

Effect of Exogenous Estrogen on Growth and Mammary Gland Development in Korean Native Heifers

Woo, J. S., K. S. Choi*, G. H. Park*, W. J. Shin*, H. S. Choi*, S. W. Na, K. J. Sin and S. K. Im
Alpine Experimental Station

외인성 Estrogen이 한우 암송아지의 성장과 유선 및 유방의 발달에 미치는 영향

우재석 · 최광수* · 박강희* · 신원집* · 최호성* · 나승환 · 신기준 · 임석기
고령지 시험장

要 約

外因性 estrogen이 成長과 乳腺發達 및 初發情日齡에 미치는 影響을 6 個月齡 韓牛 암송아지에서 調査되었다. 10 mg의 estrogen이 插入된 송아지의 處理後 90日 동안 增體量은 無處理區와 다르지 않았다. 그러나 20 mg의 estrogen이 插入된 송아지의 增體量은 無處理區에 比하여 18%의 增加를 나타내었다($P < 0.05$). 處理後 180日 동안의 增體量은 10 mg 및 20 mg의 estrogen 處理가 無處理에 比하여 각각 平均 6.7% 및 17.8% 增加하였지만 有意性은 없었다. 處理後 90日 동안 乳頭 直徑의 增加量은 estrogen 插入量에 相關없이 處理區가 無處理區에 比하여 159%의 有意的 增加를 나타내었다($P < 0.05$). 處理後 180日 동안 乳頭 直徑의 增加量도 10 mg과 20 mg의 estrogen 處理가 無處理에 比하여 각각 100% 및 128%의 有意的 增加를 나타내었다($P < 0.05$). 處理後 90日 동안 乳頭 길이 的 增加量은 10 mg과 20 mg의 estrogen 處理가 無處理에 比하여 각각 200% 및 295%의 有意的 增加를 나타내었다($P < 0.05$). 處理後 180日 동안 乳頭 길이 的 增加量도 10 mg과 20 mg의 estrogen 處理가 無處理에 比하여 각각 265% 및 325%의 有意的 增加를 나타내었다($P < 0.05$). 乳頭 容積의 增加量은 10 mg과 20 mg의 estrogen 處理가 無處理에 比하여 處理後 90日 동안 각각 282% 및 246%의 有意的 增加를 나타내었다($P < 0.05$). 處理後 180日 동안 乳頭 容積의 增加量도 10 mg과 20 mg의 estrogen 處理가 無處理에 比하여 각각 251% 및 244%의 有意的 增加를 나타내었다($P < 0.05$). 그러나 期間에 關係없이 10 mg과 20 mg의 estrogen 處理區 사이에 乳頭 直徑, 길이 그리고 容積의 增加量에 있어서는 差異가 없었다. 10 mg 및 20 mg의 estrogen 處理는 初發情日齡을 각각 20日 및 124日 短縮시켰다. 全體적으로 이러한 結果는 송아지에 estradiol의 插入은 成長과 乳腺 發達을 促進시키고 初發情日齡을 短縮시킬 수 있다는 것을 強力하게 指摘한다.

I. INTRODUCTION

Exogenous bovine growth hormone (somatotropin) has been investigated in an effort to

promote growth of heifers (Sejrsen *et al.*, 1986; Fabry *et al.*, 1987; Grings *et al.*, 1987; Kirchgessner *et al.*, 1987; Sandles and Peel, 1987). For example, Sejrsen *et al.* (1986) found a significant increase in average daily gains of the

* 전북대학교 축산학과(Department of Animal Science, Chonbuk National University)

heifers aged 8 to 12 months injected daily with up to 18 mg of pituitary growth hormone. Similarly, Grings *et al.* (1987) and Kirchgessner *et al.* (1987) showed a significant increase in average daily gains of heifers by recombinant growth hormone injections. Even though there is a tremendous potential for the use of bovine pituitary growth hormone or recombinant bovine growth hormone, problems may be involved with its use, most notably regarding administration. Their studies have involved daily injections, which is not considered practical.

Estrogen, which is very cheap and convenient to use in that it is orally active (Clegg and Carroll, 1954) and can be implanted into animals, stimulates growth hormone secretion (Preston, 1975; Davis *et al.*, 1977). Also, estrogen increases the number of prolactin receptors (Ford and Klint, 1989) and stimulates prolactin secretion (Davis *et al.*, 1978), both of which are involved in mammary development (Houdebine *et al.*, 1981; Akers, 1985). Thus, estrogen may be applied to promote growth of heifers as an alternative to a growth hormone. However, few or no data have been reported on the performance of Korean native heifers implanted with estrogen. Therefore, our study was to investigate whether estrogen implantation stimulates growth and mammary development in Korean native heifers. We have also investigated the age variables, measuring the effects of exogenous estrogen on the age at which the first estrous symptom in Korean native heifers is detected.

