indicators and also a component of good reproductive management programs in all species of livestock is estrus detection accuracy which

is the percentage of estrus periods observed that are actual estrus periods (Nebel, 1988). Error rates in estrus detection ranging from 0-60% (Reimers *et al.*, 1985), 1-12% (Elmore, 1989), and 25% (Nebel *et al.*, 1987), have been reported among cows presented for insemination. These figures must have in no small measure contributed to grave losses in the industry. According to Williamson and Morris (1972), among the signs of estrus such as grouping, ruffled tail head, homosexual activity, standing immobile to mounting was the most consistent in 79% of cows. The problems associated with estrus detection in cattle are however, multifactorial. Apart from the brevity of its duration (Trimberger, 1948), many of the indicators are unreliable and inconsistent, evaluation techniques are

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laborious, leading to poor estrus detection and pregnancy rates. For example, the best indicator of estrus being standing immobile to mounting (Gwasdauskas *et al.*, 1986), visual observation of this behavior will be the most productive way for efficient estrus detection. However, about 57% and 43% of cows show such signs between 6 am - midnight and midnight - 6 am, respectively. This implies that a 24-hourly observation would be required to obtain 100% detection rate. The reality of the challenges involved in estrus detection have therefore led to the development of estrus detection aids (EDA), some of these include: vaginal temperature monitoring (Brehme *et al.*, 2008), progesterone testing (Claycomb and Delwiche, 1998), pedometers (Rodenberg and Murray, 2007), altered vocalization (Schon *et al.*, 2007), heat watch (Heatwatch, 1992), and pressure sensing device (Dransfield, 1998). Several authors (Palmer *et al.*, 2010; Johnson *et al.*, 2012; Kamphius *et al.*, 2012; Talukdaer *et al.*, 2015) have attested to the sensitivity and positive predictive values of these aids in estrus detection. Perhaps, a more recent addition to existing EDA in Nigeria is the estrous detector probes which measure electrical resistivity of vaginal mucus (ERVm). The dynamic nature of the biophysical and biochemical characteristics of cervico-vaginal/vaginal mucus during the estrous cycle in cows has been established (Carlstedt and Sheehan, 1989; Rangnekar *et al.*, 2002). These changes are influenced by the endocrinological status of the reproduction cycle and detected as fluctuations in ERVm during different stages of the cycle (Lopez-Gatius *et al.*, 1993). According to some reports, changes in ERVm have offered usefulness in determining breeding time in the ewe (Theodosiadou and Tsiligianni, 2015), cattle (Heckman *et al.*, 1979; Tsiligianni *et al.*, 2000; Bernardi *et al.*,

2016), buffaloes (Verma *et al.*, 2014) and women (Pommerenke, 1946). Estrous detector probes are manufactured in different sizes and lengths according to species of animals and are readily available in the market. In this report, we present our recent observations arising from an intuitive application of two estrous detector probes (bovine and swine), while monitoring electrical resistivity of the vagina mucus in Sokoto Gudali cattle treated with prostaglandin F₂ alpha.

Materials and methods

Study site

The study was carried out at the Dairy Unit of the Teaching and Research Farm, University of Ibadan, Oyo State, Southwest Nigeria. Ibadan city lies on latitude 7°27' and longitude 3°45'. It has an average annual rainfall of about 1250 mm with mean temperature of 27°C.

Study animals

Forty-eight Sokoto Gudali cattle consisting of 32 heifers (175-240 kg), that have cycled at least once) and 16 cows (1-3 parity, about 60 days post calving) were used for the study. The animals had ear tags for identification and were kept in their pens throughout the day except when they grazed within the paddock to allow cleaners work in the pens. The cows were fed with silage and chopped elephant grass. Clean water was also provided *ad libitum*.

Study design

Cattle were randomly assigned into groups A and B such that each group had 16 heifers and 8 cows.

Estrus synchronization and identification of estrus

The double prostaglandin F₂ alpha (PGF) protocol was used. Cows in Groups A and B were administered (i/m) 500 µg of Estrumate® (Schering-Plough Animal Health Corp, Germany) at 11- and 12-day intervals, respectively. An animal was

regarded as being in estrus only if she accepted mounting by standing still to another animal for at least 1 minute. Arbitrary mountings that were sustained for less than a minute were disregarded. Animals were watched for mountings thrice (7 am, 11 am and 5 pm) daily, each time for two hours from the point of 2nd PGF administration until 96 hours later.

Evaluation of electrical resistivity of vaginal mucus (ERVm)

Draminski estrous detector probes for bovine and swine were used. The procedure described by Kitwood *et al.* (1993) was slightly modified. Values of ERVm were read thrice at 8.00am and the average taken as the daily reading per animal, starting from the day of first administration of PGF (d 0) in both groups until 96 hours after PGF treatment in group A (d 15). The reading could not be taken on the second day (d 2) due to a farm operation.

