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Peripheral plasma progesterone concentration in zebu (*Bos indicus*) cows during pregnancy

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Summary — Plasma progesterone concentrations were determined weekly during gestation averaging 283 ± 2 d in Ethiopian zebu *(Bos indicus)* cows. Mean progesterone levels increased from 0.2 ± 0.1 ng/ml at œstrus (service) to 3.1 ± 1.6 ng/ml on d 7 and 8.1 ± 2.1 ng/ml on d 21. Progesterone levels remained elevated throughout pregnancy. Hormone concentration differed significantly between cows ($P < 0.001$) and with the wk of pregnancy ($P < 0.05$); it tended to be higher during the last trimester of pregnancy. Mean levels dropped sharply to below 1 ng/ml during the last wk of pregnancy with considerable variation (C.V. = 39 to 63%) among cows. These data indicate that pregnancy in Ethiopian zebu cows can be reliably diagnosed by determining circulatory plasma progesterone levels.

progesterone — zebu cow — pregnancy

Résumé — ***Evolution du taux de progestérone dans le plasma sanguin périphérique chez la vache zébu au cours de la gestation.*** *Les concentrations de progestérone plasmatique ont été déterminées chaque semaine au cours de la gestation (283 ± 2 jours) chez 17 vaches zébu éthiopiennes. Le niveau moyen de la progestérone s'élève depuis 0,2 ± 0,1 ng/ml le jour de l'œstrus (J0) jusqu'à 3,1 ± 1,6 ng/ml à J7 et 8,1 ± 2,1 ng/ml à J21. Le niveau de la progestérone reste élevé pendant toute la gestation. Les concentrations d'hormone diffèrent significativement entre vaches (P < 0,001) et selon la semaine de gestation (P < 0,05); elles ont tendance à augmenter durant le dernier tiers de la gestation. Au cours de la dernière semaine de gestation les niveaux moyens chutent brutalement en-dessous de 1 ng/ml, avec de fortes variations (c.v. = 39 à 63%) entre vaches. Ces résultats indiquent que la gestation chez les vaches zébu éthiopiennes peut être correctement diagnostiquée par la mesure des niveaux de progestérone dans le plasma sanguin périphérique.*

progestérone — vache zébu — gestation

Introduction

Cattle in the tropics are predominantly of the zebu (*Bos indicus*) type. Most are raised traditionally and experience nutritional disease and thermal stresses that affect their reproductive efficiency. Although calving rates exceeding 70% have been reported in Zebu cows under modern and improved management (Rennie *et al.*, 1976; Eversbush, 1978), the fertility rates of animals raised traditionally seldom exceed 60% (Reed *et al.*, 1974; Rennie *et al.*, 1976; Butterworth and McNitt, 1984; Wilson, 1985). These disparities probably arise from prenatal reproductive wastage.

The concentration of progesterone in blood or milk can be determined by radioimmunoassay (RIA) or the enzyme-linked immunosorbent assay (ELISA) technique (Arnstadt and Cleere, 1981; Arnstadt and Schmidt-Adamopolou, 1982; Dinar and Sreenan, 1988). ELISA can be as accurate and reliabile as RIA (Meyer, 1986; Sauer *et al.*, 1986; Magnin *et al.*, 1988) and is more accessible, cheaper and safer than RIA (Blake and Gould, 1984), and thus, well suited to use in developing countries. This study was undertaken to determine the progesterone concentration in the peripheral plasma of pregnant Ethiopian zebu cows using the ELISA technique in order to know whether it would help to monitor their reproductive efficiency.

