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IMPEDANCE PATTERN OF VAGINAL AND VESTIBULAR MUCOSA IN CYCLIC GOATS

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Abstract

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The changes of vaginal and vestibular impedance during the oestrous cycle in goats were examined. The onset of oestrus was teased with a buck once a day during the experiment. Impedance was measured by a four-terminal method. The vaginal impedance was recorded under slight pressure of electrodes to the vaginal dorsal wall at the cervix. The vestibular impedance was recorded under slight pressure of electrodes to the vestibular dorsal wall 5 cm from the vulva and at the vulva. The impedance was measured once a day from 4 days before the expected oestrus to 6 days after onset of oestrus. The vaginal impedance at the cervix decreased during pro-oestrus ($P < 0.01$) and increased during oestrus ($P < 0.01$). The vestibular impedance 5 cm from the vulva decreased during pro-oestrus ($P < 0.01$) and increased after oestrus ($P < 0.01$). The decrease of vaginal impedance during peri-oestrus was nearly twofold in comparison with the vestibular impedance 5 cm from the vulva. No significant decrease of the vestibular impedance at the vulva was found during the oestrous cycle. The results indicate that the vaginal impedance at the cervix and vestibular impedance 5 cm from the vulva measured by means of a four-terminal method during the oestrous cycle display cyclic changes that are closely related to the oestrous behaviour of goats.

goat, vagina, vaginal vestibule, impedance, oestrus

Goats are seasonal breeders (Mori et al., 1987) and in our region the breeding season generally extends from August to January. In this period, goats come into oestrus approximately every 18 to 21 days (Matthews, 1989). For oestrus it is characteristic that the doe stands firmly when a buck attempts to mount (Romano et al., 1997). Another sign of oestrus is constant tail wagging from side to side. In addition, the vulva appears slightly swollen and reddened (Llewelyn et al., 1993).

In spite of all these signs, it is still sometimes possible to miss oestrus. Some does may find the buck sexually unattractive and will not stand to be bred (Perera et al., 1978). Similarly bucks occasionally ignore females, which appear to be in oestrus and pay more attention to higher ranking females when more than one doe is in oestrus (Llewelyn et al., 1993). A smaller proportion of does exhibits oestrus at first ovulation (Chemineau, 1983; Walkden-Brown et al., 1993). Similarly oestrus detection may be more difficult in the absence of a buck. Oestrous does mount other does, but the frequency is low (Matthews, 1989).

A number of diagnostic tools are available for monitoring events occurring during the oestrous cycle. One approach that could be suitable is the impedance technique. Cyclic changes of vaginal impedance were found in cattle (Carter and Dufty, 1980; Smith et al., 1989; Řezáč and Pöschl, 1991), pigs (Řezáč and Olič, 1988; Dusza et al., 1996), sheep (Adam et al., 1981; Olič et al., 1990; Bartlewski et al., 1999), and a number of other species (Moller et al., 1984; Lilley et al., 1997; Gupta and Purohit, 2001). The main problem of this technique is the wide fluctuation of impedance values (Peters, 1989).

In the ruminants, vaginal impedance studies were concentrated mainly on cattle. On the other hand, small attention was focused on goats (Řezáč et al., 2001). The aim of this study was to determine whether the goats will show cyclic changes of vaginal impedance measured by a four-terminal method during the oestrous cycle. Simultaneously it was planned to prove whether the changes of vaginal and vestibular impedance are similar.

MATERIALS AND METHODS

Animals

The experiment was conducted in October. All 11 does were White Shorthaired goat. The goats were housed indoors during the experiment and exposed to natural lighting conditions (49°5´ N, 16°38´ E). They had ad libitum access to feed and water. All goats displayed at least one oestrus during the previous period. Bucks were housed separately from does, but were within olfactory and auditory range. The onset of oestrus was teased with a buck once a day. The period of oestrus was when the doe stands firmly when a buck attempts to mount.

Impedancemeter

Impedance was measured by an instrument, which used a four-terminal arrangement to eliminate errors in the measurement of the vaginal impedance caused by the electrode polarisation. The impedance was obtained by measuring the voltage developed across the monitored tissue in response to sinusoidal electric current excitation at frequency 3.2 kHz. The cylindrical-shaped probe had four ring electrodes on the terminal pole. In operation, the alternating current was passed across the vaginal wall between the two outer current electrodes (Řezáč et al., 2003).