II. MATERIALS AND METHODS

Experiments were conducted with 6 month old Korean native heifers (n=9) raised at the Alpine Experiment Station. Before implantation, body weights of heifers were measured and

recorded. Mean initial body weight of heifers used in this study was 141 ± 6.0 kg. Teat diameter (initial value: 10.5 ± 0.3 mm) and teat length (initial value: 18.4 ± 0.5 mm) were measured to use as parameters for assessing mammary development as described in Moran *et al.* (1991). Teat volume (initial value: 1647 ± 111 mm³) was calculated using the formula, (teat diameter / 2)² × π × teat length. Heifers were assigned to one of three groups in consideration of their age and weights and age of their dams. Heifers in the control group received no medication. Heifers in treatment groups were implanted in the ear behind with pellets containing either 10 mg or 20 mg of estradiol. After treatments, heifers were maintained as described in Chung *et al.* (1992). Live body weight, teat diameter and teat length were measured at 90 day intervals. Teat volume was also calculated at the same intervals. Data were analyzed by the use of the students' t-test (Huntsberger and Billingsley, 1981) to determine the significance of treatment effects.

III. RESULTS AND DISCUSSION

The effects of estradiol on body weight gain (or expressed as average daily gain) in Korean native heifers are shown in Table 1. For the initial 90 days after treatment, body weight gains in heifers implanted with 10 mg of estradiol were not significantly different from those in the control heifers. However, heifers implanted with 20 mg of estradiol showed significant weight gains of 18% over those of the control heifers during this period. Cumulative body weight gains in the heifers implanted with either 10 mg or 20 mg of estradiol over the entire experiment (0 days to 180 days after treatment) averaged 6.7% or 17.8%, respectively, greater than those in the controls, but these

Table 1. Effects of estradiol on body weight (BW) gain and average daily gain in Korean native heifers

Treatment	Days after treatment			
	90		180	
	BW gain(kg)	ADG(kg)	BW gain(kg)	ADG(kg)
Control ^a	45.3±1.20 ^d	0.50±0.012 ^d	80.3±5.31	0.45±0.035
E1 ^b	40.3±4.05 ^d	0.45±0.045 ^d	85.3±5.78	0.48±0.032
E2 ^c	53.3±0.67 ^c	0.59±0.007 ^c	95.7±6.94	0.53±0.038

Values represents mean S.E.M

^aHeifers given no medication

^bHeifers implanted 10 mg of estradiol

^cHeifers implanted 20 mg of estradiol

^dValues with different superscripts within a column represent significant difference (P<0.05)

values were not statistically significant, due to large individual variation. Therefore, these data suggest that a single estradiol implantation into Korean native heifers tends to increase weight gain and average daily gain for a sustained period. This observation is comparable to the results obtained with Holstein heifers by the study of Moran *et al.* (1991) and with Friesian steers by the study of Enright *et al.* (1990).

Frandsen and Spurgeon (1992) postulated that estrogen stimulated mammary development in heifers. Thus, our experiments were planned to

illustrate the similar effects of estradiol on mammary development of Korean native heifers. Measuring the udder size or parameters related to mammary development was impossible; however, the teat diameter and length of heifers could be observed. These gains in teat diameter and teat length were measured in an attempt to determine the effects of exogenous estradiol on mammary development in Korean native heifers. As shown in Table 2, the implantation with 10 mg of estradiol significantly increased the gain of teat diameter in heifers by

Table 2. Effects of estradiol on the gains of teat diameter (TD), teat length (TL) and teat volume (TV) in Korean native heifers

Variables	Treatment		
	Control ^a	E1 ^b	E2 ^c
TD gain (mm)			
D 90	1.7 ± 0.37 ^d	4.4 ± 0.42 ^c	4.4 ± 0.87 ^c
D 180	2.5 ± 0.47 ^d	5.0 ± 0.59 ^c	5.7 ± 0.94 ^c
TL gain (mm)			
D 90	1.9 ± 0.82 ^d	5.7 ± 1.23 ^c	7.5 ± 0.75 ^c
D 180	2.0 ± 0.79 ^d	7.3 ± 1.34 ^c	8.5 ± 0.68 ^c
TV gain (mm)			
D 90	787 ± 156 ^d	3011 ± 470 ^c	2721 ± 522 ^c
D 180	1103 ± 168 ^d	3880 ± 658 ^c	3796 ± 698 ^c

Values represents mean S.E.M

TD;teat diameter, TL;teat length, TV: teat length

^aHeifers given no medication

^bHeifers implanted 10 mg of estradiol

^cHeifers implanted 20 mg of estradiol

^dValues with different superscripts within a row represent significant difference (P<0.05)