Materials and Methods

Animals and location of study

The study used 17 pluriparous pregnant Ethiopian Highland zebu cows of the Small East African zebu type. The cows were breed between April and July, 1987, and calved from January to April, 1988. Animals were located at the ILCA Debre Berhan experiment station, 120 km north of Addis Ababa, at an altitude of about 2 800 metres. Total station rainfall was 710 mm in 1987, of which 450 mm fell during the heavy rains season from May to October (August : 289 mm). The remainder fell as small showers from February to April (November, December, January : 0 mm). Mean monthly minimum temperature was 5.9 °C (range 2.1—8.5 °C). Mean monthly maximum temperature was 20.7 °C (range 18.5—22.1 °C). Cows grazed in fenced native pastures of *Andropogon*, *Festuca* and *Pennisetum* spp. grasses mixed with *Trifolium semense* legume during the day and had access to water *ad libitum*. They were penned overnight and supplemented to maintain body condition scores of 5 to 7 (Nicholson and Butterworth, 1986). Cows were mated naturally with a 3/4 Friesian x 1/4 Boran bull.

Blood collection and progesterone analysis

Blood was taken weekly from the jugular vein of all cows until they were palpated *per* rectum to determine pregnancy 8 wk after copulation. Five of the pregnant cows were thereafter bled weekly until wk 38 or 39 of gestation. All cows were bled twice during the last wk of pregnancy and first wk after calving. Blood was collected in heparinised vacutainer tubes (Becton-Dickinson) and centrifuged within 15 min of collection to separate the plasma which was stored at –20 °C for subsequent progesterone assay. Plasma progesterone concentration was determined by the ELISA technique (Foulkes *et al.*, 1982; Parker *et al.*, 1988) using Ovucheck kits (Cambridge Veterinary Sciences). Procedural details of the technique were as *per* manufacturer's recommendation and have been reported previously (Mukasa-Mugerwa *et al.*, 1989). For plasma containing 8 ng/ml of progesterone, the intra- and inter-assay coefficients of variation for kits delivered in different batches have been assessed as 0.18 and 0.27, respectively. Data were analysed by least squares procedures (Harvey, 1977) using a model in which animal and calf sex were regarded as fixed effects and wk of gestation as a continuous variable. All the results are expressed as mean ± SEM.

Results

Mean length of gestation was 283.3 ± 1.8 d (n = 17). The associated average plasma progesterone is shown in Figure 1. Progesterone levels were elevated throughout gestation but differed significantly between cows (range : 12.4 ± 2.1—7.4 ± 1.9 ng/ml, $P < 0.001$).

Progesterone concentrations increased from 0.2 ± 0.1 ng/ml at copulation (d 0) to 3.1 ± 1.6 ng/ml on d 7 and 7.1 ± 1.9 ng/ml on d14. Progesterone concentrations remained high (8.1 ± 2.1 ng/ml) until d 21, the day of the next expected œstrus, instead of declining as in non-pregnant animals. After conception, progesterone levels remained high and were significantly ($P < 0.001$) elevated by the stage of gestation, with a tendancy for higher levels in the last trimester of pregnancy.

Mean progesterone levels declined sharply prior to parturition, from 8.8 ± 3.49 ng/ml 2 wks before calving to 6.9 ± 4.34 ng/ml 1 wk before. Hormone values then fell to less than 1.0 ng/ml after calving, with considerable variation between cows (C.V. = 39 to 63%). Mean levels remained below 1.0 ng/ml during the first wk postpartum when sampling stopped. In the wk after calving there was little variability in progesterone levels between cows.

Discussion

The 283 d average duration of gestation obtained was within the range of 270—292 d already established for zebu cows (Plasse *et al.*, 1968; Chandramohan and

