

Studies on the Effects of Antler Extract in Osteoporosis-Induced Rats I. Effects of Antler Extract on Hormones, Ca, P and ALP Levels in Osteoporosis-Induced Rats

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녹용 추출물 투여가 골다공증 유발 Rat에 미치는 효과에 관한 연구 I. 녹용 추출물 투여가 골다공증 유발 Rat의 혈청내 호르몬, Ca, P, ALP 수준에 미치는 영향

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ABSTRACT

The present study was carried out in order to investigate the effects of antler extract on hormone concentration, Ca, P and alkaline phosphatase (ALP) levels in ovariectomized rats. Rats were ovariectomized bilaterally and were fed up with Ca- and P-free diet in order to induce osteoporosis. Osteoporosis was determined by the extent of density of bone mineral and lowering the concentrations of serum Ca and P. Male or female antler extract were administrated for 5 weeks to elucidate the protective and therapeutic effects for osteoporosis. The serum concentrations of estradiol, progesterone, calcitonin, osteocalcin, Ca and P, and the activities of ALP of ovariectomized rats were examined for 5 weeks.

1. After administration of female or male antler extract to osteoporosis-induced rats at the doses of 625 mg/kg and 1,250 mg/kg, respectively, the levels of the serum estradiol of the ovariectomized rat significantly decreased from 40.50 ± 3.34 pg/ml to 20.80 ± 1.86 pg/ml for 5 weeks, the levels of serum estradiol were a significant lower than those of control group ($49.50 \pm 2.70 \sim 50.80 \pm 3.13$ pg/ml).
2. After administration of female or male antler extract to osteoporosis-induced rats at the doses of 625 mg/kg and 1,250 mg/kg, respectively, the levels of serum progesterone were didn't show significant differences.
3. After administration of female or male antler extract to osteoporosis-induced rats at the doses of 625 mg/kg and 1,250 mg/kg, respectively, the levels of serum calcitonin were a little higher than

* 본 연구는 축산기술연구소 종축개량부와의 공동연구에 의해 수행되었음.

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those of control group ($0.64 \pm 0.03 \sim 0.68 \pm 0.04$ pg/ml).

4. After administration of female or male antler extract to osteoporosis-induced rats at the doses of 625 mg/kg and 1,250 mg/kg, respectively, the levels of serum osteocalcin were little higher than those of control groups ($0.28 \pm 0.02 \sim 0.31 \pm 0.02$ ng/ml). In addition, the levels of serum osteocalcin of female antler extract administered group were little higher than those of male antler extract administered group.
5. The levels of serum Ca and P in osteoporosis-induced rats, administered with male or female antler extract, were little higher than those of control group. However, the levels of serum Ca and P in ovariectomized rats were significantly higher than those of control group ($p < 0.05$).
6. After administration of female or male antler extract to osteoporosis-induced rats, the activities of serum ALP increased compared with those of normal control group. There were significant differences between the serum ALP activities of FA 1,250 and MA625 groups ($p < 0.05$).

These findings suggest a possible protective and therapeutic effects of female or male antler extract against bone loss in ovariectomized rats, associated with a significant increase of serum estradiol level.

(Key words : Osteoporosis, Estradiol, Calcitonin, Osteocalcin, Ca, P, ALP)

I. INTRODUCTION

Osteoporosis is a metabolic ailment of bone, the decrease of bone density, when the symptom is being more susceptible to fractures. Moreover, the decrease of bone density is a major risk factor leading to osteoporosis (Hauselmann et al., 1998; Bembem et al., 1999). Osteoporosis occurs inherently in cats and dogs (e.g., Dachshund), but sometimes it occurs by non-specific causes, such as aging, non-use, nutritional imbalance (Ettinger & Feldman, 1995). It is reported in animals that osteoporosis arises from the decrease in bone anabolism due to the deficient state of nutrition. In lamb, osteoporosis was taken place by the disturbances of osteoblasts by copper deficiency or disturbances of osteoid formation in chronic lead poisoning (Blood et al., 1989). The pharmaceutical effects and compositions of antlers are different according to the portions of the antler (i.e., upper, middle and lower) and the habitats where the deer live (Namaba, 1980; Chien, 1982).