Measurement procedure

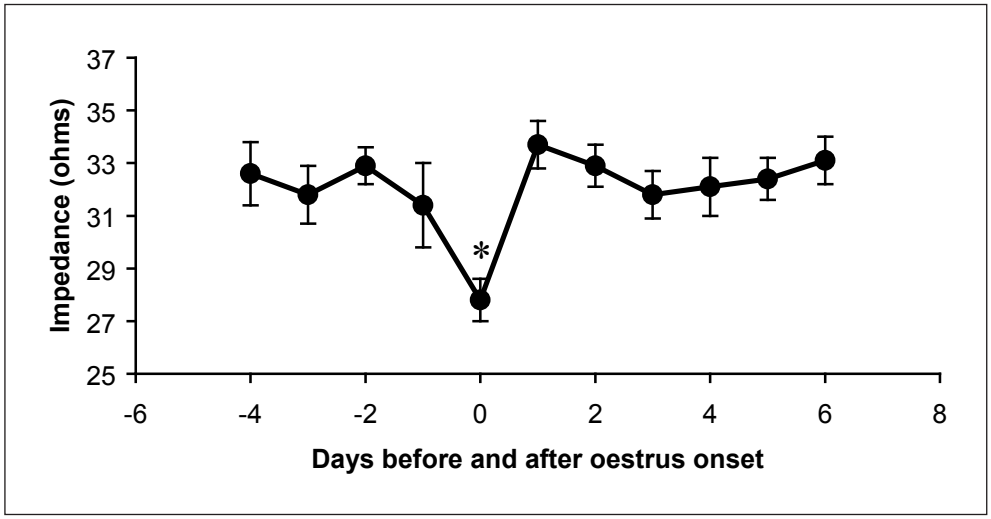
A standardized procedure was used for all goats. The probe was disinfected before using for the measurement. Thereafter, the probe was inserted into the anterior part of the vagina and a reading was taken under slight pressure of electrodes to the vaginal dorsal wall at the cervix. Afterwards, the probe was withdrawn slowly to the vaginal vestibule. The vestibular impedance was recorded under slight pressure of electrodes to the dorsal wall of the vaginal vestibule 5 cm from the vulva and at the vulva. Impedance measurements were carried out every day from 14th day after the previous oestrus to 6 days after oestrus onset.

Statistical analyses

The data are presented as mean ± SEM (the standard error of the mean). Statistical evaluation of the data was performed using the Unistat statistical package (Unistat Ltd., London, England). Differences of impedance values were compared by Shapiro-Wilk test of normality, followed by Paired t-test or Wilcoxon signed rank test. Results were considered statistically significant if in any of the above-mentioned tests $P < 0.05$ was obtained. The P-value is defined as the probability of seeing a value of the test statistic at least as extreme as the observed value, assuming that the null hypothesis is true.

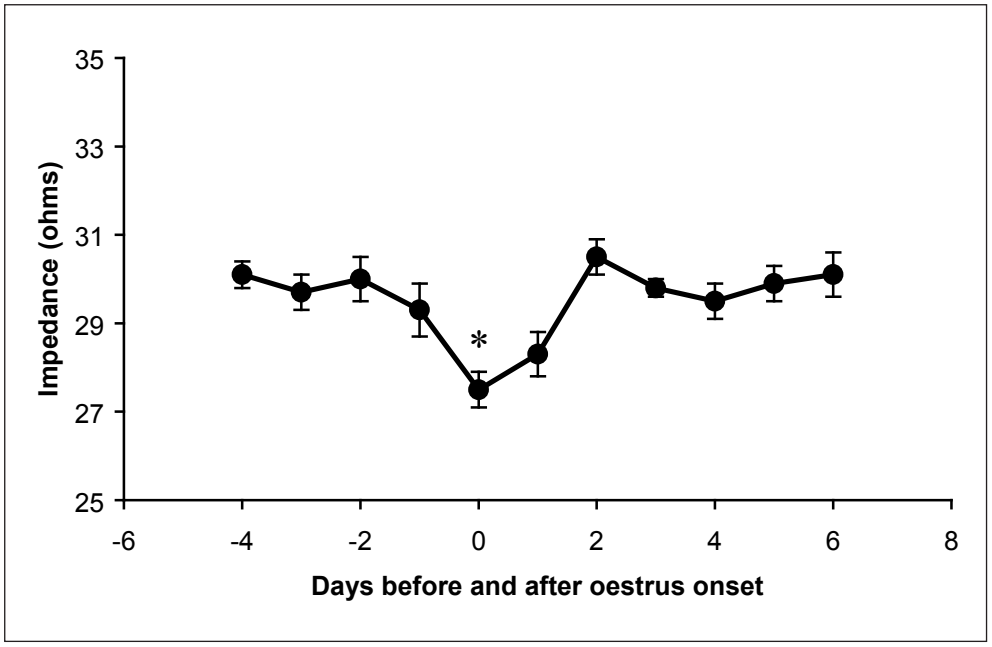
RESULTS AND DISCUSSION

One day before oestrus, the vaginal impedance at the cervix (Fig. 1) decreased ($P < 0.01$). The lowest value was observed during oestrus onset. A marked increase of the impedance was recorded during oestrus ($P < 0.01$). No significant changes of the vaginal impedance at the cervix were found during dioestrus.