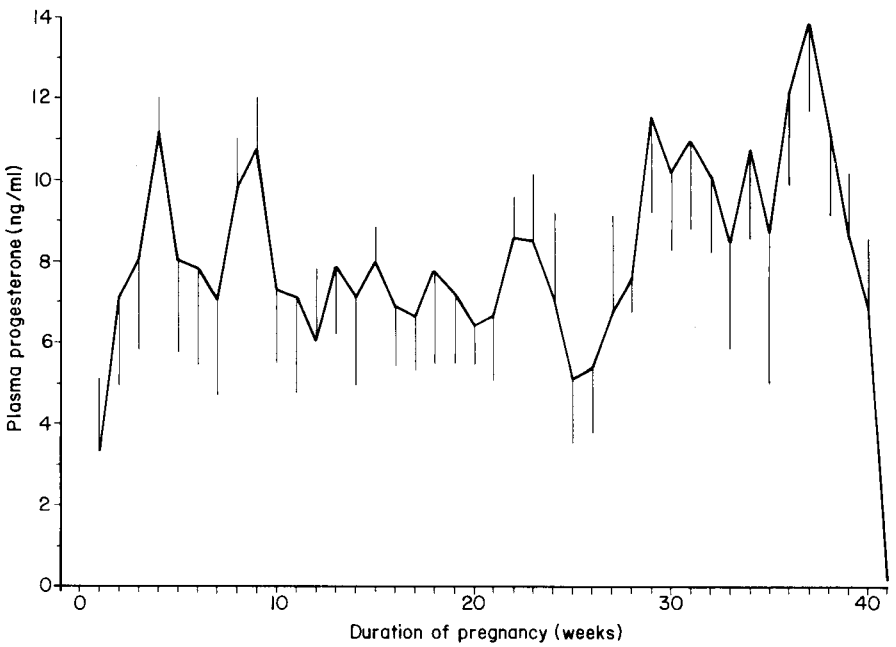

Fig. 1. Mean (± SEM) progesterone concentrations in Ethiopian highland (zebu) cattle during pregnancy. Cows bred between April and July 1987. n = 17 week 0—8 and 38—39; n = 5 week 8—38.

Bhat, 1981) and taurine cows (Hunter, 1980).

The observation that, up to 15 d after copulation, all cows had progesterone values similar to those observed in the luteal phase of the œstrous cycle, agrees with Donaldson *et al.* (1970), Henricks *et al.* (1972) and Robertson (1972). Details of mean plasma progesterone levels during the spontaneous and induced œstrous cycle of Ethiopian cows are reported by Mukasa-Mugerwa *et al.* (1989). Our observation that progesterone levels did not decline at 15 d after œstrus but remained elevated 21 d after successful copulation, and throughout gestation, is consistent with data on Haryana (Agarwal *et al.*, 1980), Brahman (Shelton and Summers, 1983) and taurine (Melampy *et al.*, 1959; Henriks *et al.*, 1972; Robertson, 1972) cows. The observation that progesterone levels vary significantly with stage of gestation is nonetheless contrary to that of Agarwal *et al.* (1980) in Haryana cows. On the other hand, our observation of rapid declines in progesterone levels towards parturition agrees with previous reports (Donaldson *et al.*, 1970; Henricks *et al.*, 1972; Edquist *et al.*, 1973; Smith *et al.*, 1973). Progesterone levels under 1 ng/ml during the week after delivery were also observed by Coetzer *et al.* (1978) in Africander cattle. However, we failed to demonstrate the tempory rise in progesterone values which these authors reported during and shortly after parturition.

The corpus luteum is the major source of progesterone during pregnancy in the cow (Shelton and Summers, 1983). Bilateral ovariectomy prior to 200 d of gestation terminates pregnancy (Tanabe, 1966; Estergreen *et al.*, 1967). However, Estergreen *et al.* (1967) and Hoffmann *et al.* (1979) found that pregnancy was maintained if ovariectomy was performed after 200 d of gestation. Wickersham and Tanabe (1967) found that the functional activity of the corpus luteum remained relatively constant during gestation and our results show that average progesterone levels were highter during the last trimester than before. It seems that 200 d after conception, an extraovarian source of progesterone exists in taurine cattle (Wendorf *et al.*, 1983), as well as in zebu cattle (our data). The placenta and adrenal glands, which are known to produce progesterone (Melampy *et al.*, 1959; Wendorf *et al.*, 1983), may be the additional source of this hormone.

We conclude that determination of circulatory progesterone can be used to diagnose pregnancy status in Ethiopian zebu cows. This would assist studies on the timing and magnitude of prenatal reproductive losses in these tropical cattle.

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