Original Article

Effect of total cholesterol, glucose and blood urea nitrogen on embryo quality in post-partum superovulated suckling Japanese Black cattle

RAJANI PRADHAN,1 KAZUNAGA OSHIMA,2 YOSHINORI OCHIAI,2 TAKATOSHI KOJIMA,2 NAOYUKI YAMAMOTO,2 MOHAMED ELSHABRAWY GHANEM3,4* and NOBUKAZU NAKAGOSHI1

1Graduate School for International Development and Cooperation, Hiroshima University and 3Laboratory of Animal Genetics, Graduate School of Biosphere Science, Hiroshima University, Hiroshima, 2National Agricultural Research Center for Western Region, Shimam, Japan; and 4Department of Theriogenology, Faculty of Veterinary Medicine, Suez Canal University, Ismailia, Egypt

Aim: This study was conducted to examine the effect of blood metabolites on embryo quality in post-partum suckling Japanese Black cattle.

Methods: Blood samples were taken from 23 cows 30 days before, at and 30 days after parturition. Cows were synchronized 40 or 41 days after calving (day 0) and divided into three groups: control (n = 6), gonadotropin-releasing hormone ([GnRH] n = 10) and estradiol benzoate ([EB] n = 7). All groups received a controlled internal drug release (CIDR) device intravaginally together with 2 mg EB i.m. on day 0 and superovulation was induced in all groups from days 5–7 with a gradually decreasing dose of follicle-stimulating hormone (FSH). Two milligrams of EB was given on day 8 and GnRH (0.1 mg) was given on day 9 of insertion of the CIDR in the EB and GnRH groups. Cows were inseminated twice after the onset of estrus and embryos were recovered 7–8 days after artificial insemination.

Results: The number of corpus luteum detected by ultrasonography in the EB group was significantly higher (P < 0.05) than that in the GnRH group. The number and rate of transferable and freezable embryos did not differ significantly among the groups. Regardless of the treatments, the total cholesterol level from parturition until 30 days after parturition was significantly higher (P < 0.01) in the good category than in the poor category of cows.

Conclusions: The number of transferable embryos produced by post-partum superovulated suckling Japanese Black cattle was affected by the level of total cholesterol from parturition until 30 days after parturition. Moreover, administration of EB in CIDR-treated cows increased the numbers of corpus luteum and yielded better rates of transferable and freezable embryos. (Reprod Med Biol 2008; 7: 55–62)

Key words: corpus luteum, embryo quality, superovulation, total cholesterol.

INTRODUCTION

REPRODUCTIVE EFFICIENCY IS one of the key factors for the determination of economic success of a cow–calf operation. In general, to obtain maximum economic benefit cattle should calve once per year.1 Various hormonal technologies have been developed for the purpose of adequately timing insemination with ovulation.2,3 The addition of estradiol at 24–48 h after the end of progesterone treatment facilitates a stronger and more synchronized expression of estrus.4,5 Moreover, with this approach, the rate of estrus expression exceeded 90% in cyclic cows.6 Estrus was increased to 90% when anestrus cows were induced to ovulate with estradiol benzoate (EB).7,8

Despite progress in the technologies of hormonal treatment, the effect of nutritional state on embryo quality cannot be denied. Total cholesterol (T-cholesterol) concentrations may have important long-term regulatory effects on ovarian steroidogenesis.9 Blood urea nitrogen (BUN) above a general level implies insufficient or
excessive protein supply in a feeding ration and reflects nitrogen loss, which often causes problems in reproduction. There is a strong relationship between the energy value of feeding and the content of glucose in cows’ blood. One of the main areas where nutrition influences reproductive efficiency is at the level of embryo production. Dietary intake can also affect oocyte morphology, oocyte developmental capacity and embryo production. Decreases in the number of transferable embryos in superovulated dairy heifers have been recorded as the net energy per intake per day increased. Several studies have indicated that excess energy intake reduces the response to superovulation and decreases the yield of embryos.