Antlers contain several essential amino acids, Ca,

Mg, saccharides, squalene, mucopolysaccharide, triglyceride, metabolites of nucleic acids (i.e., uracil, uridine, and hypoxanthine) prostaglandins, lipopolysaccharides, phospholipids, cholesterol-derivatives, and epidermal growth factor (EGF). The receptor of insuline-like growth factor was found in growth palate at the end of an antler. It has been reported that antler-extract has some therapeutic effects such as growth-promoting of white rats, lowering the cholesterol levels, and improving promotion of hepatic function. In addition, antler-extract promotes the antibody production, hematopoiesis of bone marrow, and the phagocytosis and immunity of reticuloendothelial system. Moreover, antler-extract appear to have anti-stress and anti-aging effects, and ameliorate the movement related-osteoporosis (Suttie et al., 1985; Hattori et al., 1989; Elliott et al., 1992; Zhang et al., 1992; Kim, 1996; ; Seo, 1998). Medical treatments of osteoporosis are divided into the prevention of bone resorption to which estrogen, calcitonin biphosphonate, Ca, and vitamin D derivatives therapies belong, and the bone formations to which sodium fluoride, and PTH therapies belong.

The uses of estrogen and calcitonin were approved by FDA. Estrogen therapy has several side effects and it is difficult to arrange the administration time appropriately. And then, it is contradictory to patients who are suffering from breast cancer, metrocarcinoma, hepatic disorder, hypertension, and migraine. The risk factors of osteoporosis are ages, sex, race, genetic inheritance, non-use, endocrinal disorders including abnormal secretion of estrogen, thyroidism, parathyroidism, nutritional imbalance, long term uses of anti-epileptics or steroid derivatives, smoking, and alcoholism etc. (Nyda et al., 1948; Wronski et al., 1989; Hauselmann et al., 1998).

This study, we investigated the serum concentrations of estradiol, progesterone, calcitonin, osteocalcin, Ca, P, ALP levels in ovariectomized rats, which were administered with male or female antler-extracts through 5 weeks.

II. MATERIALS AND METHODS

1. Animals

10 week-old female Sprague-Dawley 200 rats were used. Animals were acclimatized for 2 weeks before use, and had free access to feed and water. The cycles of dark and light were 12h/12h. The other animal husbandry were followed according to the methods of Chungnam National University. Experimental groups were allocated to control (Control) group, ovariectomized (OG) group, sham operation (SO) group, female antler-extract administered (FA) group, male antler-extract administered (MA) group. SO rats were laparotomized without ovariectomy. The FA and MA groups were supplied with Ca- and P-deficient diet (Table 1) for 5 weeks after ovariectomy, and then they were administered with the respective antler-extract.

2. Preparation and Administration of Antler-extracts

Table 1. Composition of experimental diets(Ca- and P-not added diets)

Ingredient	%
Crude protein	22.5% above
Crude fat	3.5% "
Ca	Not added
P	Not added
Crude fiber	7.0% above
Crude Ash	10.0% above

The antlers of Elk deer were obtained from the Department of Livestock Improvement, National Livestock Research Institute (NLRI). The distal one third of each antler (11.25g) was boiled with 10 times water (v/v) for 4 h, according to the prescription of Oriental medicine. Thereafter, the antler was extracted, filtrated, and concentrated into a volume of 60 ml. The female antlers were obtained by the method of NLRI. The female and male extracts were administered per orally with stomach tube at doses of 625, 1,250 mg/kg in every other day.

3. Induction of Osteoporosis

The rats were anesthetized i.p. with 0.01 ml/g of Avertin solution (Aldrich Co., USA) and were incised at one third of midline according to the method of Waynforth and Flecknell (Waynforth and Flecknell, 1996). Osteoporosis was determined by analysis of serum concentrations of estradiol, calcitonin, osteocalcin, Ca, P, and alkaline phosphatase (ALP) activity.