Evaluation of graphs of electrical resistivity of vaginal mucus (ERVm) obtained with bovine and swine probes

Line graphs were plotted with ERVm on the ordinate and days on the abscissa. The criteria used for comparison of graphs (Figures) obtained were as follows:

Similarity/Dissimilarity of appearance/pattern of graphs between the bovine and swine probes during 0-96 hours after administration of the 2nd PGF in both Groups of cattle.

Similarity connoted patterns of ERVm in which the two probes either showed a spike

or a decline, while dissimilarity connotes that either showed a spike and the other a decline or plateau during 0-96 h post PGF treatment.

Statistical analysis

Data were analysed using descriptive statistics and the student t-test at 95% confidence interval (Elston and Johnson, 2008). Values of $p < 0.05$ were considered significant.

Guide on research conduct

The study was conducted under strict adherence to the principles of the care and use of farm animals in research, teaching and testing of the Canadian Council on Animal Use (CCAC, 1993).

Results

Comparison of electrical resistivity of vaginal mucus

Table 1 shows the differences in electrical resistivity of vaginal mucus (ERVm) obtained with bovine and swine probes. For the 48 cattle, the difference in the mean values of ERVm between bovine (267.07 ± 20.81) and swine (256.64 ± 39.41) probes during the study was not significant ($p > 0.05$). Similarly, the differences between values of ERVm by the bovine and swine probes at 48 h post 1st PGF in all cows (239.20 ± 5.09 and 231.60 ± 13.53) and at 48 h post 2nd PGF for 11-day (253.07 ± 5.22 and 224.67 ± 23.45) as well as 12-day (266.67 ± 25.55 and 233.03 ± 21.96) PGF interval groups were not significant ($p > 0.05$), respectively.

Table 1: Comparison of electrical resistivity of vaginal mucus obtained with Draminski bovine and swine estrous detector probes in cattle treated with double injections of prostaglandin F₂ alpha (Estrumate®)

Criteria	Bovine probe (Mean±S.D)	Swine probe (Mean±S.D)	P-value /Significance
Readings; d (0 – 15)	267.07±20.81	256.64±39.41	0.223/ $p > 0.05$
48 h post 1 st PGF (in all cattle)	239.20±5.09	231.60±13.53	0.667/ $p > 0.05$
48 h post 2 nd PGF (11-d treatment cattle)	253.07±5.22	224.67±23.45	0.131/ $p > 0.05$
48 h post 2 nd PGF (12-d treatment cattle)	266.67±25.55	233.03±21.96	0.154/ $p > 0.05$

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Relationships in the patterns of electrical resistivity of vaginal mucus (ERVm)

Figure 1 shows that 25% of cows showed

dissimilarity in their patterns of ERVm while 58% had similar pattern and 17% had a different but also similar pattern of ERVm.

Figure 1: Relationships in the patterns of electrical resistivity of vaginal mucus (ERVm) obtained with Draminski bovine and swine estrous detector probes in cattle at 0-96 h post double injections of prostaglandin F₂ alpha (Estrumate®).

Graphs of ERVm in cows

Figure 2 shows the dissimilar pattern in values of ERVm. Within the 25% that showed dissimilar pattern of ERVm as in Figure 1, the bovine probe showed a

continued increase in ERVm up to 24 h after PGF treatment but decreases slowly thereafter for about 48 h and then peaks to the end of the study (i.e. 96 h). During the same periods, the pattern of the swine probe was exactly opposite.

Figure 2: Line graph of ERVm in cattle showing dissimilarity between bovine and swine estrous detector probes during 0-96 h post 2nd PGF (i.e. d 11-15).

Figure 3 shows a similar pattern with spike during 0-48 h post 2nd PGF although, that of the swine probe was for 0-24 h, and a decline thereafter with both probes up to 72 h and a slight peak to the end of the study.

Figure 4 shows another similar pattern between the two probes. The values of ERVm with bovine probe started to decline during 0-48 h post 2nd PGF while that for swine declined from 24 h post treatment. Both spiked from 48 h post treatment to the

end of the study.

Figures 3 and 4 also represent the pattern for the cows that accepted mounting by pen mates. In Figure 3, the pattern of ERVm suggests that estrus occurred between 24-72 h post PGF (swine probe), and 48-72 h (bovine probe). In Figure 4, the pattern of ERVm suggests that estrus occurred between 24-48 h post PGF (swine probe), and 0-48 h (bovine probe).

Figure 3: Line graph of ERVm in cows showing similarity (decline) between bovine and swine estrous detector probes during 0-96 h post 2nd PGF (i.e. d 11-15).

