Drug Development and Industrial Pharmacy, 22(8), 847–850 (1996)

The Effect of Remotely Delivered Gonadotropin Formulations on Reproductive Function of White-Tailed Deer

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ABSTRACT

Three experiments were conducted on two white-tailed deer herds over 2 years. In the first year, 8 of 17 does were remotely treated with a human chorionic gonadotropin–ovalbumin/saponin (hCG) biobullet formulation. In the second year, 11 of 23 does from one herd and 10 of 35 does from the second herd were remotely treated with porcine luteinizing hormone (pLH) biobullet formulation. Treatments were administered from September to mid-October, before the breeding season. Reproduction was assessed the subsequent spring. All untreated and hCG-treated does gave birth and timing of the parturitions was unaffected by the hCG treatment. In the second year, more ($p < 0.05$) pLH-treated does than untreated does gave birth at the first location. In addition, a higher number of the pLH-treated deer gave birth earlier the next spring at the first location. Therefore, remote treatment with a sustained-released pLH biobullet formulation may enhance reproductive function of white-tailed deer.

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INTRODUCTION

Reproductive control is an important issue for several wild animal species including the white-tailed deer. In some cases overpopulation of species, such as the white-tailed deer, can lead to economic losses in the form of crop damage, damage to landscape planting, transmission of diseases to livestock, and damage to vehicles and humans (injury or death) in deer–vehicle collisions(1). Although regulated hunting has proven to be an effective means of controlling deer populations (2), this procedure has become very controversial. Contraception may be a logical solution to the overpopulation problem in some areas (3). In other settings, such as in zoos, the opposite scenario, infertility, for wild animal species exists. Minimal understanding exists of the endocrine basis of reproduction for many of the wild animal species. Therefore, in order to develop concepts for reproductive control and inhibition, many assumptions are made from domesticated animal species.

It has been well established that diversity in the chemical makeup of luteinizing hormone (LH) exists among species (4,5). In some cases, the administration of a gonadotropin from one species, along with an adjuvant, into another species causes immune activation and infertility (6,7). Alternatively, conjugation of the species own hormone with another protein (such as ovalbumin) and administration to the same species will evoke the immune system and cause infertility (6). Since free-roaming white-tailed deer are overabundant in many areas of the United State, the objective of these experiments was to determine if hCG conjugated with ovalbumin and porcine luteinizing hormone (pLH) would evoke immune-induced infertility.

MATERIALS AND METHODS

Experiments were conducted on two enclosed, unhunted deer herds: one in southern Connecticut (Sporting Goods Properties, Inc.) and one in northern Indiana (Northern Indiana Public Service Company—NIPSCO). The Connecticut facility was 1.76 km^2 of predominantly wooded habitat and deer were habituated to humans. The Indiana facility was 10 km^2 of primarily open herbaceous vegetation. All deer were equipped with individually numbered ear tags to facilitate identification. Supplemental feed (commercial 12% protein horse feed) was provided to the deer at the Connecticut facility.

Three experiments were conducted over 2 years. The experiment conducted in year 1 included 17 does, all from the Connecticut herd. Does were randomly assigned to one of two groups. Eight of the does were treated with a formulation containing human chorionic gonadotropin (hCG), (Sigma, St. Louis, MO) conjugated (8) to ovalbumin (5 mg), saponin, and controlled-release excipients in a solid dosage form as a biobullet. The biobullets were manufactured to have a burst release and a sustained release over about 30 days. The other 9 does were not treated and served as controls. Treatments were administered on October 10 and 11. Biobullet implants (Antech Laboratories, Inc., Savoy, IL) were delivered with a compressed air delivery system from a distance of <35 meters (3). Reproductive function was assessed 170 to 260 days later by visually assessing the presence or absence of fawns and mammary tissue development.

For experiments conducted in year 2, 23 does from the Connecticut facility and 36 does from the Indiana facility were included. Does at the Connecticut facility were randomly assigned to one of two groups. Eleven of the does were treated with a formulation containing pLH (4 mg—Sioux Biochemical, Inc., Sioux Center, IA), synthetic trehalose dicorynomycolate (RIBI Imunno. Chem Research, Inc., Hamilton, MT), and controlled-release excipients in a solid dosage form as a biobullet. The biobullets were manufactured to have a burst release and a sustained release over about 30 days. The other 12 does were not treated and served as controls. Treatments were administered on September 23 to 29. Biobullet implants were delivered with a compressed air delivery system from a distance of <35 meters (13). Reproductive function was assessed 200 to 290 days later by visually assessing the presence or absence of fawns and mammary tissue development.