4. Blood Collection and Serum Separation

The rats were anesthetized with ether. Blood was collected in 1, 2, 3, 4 and 5 weeks of experiments by heart-puncture, collected blood was stored for 30 min at room temperature, and centrifuged with 3,000 rpm for 15 min. The supernatant kept in -20°C before use.

5. Measurements of Serum Estradiol, Progesterone, Calcitonin, Osteocalcin, Ca, P and ALP

The serum concentrations were determined with estradiol RIA kits (DSI Co., USA), progesterone RIA kits (DPC Co., USA), calcitonin ELISA-OSTEO kit (CIS Bio International, France) and osteocalcin (CIS Bio International, France). The concentrations of serum Ca and P were assayed with respective analysis kit (DRY Chemistry Co., Japan). The activity of ALP was with automatic analyzer (SM-4000, Biochemical System, Italy).

6. Statistical Analysis

Statistical significances among groups were determined by Duncan's multiple range test with General Linerars Model (GLM) Procedure (SAS ver. 6.12, SAS Institute, 1996).

III. RESULTS AND DISCUSSION

1. The Changes in the Concentration of Serum Estradiol

As shown in Table 2, male or female antler-extract

estradiol in osteoporosis-induced rats was 20.80 ± 1.86 pg/ml, whereas the concentrations of serum estradiol in antlerextract administered rats were in the range of 32.20 ± 3.25 pg/ml and 34.60 ± 3.03 pg/ml. These recoveries of serum estradiol were comparable to those of normal control group (i.e., 50.80 ± 3.1 pg/ml). On the other hand, the levels of serum estradiol in FA group showed a little higher than those in MA group. It was reported by Eben et al. (1998) and Durador et al. (1997) that the serum estrogen significantly decreased in osteoporosis which was induced by ovariectomy and menopause. In agreement with this, the serum estradiol in osteoporosis-induced rats significantly decreased compared with that in normal control group. The recoveries of serum estradiol in MA and FA group was probably due to the contents of antler, such as estrogen, Ca, P, calcitonin, osteocalcin and vitamin D.

2. The Changes in the Concentration of Serum Progesterone

The effects of antler-extract on the levels of serum progesterone were shown in Table 3. The concentrations of serum progesterone in osteoporosis-induced rats is similar to those in normal

Table 2. Effects of female or male antler extract on serum estradiol concentrations in ovariectomized rats

Experimental group	Estradiol concentration (pg/ml \pm SD)				
	1	2	3	4	5(w)
Control ^a	49.50 \pm 2.70	49.50 \pm 2.73	50.70 \pm 4.62	49.80 \pm 2.93	50.80 \pm 3.13
SO	44.20 \pm 3.40	46.40 \pm 4.16	48.30 \pm 4.35	48.90 \pm 2.48	49.10 \pm 2.05
OG ^b	40.50 \pm 3.34	25.20 \pm 3.05	22.30 \pm 3.10	18.50 \pm 1.72	20.80 \pm 1.86
FA 625 ^b	40.20 \pm 3.75	38.10 \pm 2.72	38.25 \pm 3.05	36.40 \pm 3.16	33.60 \pm 3.03
FA1250 ^b	39.30 \pm 4.21	39.10 \pm 3.86	38.20 \pm 3.24	35.60 \pm 3.62	32.20 \pm 3.25
MA 625 ^b	40.90 \pm 4.54	39.70 \pm 3.53	38.70 \pm 2.87	36.80 \pm 3.04	33.40 \pm 2.74
MA1250 ^b	40.30 \pm 4.07	39.50 \pm 2.95	38.30 \pm 3.06	36.30 \pm 3.51	33.10 \pm 3.12

* Values with different superscripts within column were significantly different($p < 0.05$)

* SO : Sham operation, OG : Ovariectomized group, FA : female antler, MA : male antler

increased the concentration of serum estradiol in osteoporosis-induced rats. The concentration of serum