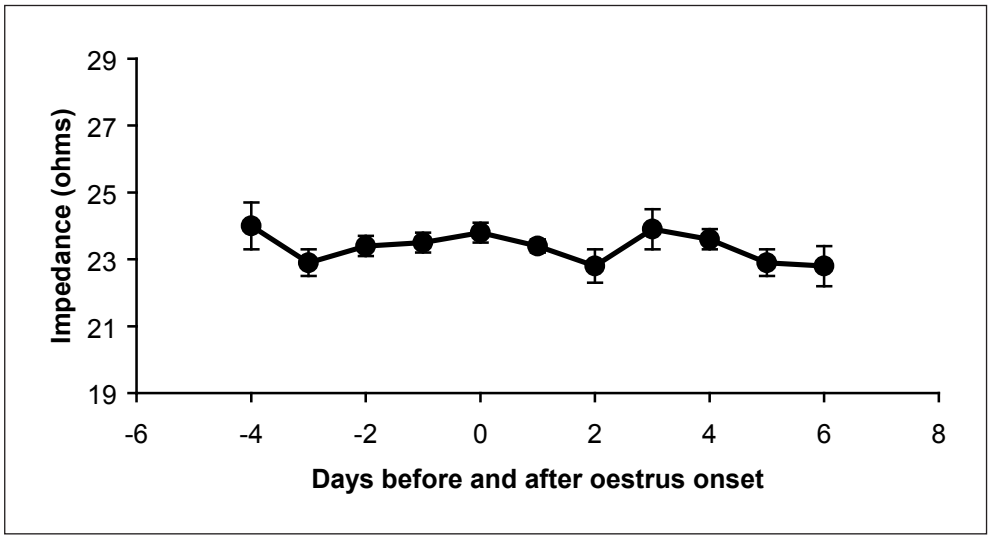


1: *The changes of vaginal impedance at the cervix during the oestrous cycle in the dairy goats. A significant decrease is indicated by an asterisk.*

The vestibular impedance at 5 cm from the vulva (Fig. 2) decreased during pro-oestrus ($P < 0.01$). The lowest value was found during oestrus onset. A marked increase of the impedance was observed after oestrus ($P < 0.01$). No significant changes of the vestibular impedance at 5 cm from the vulva were found during dioestrus. No significant changes of the vestibular impedance at the vulva (Fig. 3) were observed during the oestrous cycle.



2: *The changes of vestibular impedance 5 cm from the vulva during the oestrous cycle in the dairy goats. A significant decrease is indicated by an asterisk.*



3: *The changes of vestibular impedance at the vulva during the oestrous cycle in the dairy goats*

In the course of the experiment, the highest values of impedance were found in the vagina at the cervix and the lowest values of impedance were observed in the vaginal vestibule at the vulva. The vestibular impedance at the vulva was markedly lower compared to the vestibular impedance 5 cm from the vulva and the vaginal impedance at the cervix during the oestrous cycle ($P < 0.01$). The average values of the vaginal impedance during peri-oestrus decreased nearly twofold in comparison with the vestibular impedance 5 cm from the vulva. The variability of impedance values during the oestrus cycle was about twofold lower in the vagina compared to the vestibular mucosa.

The vaginal impedance at the cervix decreased in the does in late pro-oestrus, a nadir achieved during oestrus onset and increased in oestrus. A similar short-term fall was found in goats measured by a two-terminal method (Řezáč et al., 2001). The vaginal impedance also displayed similar changes in cows (Řezáč and Pöschl, 1991; Kitwood et al., 1993) and ewes (Olič et al., 1990; Bartlewski et al., 1999). In contrast to the ruminants the lowest value of the vaginal impedance was observed in pigs during pro-oestrus (Řezáč and Olič, 1988; Ko et al., 1989) and in horses during different phases of oestrus (Brook, 1982).

The wide fluctuation of vaginal impedance values is the main problem of the usage of bioimpedance

technique as a good indicator of oestrus and ovulation. Similarly as in cows (Peters, 1989) and ewes (Olič et al., 1990), one measurement of vaginal impedance did not enable to distinguish the does in the follicular phase from the does in the luteal phase. Daily impedance measurements are necessary to confirm the individual stages of the oestrous cycle in all ruminants studied.

