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Manipulation of reproductive seasonality using melatonin implantation in Anglo-Nubian does treated with controlled internal drug release and equine chorionic gonadotropin during the nonbreeding season[1]

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ABSTRACT

The objective of this study was to compare the efficiency of hormonal treatments on ovarian activity and reproductive performance in anestrous Anglo-Nubian does during the nonbreeding season (February to May). A total of 48 multiparous does were divided into 2 groups (24 lactating does and 24 dry does). In each group, animals were allocated randomly into 2 equal subgroups (12 does each). In the first subgroup, does received a single 18-mg melatonin implant for 42 d followed by a controlled internal drug release (CIDR) device for 19 d in conjunction with 500 IU of equine chorionic gonadotropin (eCG) i.m. on the day of CIDR device removal. The second subgroup received CIDR combined with eCG in parallel with the first subgroup. Melatonin implantation induced a luteotrophic effect, expressed as an increasing number of corpora lutea, increased serum progesterone concentration, and reduced estradiol concentration. Regardless of treatment, dry does showed greater value of progesterone concentration. With the advancement of day of treatment, number of total follicles, small follicles, and medium follicles tended to increase to the greatest values at the day of CIDR device insertion. Furthermore, at day of mating, the numbers of large follicles reached the greatest value, which was associated with the lowest value of the number of corpora lutea. At day of mating, serum progesterone concentration achieved the lowest value, which increased until d 56 of pregnancy. The estradiol:progesterone ratio showed the opposite trend. The detrimental effect of reproductive seasonality, expressed as cessation of estrus behavior and fertile mating during the nonbreeding season, was successfully alleviated by the CIDR-eCG protocol. Furthermore, melatonin implantation in conjunction with the CIDR-eCG protocol enhanced conception rate and fecundity at d 28 of pregnancy and prolificacy at d 56 of pregnancy compared with does that were not implanted. Interestingly, does that failed to conceive did not come to heat again. In conclusion, the beneficial effect of melatonin implantation in conjunction with the CIDR-eCG protocol on the luteotrophic effect was reflected in the increasing number of corpora lutea, increasing progesterone concentration, and decreasing estradiol concentration. Furthermore, conception rate, prolificacy, and fecundity were improved compared with does that were not implanted during the nonbreeding season.
Key words: melatonin, controlled internal drug release–equine chorionic gonadotropin protocol, reproductive seasonality, goat

INTRODUCTION

Goats ovulate spontaneously and are commonly considered to be seasonally polyestrous animals under temperate climatic conditions (Fatet et al., 2011). The photoperiod is one of the major factors that influence the reproductive activity in small ruminants (Bedos et al., 2014). Melatonin is the neuroendocrine signal that transduces information about the environmental light received by the retina. Reproductive activity of goats in subtropical regions is depressed from March to June (Mellado et al., 2014). In these regions, exogenously administered melatonin from continuous slow-release implants usually is inserted around the time of the spring equinox in goats (Zarazaga et al., 2012 a,b; Celi et al., 2013) to advance the onset of the breeding season by mimicking the stimulatory effect of short days (Zarazaga et al., 2009). These implants increase the concentration of melatonin without suppressing the endogenous secretion of melatonin (Zarazaga et al., 2011a). In goats, melatonin can induce ovarian and estrus activity during the seasonal anestrus (Zarazaga et al., 2011b) and increase conception rate (Kumar and Purohit, 2009) because it improves the rate of cleaved oocyte