Table 3. Effects of female or male antler extract on serum progesterone concentrations in ovariectomized rats

Experimental group	Progesterone concentration (ng/ml \pm SD)				
	1	2	3	4	5(w)
Control ^a	52.30 \pm 4.30	50.90 \pm 3.63	52.30 \pm 2.74	50.90 \pm 2.63	53.40 \pm 2.74
SO	55.90 \pm 3.74	55.70 \pm 2.82	55.20 \pm 2.55	52.40 \pm 3.28	51.60 \pm 3.01
OG ^b	52.45 \pm 2.56	51.60 \pm 2.85	50.40 \pm 3.51	49.80 \pm 2.82	47.20 \pm 2.83
FA 625	50.95 \pm 2.74	51.76 \pm 3.58	50.82 \pm 3.70	46.15 \pm 3.47	47.18 \pm 3.35
FA1250 ^b	51.52 \pm 3.25	52.96 \pm 2.72	51.23 \pm 3.16	49.82 \pm 2.55	43.30 \pm 2.24
MA 625	54.98 \pm 3.12	51.07 \pm 3.43	51.60 \pm 3.35	47.53 \pm 3.63	47.52 \pm 2.85
MA1250 ^b	54.79 \pm 2.76	51.65 \pm 3.26	52.51 \pm 2.55	48.51 \pm 3.25	47.61 \pm 2.08

* Values with different superscripts within column were significantly different(p<0.05)

control group, which were different results of Ohta et al. (1992b) and Kim (1996).

3. The Changes in the Concentration of Serum Calcitonin

As shown in Table 4, there is a decrease in the level of serum calcitonin in osteoporosis-induced rats. After administration of female or male antler-extract to osteoporosis-induced rats at the doses of 625 mg/kg and 1,250 mg/kg, respectively, the levels of serum calcitonin were 0.50 \pm 0.08~0.58 \pm 0.02 ng/ml and 0.61 \pm 0.04~0.69 \pm 0.03 ng/ml in the female antler-extract administered rats, and 0.52 \pm 0.05~0.65 \pm 0.04 ng/ml and 0.57 \pm 0.03~0.68 \pm

0.01 ng/ml in the male antler-extract administered rats. The levels of serum calcitonin in female or male antler-extract administered groups were a little higher than those of control group (i.e., 0.64 \pm 0.03 ~ -0.68 \pm 0.04 ng/ml). It is known that calcitonin inhibits the bone resorption and modulates the concentration of Ca. Therefore, it is conceivable to speculate that antler-extract affect the action of calcitonin through inhibiting the bone resorption (Shimizu et al., 1992).

4. The Changes in the Concentration of Serum Osteocalcin

The consecutive changes in the concentrations of

Table 4. Effects of female or male antler extract on serum calcitonin concentrations in ovariectomized rats

Experimental group	Calcitonin concentration (ng/ml \pm SD)				
	1	2	3	4	5(w)
Control ^a	0.67 \pm 0.02	0.66 \pm 0.02	0.68 \pm 0.04	0.64 \pm 0.03	0.67 \pm 0.03
SO	0.64 \pm 0.03	0.62 \pm 0.05	0.62 \pm 0.08	0.64 \pm 0.05	0.65 \pm 0.05
OG ^b	0.56 \pm 0.01	0.48 \pm 0.02	0.44 \pm 0.02	0.40 \pm 0.01	0.36 \pm 0.01
FA 625	0.51 \pm 0.05	0.50 \pm 0.08	0.54 \pm 0.05	0.58 \pm 0.02	0.61 \pm 0.02
FA1250 ^b	0.62 \pm 0.03	0.61 \pm 0.04	0.65 \pm 0.04	0.69 \pm 0.03	0.66 \pm 0.02
MA 625	0.52 \pm 0.05	0.52 \pm 0.06	0.60 \pm 0.03	0.62 \pm 0.06	0.65 \pm 0.04
MA1250	0.57 \pm 0.03	0.62 \pm 0.08	0.64 \pm 0.05	0.68 \pm 0.01	0.68 \pm 0.02