Superovulatory treatment in cows aims to obtain a maximum number of transferable embryos with a high probability of producing pregnancies, and nutritional state is an important factor in obtaining good-quality embryos. Little is known about the effect of blood metabolites on embryo quality in Japanese Black suckling cows. The purpose of this study was to examine the effects of pre-partum and post-partum blood metabolites on embryo recovery and quality in superovulated post-partum suckling Japanese Black beef cows.

MATERIALS AND METHODS

Animals

This experiment was carried out in an experimental farm at the National Agricultural Research Center for Western Region in Japan. Animals were handled according to the guide for care and use of laboratory animals of this center. Twenty-three post-partum suckling Japanese Black cows, weighing on average $473.1 \pm 47.0$ kg (mean ± standard deviation [SD]), were used in this experiment. The average age of the cows was $5.0 \pm 1.3$ years (mean ± SD) and their parities were $3.3 \pm 1.3$ (mean ± SD) on average. On day 40 or 41 after calving, the cows were randomly assigned into three treatment groups: a control group ($n = 6$), a gonadotropin-releasing hormone (GnRH) group ($n = 10$) and an EB group ($n = 7$). The cows were kept in free stalls and fed a ration containing straw, silage and concentrate mixtures (12% crude protein, 7.2% digestible crude protein, 50% total digestible nutrient and 6.54 kg dry matter). This feeding regimen was used to meet the maintenance, growth and lactation requirements of the Japanese Feeding Standard for beef cattle. Feeding was ad libitum through broadbent gates. Cattle were locked to a stanchion when concentrate and roughage were fed. A mineral block and fresh water were available continuously throughout the experimental period.

Blood sampling and superovulatory treatment

The protocol of blood collection and superovulatory treatment is shown in Figure 1. All groups received a controlled internal drug release (CIDR) device intravaginally (containing 1.9 g of progesterone; Easy-Breed, InterAg, Hamilton, New Zealand) together with 2 mg EB (Kawasakimitaka Pharmacy, Kawasaki, Japan) i.m. on day 0 (day 0 = 40 or 41 days after calving). Superovulation was induced in all groups from day 5 to day 7 with a gradually decreasing dose of FSH (20 IU) prepared using Antrin 40 (Kawasakimitaka Pharmacy). All cows were injected with 0.75 mg of cloprostenol i.m. (PG; Estrumate, Nagase Medicals, Itami, Japan) following CIDR removal on day 7. Cows in the EB group received 2 mg EB i.m. on day 8 and cows in the GnRH group received 0.1 mg GnRH i.m. (Conceral, Nagase Medicals, Itami, Japan) on day 9. In the control group the cows were not treated with EB or GnRH following CIDR removal.

Artificial insemination

All cows were artificially inseminated (AI) twice after the onset of estrus according to the a.m and p.m. rule using frozen semen recovered from a single Japanese Black bull; that is, a cow in estrus during the morning was inseminated on the evening of that day. A cow in estrus during the evening was inseminated the following morning. The second AI was done 12 h after the first insemination.

Embryo recovery

Embryos were collected non-surgically using approximately 1000 mL Ringer’s lactate solution containing 6.0 g/L sodium chloride, 0.300 g/L potassium chloride, 0.20 g/L calcium chloride, 3.10 g/L sodium lactate (Nippon Zenyaki Kogyo, Fukushima, Japan) with 1% calf serum (CS) on day 7 or 8 after the day of onset of heat. Ova were recovered from the flushing medium and transferred to the Ringer’s lactate solution with 1% CS. All cows received PG (0.75 mg i.m.) and 2% povidone–iodine intrauterine (Meiji Seika, Tokyo, Japan) after flushing. The recovered flushing medium was filtered through an embryo filter (0.22 and 0.45 µm; Millipore, Fujihira, Japan). Embryos were evaluated