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and enhancement of blastocyst output (Berlinguer et al., 2009), which is reflected in increasing fecundity and fertility (Celi et al., 2013). In addition, melatonin suppresses prolactin concentration (Yue et al., 2010), which is inversely related to the pattern of reproductive activity in goats (Mori et al., 1985). Furthermore, the beneficial effects of melatonin implantation in sheep have been expressed as improvement in ovulation rate (Zúñiga et al., 2002), luteal function (Durotoye et al., 1997; Abecia et al., 2002), and embryo viability (Forcada et al., 2006) and increased oocyte maturation rate. In addition, melatonin implantation tended to improve cleavage rate in in vitro fertilization (Casao et al., 2010). Applications of exogenous hormones for increased reproductive performance in goats are usually focused on estrus synchronization, which is achieved by control of the luteal phase of the estrus cycle, either by providing exogenous progesterone (**P_4**) or by inducing premature luteolysis (Fonseca et al., 2005). Synchronization of ovulation protocols out of season is commonly based on controlled internal drug release (**CIDR**) plus equine chorionic gonadotropin (**eCG**; Abecia et al., 2011), which has been considered to be an effective protocol for inducing estrus and ovulation in goats during the nonbreeding season (Contreras-Villarreal et al., 2016). The objective of this study was to determine the effects of melatonin implants in conjunction with a CIDR-eCG protocol on the induction of synchronized fertile estrus and pregnancy in seasonally anestrous dry and lactating Anglo-Nubian does.

MATERIALS AND METHODS

All procedures and experimental protocols were conducted in accordance with the Guide for the Care and Use of Agricultural Animals in Research and Teaching (FASS, 2010). This study was carried out using Anglo-Nubian does during the nonbreeding season (from February to May) at the Agricultural Experimental Station (31°20′ N, 30° E), Alexandria University, Alexandria, Egypt.

Animals and Management

A total of 48 multiparous Anglo-Nubian does (24 dry, BW = 31.52 ± 1.58 kg; 24 lactating, BW = 30.31 ± 1.43 kg) at their third to fourth parities were used. Animals were kept outdoors with shelter during the day and were housed in a semiopen barn at night. Animals were offered roughage and concentrate supplement according to their BW requirements (NRC, 2007). They were given Egyptian clover (*Trifolium alexandrinum*) in winter and spring and chopped green maize in summer and autumn in addition to hay. Each animal also received 1 kg/d of a concentrate mixture (prepared at the Agriculture Experimental Station) consisting of 18% soybean meal, 40% wheat bran, 40% ground maize, and 2% limestone plus salt. The chemical analysis of the concentrate mixture according to the Association of Official Analytical Chemists (AOAC, 1984) indicated that it contained 16.04% CP, 3.31% ether extract, 6.94% crude fiber, 67.76% carbohydrate, and 5.95% ash and offered 68% TDN. Free access to water was provided to animals at all times. Animals were free of any disease and were clinically normal with a healthy appearance.

Experimental Design

Forty-eight Anglo-Nubian does were divided into 2 groups (24 lactating and 24 dry). In each group animals were divided into 2 subgroups of 12 does each. The first subgroup was implanted with 2 × 4 mm absorbable melatonin implants (18 mg of melatonin/implant; Melovine, Ceva Santé Animale, La Ballastière, Libourne, France) at the base of the left ear using an implanter. These implants are designed to release melatonin for at least 60 d, although their functionality can extend to more than 100 d (Forcada et al., 2002) without disturbing the endogenous secretion of melatonin as seen in ewes (Forcada et al., 1995). On d 42 after melatonin implantation, all implanted does were treated with Eazi-Breed CIDR (0.3 g of P_4; Pfizer Animal Health, Auckland, New Zealand), which were removed after 19 d. On the day of CIDR removal (d 61), animals were injected i.m. with 500 IU of eCG (Syncropart, Ceva Santé Animale). Estrus signs of the females were detected using teaser bucks daily, and does that exhibited estrus were mated with fertile bucks (through 48 h after CIDR removal; Abecia et al., 2011). In the second subgroup, the CIDR was inserted at the same time as in the first subgroup, and the group thereafter received a similar protocol. In the lactating group, the experimental protocol was carried out on d 40 after parturition. Uterine involution has been reported to be completed by d 27, so does can exert their first postpartum estrus after 5 to 10 wk after parturition (Hafez and Hafez, 2000). In all animals, pregnancy diagnosis was carried out by ultrasonography at d 28 and 56 after mating (representing d 91 and 119 of the experiment). The experimental layout is shown in Figure 1.

Ovarian Activity and Pregnancy Diagnosis

A real-time B-mode ultrasound scanner equipped with 5- and 7.5-MHz linear-array endorectal probes (Pie Medical Equipment B.V., Maastricht, the Netherlands) was used to determine the ovarian response to melatonin and CIDR treatment. The scanning pro-