* Values with different superscripts within column were significantly different(p<0.05)

Table 5. Effects of female or male antler extract on serum osteocalcin concentrations in ovariectomized rats

Experimental group	Osteocalcin concentration (ng/ml \pm SD)				
	1	2	3	4	5(w)
Control ^a	0.28 \pm 0.02	0.29 \pm 0.01	0.31 \pm 0.02	0.29 \pm 0.01	0.28 \pm 0.02
SO ^b	0.20 \pm 0.04	0.24 \pm 0.02	0.35 \pm 0.02	0.64 \pm 0.03	0.50 \pm 0.03
OG	0.22 \pm 0.05	0.23 \pm 0.03	0.25 \pm 0.01	0.26 \pm 0.02	0.24 \pm 0.01
FA 625 ^b	0.21 \pm 0.02	0.23 \pm 0.02	0.25 \pm 0.03	0.28 \pm 0.02	0.28 \pm 0.02
FA1250 ^b	0.24 \pm 0.04	0.26 \pm 0.02	0.28 \pm 0.04	0.30 \pm 0.03	0.31 \pm 0.03
MA 625	0.24 \pm 0.03	0.24 \pm 0.01	0.26 \pm 0.03	0.28 \pm 0.01	0.29 \pm 0.01
MA1250 ^b	0.21 \pm 0.02	0.24 \pm 0.02	0.26 \pm 0.02	0.29 \pm 0.02	0.30 \pm 0.02

* Values with different superscripts within column were significantly different (p<0.05)

serum osteocalcin are represented in Table 5. The levels of serum osteocalcin in osteoporosis-induced rats significantly decreased compared with those of normal control group (in 5 weeks, 0.24 \pm 0.01 ng/ml vs 0.28 \pm 0.02 ng/ml). However, male or female antler-extract in osteoporosis-induced rats recover the levels of serum osteocalcin comparable to those of normal control groups. It is reported that osteocalcin is vitamin K-dependent and calcium-coupled protein, and is known to be the representative index in bone formation. Moreover, osteocalcin a bone-specific protein, is related to the bone calcify, and is in an extent to activity of osteoblast. Therefore, ameliorative activity of antler-extract in

osteoporosis is probably due to the direct activation of bone formative factor (Wronski et al., 1988, 1989).

5. The Changes in the Concentration of Serum Ca

The effects of antler-extract on the levels of serum Ca are shown in Table 6. In 5 weeks, the concentrations of serum Ca in control and OG groups were 10.80 \pm 0.18 mg/dl and 11.80 \pm 0.29 mg/dl, respectively. This significant decrease in OG groups was recovered by treatment of antler-extract either in FA (i.e., 11.50 \pm 0.19~11.80 \pm 0.24 mg/dl) or in MA groups (i.e., 11.15 \pm 0.15~11.50 \pm 0.18

Table 6. Effects of female or male antler extract on serum Ca levels in ovariectomized rats

Experimental group	Ca concentration (mg/dl \pm SD)				
	1	2	3	4	5(w)
Control ^b	10.60 \pm 0.12	10.40 \pm 0.19	10.50 \pm 0.15	10.60 \pm 0.19	10.80 \pm 0.18
SO	10.80 \pm 0.22	10.20 \pm 0.21	10.50 \pm 0.24	10.80 \pm 0.16	10.10 \pm 0.26
OG ^a	10.50 \pm 0.34	11.20 \pm 0.25	11.40 \pm 0.23	11.60 \pm 0.47	11.80 \pm 0.29
FA 625 ^b	10.50 \pm 0.22	10.90 \pm 0.15	11.10 \pm 0.28	11.20 \pm 0.24	11.50 \pm 0.19
FA1250 ^b	10.70 \pm 0.32	11.50 \pm 0.10	12.40 \pm 0.31	12.20 \pm 0.27	11.80 \pm 0.24
MA 625	10.60 \pm 0.14	11.10 \pm 0.29	11.20 \pm 0.26	11.40 \pm 0.25	11.50 \pm 0.18
MA1250 ^b	10.10 \pm 0.21	10.50 \pm 0.27	11.50 \pm 0.37	12.15 \pm 0.29	11.15 \pm 0.15

* Values with different superscripts within column were significantly different(p<0.05)

mg/dl). Nyda et al. (1948) reported that concentrations of serum P was on the increase in ovariectomy, Whereas Ohta et al. (1992b) reported that both concentrations of serum Ca and P was on the increase in ovariectomy.