The causes of variability in vaginal impedance were studied mainly in cows. Among the possible factors that influence the measurement data are the instability of the contact between the vaginal mucosa and the electrodes or unequal pressure on the probe (Aizinbud et al., 1980; Smith et al., 1989), the entrapment of air in the vagina during insertion of an electrode-bearing probe (Lehrer et al., 1991) and the depth of probe insertion (McCaughey and Patterson, 1981). References on suitable places for the impedance measurement are variable. Some authors prefer the anterior part of the vagina (McCaughey and Patterson, 1981; Scipioni and Food, 1999) and others the vagina vestibule (Edwards and Levin, 1974; Böhme and Buchholz, 1977). Results in this study clearly show that the vaginal impedance at the cervix in comparison with the vestibular impedance 5 cm from the vulva shows a greater decrease during oestrus in goats. The impedance of the vaginal vestibule at the vulva in contrast to the vestibular impedance 5 cm from the vulva did not display any significant changes during the oestrous cycle. Further studies will be necessary to elucidate the differences among these areas.

The results indicate that not only the decrease of impedance in oestrus but also the variability of impedance values during the oestrous cycle are greater in the vagina at the cervix than in the vaginal vestibule 5 cm from the vulva. In contrast to the abovementioned findings Aboul-Ela et al. (1983) reported that the variability of impedance values is greater at the posterior than at the anterior part of the vagina in cows. Possible explanation of these differences might be that a different impedance method or animal species was used – with the two-terminal method.

The most commonly used method for measuring the impedance of vaginal mucosa in farm animals has been a two-terminal technique (McCaughey and Patterson, 1981; Ko et al., 1989; Dusza et al., 1996; Scipioni and Food, 1999; Řezáč et al., 2001). The serious disadvantage of this method is the electrode polarisation impedance, which can cause significant measurement problems. The measured values are the sum of the sample impedance itself and the electrode polarisation impedance (Ackmann, 1993). In contrast with the two-terminal method, the instrument used in this study measured the vaginal impedance by four-terminal arrangement. This method can be used to reduce electrode artefacts from the varying impedance of the electrode-tissue interface (Řezáč et al., 2003).

In conclusion, the findings showed that there is a close relationship of the cyclic changes of vaginal impedance at the cervix measured by means of a four-terminal method to the oestrous behaviour of goats. The results suggest that the depth of probe insertion affects the impedance changes during the oestrous cycle. The vaginal impedance displays cyclic changes similar to the vestibular impedance 5 cm from the vulva but not to the vestibular impedance at the vulva.

SUMMARY

The changes of vaginal and vestibular impedance were examined in goats during the oestrous cycle. The experiment was conducted in October. All 11 does were White Shorthaired goat. The goats were housed indoors during the experiment and exposed to natural lighting conditions. They had ad libitum access to feed and water. All goats displayed at least one oestrus during the previous period. Bucks were housed separately from does, but were within olfactory and auditory range. The onset of oestrus was teased with a buck once a day during the experiment. Impedance was measured by a four-terminal method in response to sinusoidal electric current excitation at frequency 3.2 kHz. The vaginal impedance was recorded under slight pressure of electrodes to the vaginal dorsal wall at the cervix. The vestibular impedance was recorded under slight pressure of electrodes to the vestibular dorsal wall 5 cm from the vulva and at the vulva. The impedance was measured once a day from 4 days before the expected oestrus to 6 days after onset of oestrus. The vaginal impedance at the cervix decreased during pro-oestrus ($P < 0.01$) and increased during oestrus ($P < 0.01$). The vestibular impedance 5 cm from the vulva decreased during pro-oestrus ($P < 0.01$) and increased after oestrus ($P < 0.01$). The decrease of vaginal impedance during peri-oestrus was nearly twofold lower in comparison with the vestibular impedance 5 cm from the vulva. No significant decrease of the vestibular impedance at the vulva was found during the oestrous cycle. In conclusion, the results suggest that the depth of probe insertion affects the impedance changes during the oestrous cycle. The vaginal impedance at the cervix and vestibular impedance 5 cm from the vulva measured by means of a four-terminal method during the oestrous cycle display cyclic changes that are closely related to the oestrous behaviour of goats.

