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The anterior pituitary (AP) gland functions as a storage and releasing unit for several hormones; growth hormone (GH), gonadotropins (luteinizing hormone and follicle stimulating hormone), prolactin, adrenocorticotropin hormone, and thyroid stimulating hormone. Luteinizing hormone (LH) functions to increase ovarian follicular growth and maturation and responds to increasing concentrations of estradiol-17β (E_2) that occur at estrus to cause ovulation. Production and secretion of the protein, insulin-like growth factor-I (IGF-I), occurs primarily in the liver, in response to GH release from the anterior pituitary gland. Insulin-like growth factor-I increases glucose uptake, amino acid transport, and glycogen synthesis resulting in increased protein accretion. Mitogenic effects of IGF-I can be manifested by increases in DNA, RNA, and protein. Furthermore, IGF-I stimulates differentiation at low levels usually preceding a mitogenic response. The biological effects of IGF-I are mediated by it's interaction with the IGF type I receptor and modulated by IGF binding proteins (IGFBPs). Insulin-like growth factor-I, IGFBPs, and IGF receptors have been detected in the AP gland of several species and may exert regulatory effects at the hypothalamic-hypophyseal level affecting gonadotropins, and in turn, reproductive performance.

There is evidence to suggest that estrogens can increase serum and AP concentrations of IGF-I as well as expression of certain IGFBPs within the AP gland. Previous research has demonstrated that fluctuations in components of the IGF system can influence gonadotroph function. Addition of IGF-I to dispersed AP cells obtained from gilts in either the follicular or luteal phase of the estrous cycle increased gonadotropin releasing hormone (GnRH) stimulated LH secretion over that in cells treated with no IGF-I. Studies have shown that administration of E_2 to pituitary tumor cells increases production of IGF-I and IGFBP-3. Changes in relative amounts of pituitary IGFBPs have been noted throughout the bovine estrous cycle. Extended treatment of steers with exogenous estradiol resulted in increased serum concentrations of IGF-I. Simpson and co-workers found that treating ovariectomized cows with estradiol for 45 days increased pituitary gland weight and resulted in greater plasma concentrations of IGF-I and total plasma IGFBP activity compared to control cows.

Steroid implants have long been used in cattle to improve growth and performance. By using such implants producers have improved feed efficiency and decreased feed costs, thus increasing their profitability. Use of E_2 and trenbolone acetate (TBA) implants elicited an increase in circulating levels of IGF-I stimulating muscle growth in crossbred yearling steers. Wethers treated with E_2 and TBA also had increased serum concentrations of IGF-I and had improved average daily gain and feed efficiency. Research has shown that boars produce and secrete greater amounts of E_2, of testicular origin, and produce leaner carcasses than gilts or barrows. A study conducted in our lab with prepubertal boars, found that rising serum concentrations of IGF-I paralleled rising serum concentrations of E_2. Similarly, feed efficiency was greater in boars than in gilts or barrows (castrated males.).

The AP IGF system in swine has not been well defined. The effects of E_2 on AP function may be partially explained by changes in components of the IGF system. A thorough understanding of the porcine AP IGF system, is a necessary first step in developing strategies to control pituitary function that enhance reproduction and growth. Improved reproductive and growth performance will ultimately have a positive economic impact on the producer.

We performed a preliminary study to determine if administration of E_2 implants (25.7 mg E_2) could elevate serum concentrations of E_2 in barrows similar to that of boars of

comparable age and maturity and subsequently affect the AP IGF system. Twenty crossbred barrows were randomly assigned by litter to one of four treatment groups of five barrows each. Treatment groups were as follows; 1) two implants, 2) three implants, 3) four implants, and 4) no implants.