6. The Changes in the Concentration of Serum P

Table 7 shows the consecutive changes in concentrations of serum P in control, SO, OG, FA and MA groups. The levels of serum P in OG group was similar to those in control group (in 5 weeks, 7.14 ± 0.33 mg/dl vs 7.12 ± 0.25 mg/dl). Moreover the treatment of antler-extract did not affect the concentration of serum P in FA and MA groups compared to those in OG group. Nyda et al.

(1948) reported that concentrations of serum P was on the increase in ovariectomy, Whereas Ohta et al. (1992b) reported that both concentrations of serum Ca and P was on the increase in ovariectomy. In our works, the concentration of serum P in OG group was little higher than those in control group but was insignificant.

7. The Changes in the Activity of Serum ALP

The changes of serum ALP activity is more dramatic than others in this works. As shown in Table 8, the activities of serum ALP in OG group significantly increased after 2 weeks of operation compared to those of control group (i.e., 154.2 ± 7.6 IU ~ 336.9 ± 7.7 IU vs 144.1 ± 3.5 IU ~ $153.2 \pm$

Table 7. Effects of female or male antler extract on serum phosphorus levels in ovariectomized rats

Experimental group	P concentration (mg/dl \pm SD)				
	1	2	3	4	5(w)
Control ^a	6.98 ± 0.33	7.04 ± 0.24	7.05 ± 0.25	7.11 ± 0.18	7.12 ± 0.25
SO	7.10 ± 0.25	7.18 ± 0.28	7.12 ± 0.14	6.99 ± 0.24	7.14 ± 0.25
OG ^b	7.44 ± 0.20	7.36 ± 0.23	7.65 ± 0.33	7.34 ± 0.45	7.44 ± 0.33
FA 625	7.10 ± 0.52	7.28 ± 0.41	7.45 ± 0.55	7.53 ± 0.44	7.65 ± 0.48
FA1250 ^b	7.32 ± 0.45	7.48 ± 0.50	7.59 ± 0.28	7.44 ± 0.33	7.84 ± 0.57
MA 625	7.24 ± 0.33	7.50 ± 0.33	7.40 ± 0.24	7.15 ± 0.33	7.16 ± 0.31
MA1250	7.14 ± 0.33	7.50 ± 0.26	7.40 ± 0.33	7.25 ± 0.45	7.16 ± 0.36

* Values with different superscripts within column were significantly different ($p < 0.05$)

Table 8. Effects of female or male antler extract on serum ALP levels in ovariectomized rats

Experimental group	ALP concentration (IU \pm SD)				
	1	2	3	4	5(w)
Control ^a	142.3 ± 4.2	153.2 ± 3.8	143.7 ± 4.4	146.7 ± 3.8	144.1 ± 3.5
SO ^b	135.8 ± 4.6	137.4 ± 4.1	140.0 ± 3.2	136.6 ± 4.4	138.1 ± 3.4
OG ^b	154.2 ± 7.6	320.8 ± 5.5	347.3 ± 7.2	335.3 ± 6.5	336.9 ± 7.7
FA 625	147.3 ± 6.1	164.3 ± 4.5	164.9 ± 4.5	165.3 ± 4.9	152.1 ± 3.8
FA1250 ^b	148.2 ± 4.7	155.8 ± 5.3	160.8 ± 4.1	155.9 ± 4.6	153.3 ± 4.5
MA 625 ^b	168.5 ± 5.9	176.5 ± 6.6	164.3 ± 5.2	156.4 ± 4.4	155.5 ± 5.7
MA1250	165.3 ± 4.7	162.3 ± 5.3	160.5 ± 4.7	157.8 ± 4.8	149.4 ± 5.4