Ten of the 36 does from the Indiana facility were selected to be treated with the same pLH formulation as used at the Connecticut facility. They were immobilized and then treated in the center of the hindquarter while immobilized at 3 m with the pLH biobullet (9). the other 26 does were not treated and served as controls. Treatments were administered on September 12 to 15. Reproductive function was assessed 230 to 290 days later by visually assessing the presence or absence of fawns and mammary tissue development. At the Indiana facility one of the treated does was not found the next spring and was, therefore, eliminated from the experiment.

At the Connecticut facility it was possible to determine the approximate day of parturition along with the number of fawns. At the Indiana facility it was only possible to determine whether the does had or had not given birth. Categorical data (number giving birth and number with twins) were analyzed by chi-square analy-

sis (10). The numbers of does giving birth during two periods (116 to 135 days and >135 days) in the spring for control and treated deer were compared using Fisher's exact test (11).

RESULTS AND DISCUSSION

All untreated and hCG-treated does gave birth the first year, and the incidence of twinning was similar ($p > 0.25$) between groups. Further, the time of the year when parturitions occurred was similar ($p > 0.25$) between groups (Table 1).

In the second year, more ($p < 0.05$) pLH-treated does gave birth the following spring than untreated does at the Connecticut facility (Table 1). The incidence of twinning was similar ($p > 0.25$) between groups. However, a greater ($p < 0.05$) number of pLH-treated does gave birth earlier in the year than for the untreated does (Table 1). For both years at the Connecticut facility the majority (88%) of the untreated does gave birth May 16 to June 4. At the Indiana facility 25 of the 26 (96%) untreated does and all 9 (100%) of the treated does were determined to have given birth the next spring.

All the results of these experiments clearly suggest that the gonadotropin formulations used in these experiments did not have a contraceptive effect in white-tailed deer. Although no other data on the administration of these gonadotropins to white-tailed deer exist, it was anticipated that the formulations would be efficacious. When the same components used to manufacture the pLH biobullet were used with porcine zona pellucida, immunity and sterility were elicited in mares (12). Further, hCG and LH have been successfully used to evoke immunity and infertility in cattle (6), and saponin (13) has been demonstrated to be an efficacious adjuvant.

In year 2, because the fertility rate of the untreated does was not optimum, it was possible to ascertain that pLH had a positive effect on the fertility of white-tailed deer. Not only did more of the does give birth the next spring, but they gave birth earlier ($p < 0.05$) than the untreated does. These results suggest that pLH may have adequate chemical analogy to deer LH so that, rather than evoking immunity, the sustained release of exogenous LH hastened fertility earlier during the fall. Because fertility was very high for the untreated does and because the day of fawning was not determined, it was not possible to ascertain the fertility enhancement effect of pLH at the Indiana facility.

Since fertility was 100% in the untreated does during the year that the hCG formulation was administered

Table 1

Reproductive Function of White-Tailed Deer Treated with Formulations Containing Gonadotropins (Connecticut Facility)

Item	Control	Treated
Year 1: Human Chorionic Gonadotropin Treatment		
Number giving birth	9/9 (100%)	8/8 (100%)
Number with twins	3/9 (33%)	2/8 (25%)
Mean day of parturition[c]	155 ± 15.5[e]	156 ± 10.5[e]
Timing of birth		
Days 116–135 (%)	0	0
Day 136+ (%)	100[f]	100
Year 2: Porcine Luteinizing Hormone Treatment		
Number giving birth	8/12 (67%)[a]	11/11 (100%)[b]
Number with twins	3/8 (38%)	3/11 (27%)
Mean day of parturition[c,d]	140 ± 1.9[e]	132 ± 6.4[e]
Timing of birth[d]:		
Days 116–135 (%)	0[a]	63[b]
Day 136+(%)	100[a]	37[b]

[a,b]Values with different superscripts differ at the 0.05 level.
[c]Day 1 - January 1 only for deer parturition.
[d]Data were available for only 4 control and 8 treated deer.
[e]Standard error.
[f]Data were available for only 8 of the 9 untreated deer.

to the treated does, it was not possible to fully ascertain the fertility effect of hCG. However, the data available would suggest that hCG had no effect since the breeding season was not hastened as for pLH at the same location the next year.

CONCLUSION

These data demonstrate that the administration of a sustained-release formulation of pLH enhanced and/or hastened fertility in white-tailed deer. This pLH formulation may therefore have utility in deer herds where a higher fecundity rate is desired.

ACKNOWLEDGMENTS

Thanks are extended to T. DiPaolo, V. Ordija, NIPSCO, and Sporting Goods Properties, Inc., Division of E. I. du Pont de Nemours and Company, for assistance and support with the study.

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