This preliminary study determined that administration of E_2 implants elevated serum concentrations of E_2 in barrows over a 35-day period similar to what is found in gonadally intact boars of comparable age. Mean serum concentrations of E_2 for barrows receiving 0, 2, 3, or 4 implants were 11.7, 58.6, 78.3, and 87.4 pg/mL, respectively. Anterior pituitary concentrations of IGF-I were increased ($P<.05$) by implantation with E_2 versus no implant (623.2 ± 73.8 ng/mL versus 208.2 ± 73.8 ng/mL, respectively.) Serum concentrations of IGF-I were also increased ($P<.05$) in implanted barrows versus non-implanted from day 7 through day 35 of the experiment. Mean serum concentrations of IGF-I in implanted barrows were 196.4 ± 10.3 ng/mL compared to 141.1 ± 10.3 ng/mL in barrows without implants. Implant effects on serum IGF-I levels were not dose dependent ($P>.05$). Feed efficiency, measured by G/F ratios, was greater ($P<.05$) in implanted animals versus those without implants. Feed efficiency of barrows with zero and two implants was not different ($P>.05$), whereas, barrows with three and four implants had an improved ($P<.05$) feed efficiency compared to controls, but were not different from barrows with two implants ($P>.05$).

Our preliminary work indicated that E_2 does regulate the IGF system in swine. Both serum and AP concentrations of IGF-I were increased after administration of E_2. These data suggest that boars and gilts, which naturally produce E_2, have greater serum and AP concentrations of IGF-I and may influence growth and reproductive performance. Further investigations are required to determine if boars and gilts have similar responses to endogenous E_2.

A second experiment was designed to determine if administration of E_2 to barrows increases components of the IGF system to levels similar to that found in boars of similar age and weight. Hypophyseal concentrations of IGF-I, serum concentrations of E_2 and IGF-I, relative amounts of serum and AP IGFBPs, and concentrations of AP LH and GH were analyzed in barrows after administration of E_2 and compared to boars and non-implanted barrows.

Three groups of pigs were randomly allotted by litter; boars (n=11), non-implanted barrows (n=12), and E_2 implanted barrows (n=9). All pigs were penned individually throughout the experiment. Implanted barrows were administered two E_2 implants (25.7 mg E_2 each) subcutaneously at the base of each ear on d 1. Blood samples, body weight, and feed disappearance was collected every two weeks thereafter and at slaughter (d 90).

Chronic administration of E_2 to barrows increased ($P<.05$) serum concentrations of E_2 in implanted barrows versus boars. Serum concentrations of T increased ($P<.05$) over time in the boars from d 0 to d 90. Administration of E_2 to implanted barrows increased ($P<.05$) AP concentrations of IGF-I compared to boars and non-implanted barrows, but had no affect ($P>.05$) on relative amounts of serum and AP IGFBPs. Mean serum concentrations of IGF-I tended to be greater ($P=.08$) in implanted barrows versus non-implanted barrows. Gain to feed ratios increased in the implanted barrows versus control barrows, but boars grew more efficiently than implanted barrows. In collaboration with Dr. Andy Roberts at the Meat Animal Research Center in Clay Center, Nebraska, we were able to identify two IGFBPs in the AP gland, IGFBP-2 and -5, through immunoprecipitation. Relative amounts of each of these AP IGFBPs were greater ($P<.05$) in boars than either barrows with or without E_2 implants. To date, no one has published such a find in the porcine pituitary gland.

Estradiol is believed to have a great impact on the IGF system in ruminant animals. Our work has led us to conclude that E_2 plays a primary role in the porcine AP IGF system. The use of E_2 in the barrow allowed us to use a model with levels of endogenous E_2 at nearly zero. However, at the same time we eliminated other testicular hormones and factors. Our study implies that the boar produces and secretes other hormones and factors that could work synergistically or additively in the regulation of the AP IGF system. Analyses presently being conducted include the quantification of expression for IGF-I, IGF-I receptor, and IGFBPs, to substantiate our hypothesis that E_2 upregulates components of the porcine AP IGF system. Furthermore, our lab will also determine if AP concentrations of IGF-I are related to expression of GnRH receptor, α sub-unit, and LH β and FSH β sub-units.