* Values with different superscripts within column were significantly different ($p < 0.05$)

3.8IU, $p < 0.05$). In agreement with this, Ohta et al. (1992a) reported that the increase of serum P in ovariectomy is due to the up-regulation of bone exchange rate. Serum ALP is known to be the biochemical marker in osteosynthesis, which is synthesized in osteoblast and liver (Meller et al., 1984). In addition, serum ALP fluctuates depending on age, sex, and menopause. The activity of ALP in male is higher than in female, but after menopause the activity of it increases (Ohta et al., 1992b).

IV. 요약

본 연구는 골다공증유발 rat에 녹용추출물의 투여가 예방 및 치료효과에 미치는 영향을 구명하고자, 양측 난소를 적출한 후 골다공증이 유발된 rat에 암, 수녹용 추출물 625, 1,250 mg/kg을 5주간 투여하면서 혈청중 estradiol, progesterone, calcitonin, osteocalcin 농도와 Ca, P 및 ALP 함량변화 등을 조사하였다.

1. 난소적출 후 골다공증이 유발된 rat에 암, 수녹용 추출물 625mg/kg, 1,250mg/kg을 각각 투여했을 때 혈청내 estradiol 수준은 난소적출군이 $20.80 \pm 1.86 \sim 40.50 \pm 3.34$ pg/ml로서 정상대조군의 $49.50 \pm 2.70 \sim 50.80 \pm 3.13$ pg/ml에 비하여 유의한 감소를 나타냈다 ($p < 0.05$).
2. 골다공증 유발 rat에 암, 수녹용 추출물 625 mg/kg, 1,250mg/kg을 각각 투여했을 때 혈청중 progesterone 수준은 정상대조군의 $50.90 \pm 3.63 \sim 53.40 \pm 2.74$ ng/ml에 비하여 큰 차이를 나타내지 않았다.
3. 골다공증 유발 rat에 암, 수녹용 추출물 625 mg/kg, 1,250mg/kg을 투여했을 때 혈청중 calcitonin수준은 정상대조군의 $0.64 \pm 0.03 \sim 0.68 \pm 0.04$ pg/ml에 비하여 약간 높은 증가를 나타냈으며 특히, 난소적출군은 대조군에 비해 현저한 감소를 나타냈다.
4. 골다공증 유발 rat에 암, 수녹용 추출물 625 mg/kg, 1,250mg/kg을 각각 투여했을 때 혈청

중 osteocalcin 수준은 정상대조군의 $0.28 \pm 0.02 \sim 0.31 \pm 0.02$ ng/ml에 비하여 약간 높은치를 나타냈다. 한편, 암, 수녹용 추출물의 처리군의 osteocalcin치는 암컷녹용 추출물 처리군이 약간 높았으나 유의성은 인정되지 않았다.

5. 골다공증유발 rat에 암, 수녹용 추출물을 투여했을 때 혈청중 Ca, P 함량은 각각 정상대조군에 비하여 약간 높은치를 나타냈으며, 난소적출 무처치군은 대조군에 비해 유의한 증가를 나타냈다 ($p < 0.05$).
6. 골다공증유발 rat에 암, 수녹용 추출물을 투여했을 때 혈청중 ALP 함량은 정상대조군에 비하여 증가치를 나타냈으며, 암, 수사슴녹용 추출물의 처리군중 대조군과 FA1,250 처리군과 MA625 처리군간에 유의한 변화가 인정되었다 ($p < 0.05$).

위의 결과들에서 암, 수녹용 추출액은 난소제거 후의 estrogen의 감소를 억제시키고 골소실을 억제하므로 골다공증의 예방과 치료에 효과가 있는 것으로 판단된다.

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- (접수일자: 2000. 3. 4. / 채택일자: 2000. 6. 14.)