Figure 4: Line graph of ERVm in cows showing similarity between bovine and swine estrous detector probes during 0-96 h post 2nd PGF (i.e. d 11-15).

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Discussion

Since values of electrical resistivity of vaginal mucus (ERVm) reflect the reproductive endocrinological milieu of the cows species at any given time (Roth, 1993), it may be expected that readings evaluated with a species-specific probe would provide information that are specific for the species and distinct from readings obtained using other probes that are not labelled for same species. Our results however showed non-significant differences between the values of ERVm obtained using bovine and swine probes in cattle. Simply, there may be non-significant between the probes that may warrant species-specific labelling as they are usually marketed. This would imply that outside of the differences in size and length of the shaft (bovine being longer than swine) inserted into the vagina, the sensitivities of the equipment are comparable. This ought not to be, considering the clinical value of ERVm as a useful estrus detection aid. Figure 1 appears to buttress the position suggested by the earlier finding in this study as it showed that 75% of the patterns of ERVm obtained by both probes were similar. Although among this proportion, 17% and 58% of ERVm from the animals as evaluated by both probes agreed separately in pattern. The proportion of the ERVm pattern that was dissimilar may be viewed in a different perspective. A consideration of the line plot for the bovine probe in this group (Figure 2) of cattle closely resembles the pattern obtained in Figure 3 where evidence of similarity between both probes was found. It therefore becomes obvious that $25 + 17\%$ i.e. 42% of cows would have a similar pattern of ERVm (Figure 3) and another 58% cows would have another similar (Figure 4), but different from the earlier pattern of ERVm. Minor differences among individual cows e.g. 11- and 12-day PGF

treatment interval may be responsible for the similar but different groups into which the cows would then be categorized. Be that as it may, it would still subsist that there is a 75:25 success to failure ratio for evaluating ERVm values in cows with the aid of a swine vaginal probe. This success rate may be viewed as high enough, making species labelling unnecessary, except for probe length. In the current study, two injections of prostaglandin F_2 alpha (PGF) were administered to cycling cows, implying that 75 to 85% at least should exhibit estrus within two (48 hours) to four (96 hours) days after the second injection (Day, 2005). Our observation on the proportion of cows that stood to mounting by pen mates is in agreement with this earlier report as 75% of the cows were in heat. The actual figure in heat may be more than this figure since deficits can occur due to unobserved estrus. Among the animals that showed standing estrus, the pattern of ERVm further suggest that in all cases, estrus occurred between 0-72 h post PGF treatment with both probes. This result is in agreement with several studies (Voh Jr. *et al.*, 2000; Venkata *et al.*, 2013) and further validate the instructional guide attached to the equipment that estrus is always characterized by a decline, preceded by a spike in ERVm. The agreement between the two probes in detecting estrus is also worrisome, lending credence to the probable similarity in the sensitivities of both probes and possibly raising a query on the clinical advantage of species labelling and electrical resistivity of vaginal mucus. This finding may suffice to suggest that the different probes interacted in a similar way with the vaginal mucus produced at the different stages of the study. Apart from the fact that obvious differences with respect to reproductive anatomy exist between the swine and the bovine, salient differences also exist in their reproductive endocrinology e.g. their lengths of estrus,

duration of ovulation and luteal phases as well as vaginal cytology, even though, lengths of the cycle are similar. If these differences are peculiar enough, they are likely to affect the nature of the vaginal mucus and sufficient therefore to be factored into the manufacture of a species-specific vaginal probe. Some reports have shown that hormonal treatments in animals for estrus induction often disrupt the physico-chemical nature of cervico-vaginal mucus (Tsiligianni *et al.*, 2001). It is not unlikely that a similar effect as this is seen in the present study or how else would it be explained that a vaginal probe labeled for swine produced comparable values ($p>0.05$) of ERVm to the one specific for bovine in cattle. These findings can only strengthen earlier implication that a great similarity is in both the bovine and swine probes, suggesting that in cattle, either probe may be applicable. The present authors strongly feel that species peculiarities in terms of physico-chemical properties of vaginal mucus, except they are identical across species or the ones in question, ought to distinguish between values obtained with different probes in a single species to warrant labelling as such. Otherwise, it will be scientific and appreciative of the physiological differences between the swine and the bovine not to have reduced the differences between these species in terms of the biology of the vaginal mucus, if there are any, to difference in the sizes of the probes as our findings in this study suggest.

Conclusion

The study showed that there may be no species-sensitivity differences between the Draminski bovine and swine probes and that either may be used to evaluate electrical resistivity of vaginal mucus in Sokoto Gudali cattle treated with prostaglandin F_2 alpha.

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