SOUHRN

Dynamika impedance sliznice pochvy a poševní předsíně u cyklujících koz

Byly sledovány změny poševní a vestibulární impedance u cyklujících koz. Pokus byl uskutečněn v měsíci říjnu. Sledování bylo provedeno na 11 kozách plemene bílá krátkosrstá. Kozy byly během experimentu umístěny ve stáji a vystaveny přirozenému přírodnímu osvětlení v tomto měsíci v našich zeměpisných podmínkách. Nástup říje byl testován pomocí kozla jednou denně. Impedance byla měřena čtyřelektrodovou metodou jednou denně od 4 dnů před očekávanou říjí do 6. dne po nástupu říje. Čtyřelektrodová metoda měření impedance eliminuje chyby při měření způsobené polarizací měřicích elektrod a změn jejich přechodových elektrických odporů kontakt – sledovaný biologický materiál. Měřicí přístroj používal při měření konstantní velikost střídavého elektrického proudu sinusového průběhu o frekvenci 3.2 kHz. Čtyři prstencové měřicí elektrody měly mezi sebou homogenní elektrické pole. Střídavé elektrické napětí sinusového průběhu U bylo snímáno jako lineární funkce impedance Z (U = I . Z, kde I je střídavý elektrický proud konstantní velikosti). Standardní procedura měření byla použita při měření velikosti impedance a jejich změn u všech sledovaných koz. Měřicí sonda byla vždy před měřením desinfikována. Impedance pochvy u děložního krčku klesala v období proestru ($P < 0,01$) a zvyšovala se během říje ($P < 0,01$). Impedance pochvy byla snímána za mírného tlaku elektrod na dorzální stěnu pochvy u krčku. Impedance poševní předsíně byla snímána za mírného tlaku elektrod na dorzální stěnu poševní předsíně ve vzdálenosti 5 cm od ochodu a u ochodu. Impedance poševní předsíně 5 cm od ochodu klesala v období proestru ($P < 0,01$) a zvyšovala se po říji ($P < 0,01$). Pokles impedance pochvy v periestrálním období byl ve srovnání s poklesem impedance poševní předsíně 5 cm od ochodu téměř dvojnásobný. Žádné průkazné změny impedance nebyly během pohlavního cyklu zjištěny na poševní předsíni u ochodu. Výsledky naznačují, že během pohlavního cyklu impedance pochvy u děložního krčku a poševní předsíně ve vzdálenosti 5 cm od ochodu, měřená čtyřelektrodovou metodou, vykazuje cyklické změny, které mají těsnou vazbu k říjovému chování koz.

koza, pochva, poševní předsíň, impedance, říje

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P PAH, pulmonary arterial hyperten-sion PAI, plasminogen activator inhibi-tor PAMPs, pathogen associated mo-lecular patterns PARs, protease-activated receptors PD, Parkinsonâ€™s disease PDGF, platelet derived growth fac-tor PGs, prostaglandins PL A2, phospholipase A2 PMNs, polymorphonuclear neutro-phils.Â Hypervolemia is defined as an increasing of the total blood volume. Simple hypervolemia is characterized by unchanged Hct. Causes: transient state after a transfusion of a significant volume of the whole blood; intensive physical activity followed by translocation of the interstitial fluid and deposited blood in the blood vessels. Oligocytemic hypervolemia is a result of an increasing of the plasma volume. Hct is decreased. Glucose (A+G) Lactose Mannitol Serogroup. S. sonnei S. flexneri S. dysenteriae. Abscesses in Lymph. nodes mucosa. Blood. Shigellosis and salmonellosis pathogenesis.Â Minor toxin. enterotoxin. violates the permeability of the mucosa of the small intestine. delta-toxin hemolysis. theta toxin hemolysis, cytolysis. Vestibule: (vestibule of the vagina) - extends from vulval cleft to the transverse fold (hymen) that marks the vestibulo-vaginal junction - receives the external urethral opening, on a tubercle (dog) or in a slit (cat) - constrictor vestibuli m. (striated) is in the wall of the vestibule - the wall contains vestibular glands (mucous) â€” a major vestibular gland in the cat - in the dog, the wall. contains an accumulation of erectile tissue = vestibular bulb. Clitoris: homologue of the penis. - located deep (cranial) to the fossa of the clitoris. Goats are prolific breeders and the most abundant ruminant in Nigeria with an estimated population of 53.8 million, contributing about 35% of the total national meat supply and raw materials for agro-based industries (Maina, 2002; Oni, 2002; Abdel Aziz, 2010) thus contributing to the growth of the national economy.Â Figure 1. Gross appearance of the mucosa of the uterus of WAD goat at birth and week 12 showing the caruncles (C) and the cranial cervix (CV).Â The patterns of development observed in this study agrees with reports that establishment of tissue-specific histoarchitecture of the uterus is only completed postnatally (Gray et al., 2001a; Spencer et al., 2005, 2012).