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Short Communication

Short-term glutamate administration positively affects the number of antral follicles and the ovulation rate in cyclic adult goats

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ABSTRACT

The acute effects of short-term glutamate administration on the number of antral follicles and ovulation rate were examined in adult goats. Neither live weight (44.5 ± 1.3 kg) nor body condition (3.3 ± 0.8 units) differed between the control (untreated) and glutamate-treated (0.175 mg/kg) animals ($p > 0.05$). However, the number of antral follicles (3.4 vs. 2.1, $p = 0.05$) and ovulation rate (2.5 vs. 1.5, $p = 0.05$) was higher in the glutamate-administered group than in the controls.

1. Introduction

In both prolific and non-prolific genotypes of small ruminants, the growth of antral follicles until ovulatory size is reached, takes place in a wave-like pattern with three to four waves of follicular growth observed during the inter-ovulatory period. Although changes in serum FSH concentration control the emergence of the follicular waves, their actual number in the cycle might also depend on ovarian responsiveness to

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gonadotropins [1,2]. The follicles with the lowest responsiveness threshold to FSH will develop LH receptors in granulosa cells. This increase in LH receptor expression in granulosa cells leads to an increase in estradiol secretion with peak values occurring around the time of maximum antrum diameter.

Nutritional signals enhance follicular growth and development as well as ovulation rate, often without a detectable increase in live weight (the so-called ''acute effect of nutrition'') [1,2]. The physiological signals responsible for this phenomenon have not been fully elucidated, but glutamatergic neurons may be involved. Glutamate is a primary mediator of excitatory synaptic transmission in the central nervous system and its receptors are localized in a variety of hypothalamic nuclei, some of which are critical for reproduction and neuroendocrine function. Glutamate plays a decisive role in puberty, neurogenesis and reproductive behavior [3,4]. Moreover, glutamate has been detected in the follicular fluid of early dominant, late dominant and preovulatory follicles [5]. In addition, the activation of the ionotropic glutamate receptor AMPA1 in oocytes has been positively associated with ovulation rate [6]. Therefore, in the present study, we tested whether the acute administration of glutamate affects the number of antral follicles and ovulation rate in cyclic goats.

2. Materials and methods

The study was performed at the Southern Goat Research Unit (26° NL, 103° WL, 1117 m) of the Regional Universitary Unit in Arid Lands, Chapingo Autonomous University (URUZA-UACH). The area has a warm-dry climate with a mean annual precipitation of 217.1 mm and temperature of 22.3 °C. The experiment was performed on 22 mixed breed adult goats (7/8 Sannen-Alpine 1/8 Criollo) with a live weight (LW) of 46.04 ± 1.35 kg and an average age of 2.9 years. Throughout the experiment, all animals were fed a mixed-ration basal diet of alfalfa hay [14% crude protein, CP; 4.7 MJ kg net energy of maintenance, NEm] plus corn silage [8.1% CP; 6.7 MJ kg NEm] to cover 100% of their maintenance requirements [7]. They had free access to water, shade and mineral salts. A schematic representation of the experimental protocol is depicted in Fig. 1. In November, the goats were randomly distributed into individual pens and allocated into two experimental groups balanced for initial weight: (1) glutamate-treated group ($n = 10$; 45.8 ± 4.37 kg), and (2) control group (untreated; $n = 12$; 46.2 ± 5.87 kg). After a period of adaptation to general management, pens and basal diet (two weeks), the estrous cycles were synchronized with the use of intravaginal sponges containing 45 mg of fluorogestone acetate (FGA; Chronogest®, Intervet International B.V., Boxmeer, Holland). The sponges were kept in the goats for 10 days. On the 9th day of the sponge treatment (day −3, with day 0 as the day of expected estrus), each goat was injected i.m. with 1 mL (0.075 mg) of the prostaglandin $F_{2\alpha}$ analog cloprostenol (Prosolvin-C®, Intervet International B. V., Boxmeer-Holland). The glutamate was applied on days that were coincident to the days of the emergence of the four follicular waves reported previously for goats [8]. Glutamate-treated goats received (iv) 0.175 mg/kg LW of glutamate (Sigma, St. Louis, MO, USA) per treatment day and untreated-goats received (iv) saline (0.0875 mL/kg LW). The glutamate solution was prepared by dissolving 4 g L-glutamate in 50 mL saline (final concentration 80 mg/mL). Body condition score (BCS) and LW were recorded before feeding and at the beginning and the end of the study. BCS was always determined by the same experienced technician by palpation of the transverse and vertical processes of the lumbar vertebrae (L2 through L5), and expressed using a 5-point scale (1 – emaciated, 5 – obese).

The population of antral follicles was estimated on day 19 (during the mid-follicular phase) by an expert operator using a transrectal ultrasonographic scanning with a 7.5 MHz linear-array transducer (Toshiba Medical Systems, Ltd., Crawley, UK). Scanning provided an estimate of the total number of antral follicles (diameter > 5 mm) in each ovary [9]. On day 6 after the second estrus, the same expert operator estimated ovulation rate by observing the collapse of large follicles (>5 mm); six days later the operator searched for the presence of luteal tissue at the same site. Data were analyzed with a CRD-ANOVA, whereas separation of the means was assessed using the LSMEANS-PDIFF option of the PROC GLM. All statistical analyses were aided by the GLM procedures of SAS (SAS Inst. Inc. V9.1 Cary, NC, USA). Correlation analyses between different variables were conducted by Pearson's product-moment test. Reported values are defined as least-square

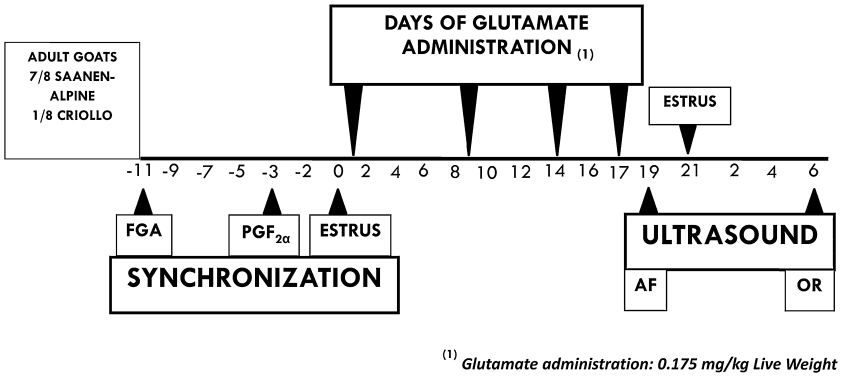

Fig. 1 – A schematic representation of the procedure for the estrous cycle synchronization and glutamate (0.175 mg/kg) or saline infusion at times coincident with the expected follicular waves. Ultrasound scanning was performed on day 19 before the second estrus (counting of antral follicles, AF; >5 mm) and on day 6 after the second estrus (estimation of ovulation rate, OR). FGA – fluorogestone acetate, administered for 10 days via intravaginal sponge. $PGF_{2\alpha}$ – prostaglandin analog (cloprostenol).