159% for the first 90 days after treatment compared to those given no medication. The gain of teat diameter in the heifers implanted with 20 mg of estradiol was also about 159% significantly higher than that of the control heifers. In addition, cumulative gains of teat diameter in the heifers implanted with 10 mg and 20 mg of estradiol over the entire experiment (for 180 days after treatment) were also significantly increased by 100% and 128%, respectively, compared to control values. However, there was no significant difference in gain of teat diameter between heifers implanted with 10 mg and 20 mg of estradiol regardless of the measurement periods. Similarly, the gains of teat length in the heifers implanted with either 10 mg or 20 mg of estradiol were significantly increased for the first 90 days after treatments by 200% and 295%, respectively, compared to those in the control heifers. Cumulative gains of teat length in the heifers implanted with either 10 mg or 20 mg of estradiol over the entire experiment were significantly increased by 265% or 325%, respectively compared to control values. However, there were no significant differences in teat length gains between heifers implanted with 10 mg and 20 mg of estradiol regardless of 90 days or 180 days. The teat volumes in Korean native heifers were calculated using the individual teat diameter

and teat length, and the data of the teat volume gains were presented in Table 3. The heifers implanted with either 10 mg or 20 mg of estradiol showed significant teat volume gains of 282% or 246%, respectively, over those of the control heifers for the first 90 days after treatments. Also, cumulative gains of teat volume in the heifers implanted with either 10 mg or 20 mg of estradiol over the entire experiment were significantly increased by 251% and 244%, respectively, compared to control values. However, there were no significant differences in gains of teat volume between heifers implanted with 10 mg and 20 mg of estradiol regardless of measuring periods. Overall, these data strongly suggest that estradiol implantation into heifers stimulates mammary development. This suggestion is in agreement with previous comparable studies with heifers (Moran *et al.*, 1991; Deutscher *et al.*, 1986)

The effects of exogenous estradiol on the age at which the first estrous symptom in Korean native heifers is detected are shown in Table 3. Regardless of dosage, the first estrus in Korean native heifers implanted with estradiol was detected on earlier age than that in the control heifers. The first estrus in the control heifers was observed at 320 days of age. However, heifers implanted with 10 mg or 20 mg of estradiol showed the first estrus at the 300 days

Table 3. Effects of estradiol on the age at which the first estrous symptom in Korean native heifers is observed

	Treatment		
	Control ^a	E1 ^b	E2 ^c
The age at first estrus (days)	320 ± 3 ^d	300 ± 5 ^e	196 ± 2 ^f

Values represents mean S.E.M

^aHeifers given no medication

^bHeifers implanted 10 mg of estradiol

^cHeifers implanted 20 mg of estradiol

^{def}Values with different superscripts within a row represent significant difference (P<0.05)

or 196 days of age, respectively. Therefore, these results clearly indicated that implantation with estradiol into Korean native heifers hastened the age at which they show the first estrous symptom.

In conclusion, These data clearly demonstrate that estradiol can improve weight gain and mammary development in Korean native heifers. In addition, the age at which the first estrus in heifers is detected can be hastened by estradiol implantation. However, further study is needed to prove the mechanisms underlying these phenomena.

IV. ABSTRACT

The effects of exogenous estrogen on growth, mammary development, and the age at which the first estrous symptoms are detected were investigated for the first time in Korean native heifers at 6 months of age. At 90 days after treatment, weight gains of heifers implanted with 10 mg of estradiol were not different from those of the control heifers. However, weight gains of heifers implanted with 20 mg of estradiol were significantly increased at 90 days by 18%, relative to control values. At 180 days, cumulative weight gains of heifers implanted with either 10 mg or 20 mg of estradiol averaged 6.7% or 17.8%, respectively, greater than controls. But these values were not statistically significant. Regardless of dosage, teat diameter gains in the treatment groups were significantly increased at 90 days about 159%, relative to controls. Cumulative teat diameter gains in the heifers implanted with either 10 mg or 20 mg of estradiol were also significantly increased at 180 days by 100% or 128%, respectively, compared to controls. Teat length gains in the heifers implanted with either 10 mg or 20 mg of estradiol were significantly increased at 90 days

by 200% and 295%, respectively, compared to controls. Cumulative teat length gains in the heifers implanted with either 10 mg or 20 mg of estradiol were significantly 265% and 325%, respectively, higher than controls. The heifers implanted with either 10 mg or 20 mg of estradiol showed a significant increase in teat volume gains at 90 days of 282% or 246%, respectively, over those of the control heifers. Cumulative teat volume gains in the heifers implanted with either 10 mg or 20 mg of estradiol were significantly increased at 180 days by 251% and 244%, respectively, compared to control values. However, there were no significant differences in gains of teat diameter, length and volume between heifers implanted with 10 mg and 20 mg of estradiol regardless of 90 days or 180 days. Heifers implanted with 10 mg or 20 mg of estradiol showed the first estrus 20 or 124 days, respectively, faster than controls. Overall, These data strongly suggest that estradiol implantation into heifers stimulates growth and mammary development and hasten the age at which the first estrus in Korean native heifers is observed.

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