International Journal of Sport Nutrition and Exercise Metabolism, 2005, 15, 366-385

Effect of Elk Velvet Antler Supplementation on the Hormonal Response to Acute and Chronic Exercise in Male and Female Rowers

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To examine the effects of elk velvet antler supplementation (EVA) combined with training on resting and exercise-stimulated hormonal response, male ($n = 25$) and female ($n = 21$) rowers ingested either EVA (560 mg/d) or placebo (PL) during 10 wk of training. VO_{2max}, 2000 m rowing time, leg and bench press strength were determined before and after 5 and 10 wk of training. Serum hormone levels were measured prior to and 5 and 60 min after a simulated 2000 m rowing race. VO_{2max} and strength increased and 2000 m times decreased similarly ($P < 0.05$) with training. There was no significant difference between the EVA and PL group for any hormonal response. Testosterone (males only) and growth hormone (both genders) were higher 5 min after the simulated race ($P < 0.05$) but returned to baseline at 60 min. Cortisol was higher 5 and 60 min compared to rest (both genders) ($P < 0.05$) and was higher 60 min post-exercise following 5 and 10 wk of training. It appears that 10 wk of EVA supplementation does not significantly improve rowing performance nor alter hormonal responses at rest or after acute exercise than training alone.

Key Words: ergogenic, testosterone, cortisol, growth hormone, strength, aerobic endurance

Velvet antler has been used in traditional Oriental medicine for thousands of years as a supplement to treat ulcers, arthritis, anemia, and impotence (16). Taken as a tonic or capsule, velvet antler is regarded as a preventive medicine that purportedly stimulates the cardiovascular, nervous, and endocrine systems (6, 8, 15). Velvet antler might come from various species of deer, Norwegian reindeer, and Canadian elk or wapiti. Sunwoo et al. (15) report that the antler of wapiti can be divided into four different sections (tip, upper, middle, and base), each of which has a varying contribution of protein, collagen, lipid, uronic acid, sulfated glycosaminoglycan (GAG), sialic acid, ash, calcium, phosphorus, and magnesium, dependent on the section of antler. Generally, protein, collagen, ash, calcium, phosphorus, and magnesium increase from tip to base, while the lipids, uronic acid, and sulfated GAG are more concentrated in the tip and upper sections of the antler (15). Other components and growth factors have also been identified in the velvet antler, including

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insulin-like growth factors I and II which have been isolated in deer velvet antler tips (12, 13, 16). Given the chemical composition of velvet antler and the subjective reports of its properties, it is plausible that elk velvet antler supplementation could elicit physiological responses associated with these substances.

Athletes and commercial supplement companies have made anecdotal health and human performance claims about the effects of velvet antler. Velvet antler has been suggested to aid performance, boost stamina, strength, and efficiency, as well as enhance recovery from training and build muscle mass. Observations in mice and rats suggest that deer velvet antler is an immunopotentiating agent, possesses anti-inflammatory properties, and promotes protein synthesis (18, 22). There is little empirical evidence to support these latter claims in humans. Early research examining deer velvet antler supplementation in humans noted gonadotrophic effects or stimulation of the gonads which were linked to improved athletic performance in a 3000 m run (23). More recent and experimentally robust work by Sleivert et al. (14) concluded that deer velvet antler improved isokinetic muscular leg strength in male subjects following a 10-wk resistance training program. Physiological mechanisms could not be identified to explain these responses.

In contrast, elk velvet antler has not been examined for any ergogenic effect it might impart on performance when consumed during training. Similar to deer velvet antler, it is thought that the varied chemical make-up of elk velvet antler could provide precursors or stimulants that could possibly contribute to either a positive anabolic hormone environment, reduced catabolic response, or both. The extent to which male and female athletes might benefit from elk velvet antler supplementation is not known and there is a paucity of peer-reviewed literature that has investigated the overall effect of such products on hormone profiles and athletic performance. Therefore, the purpose of this study was to examine the effects of elk velvet antler supplementation combined with training on resting and exercise-stimulated hormone profiles in men and women. It is hypothesized that subjects who supplemented with elk velvet antler during training will exhibit superior performance compared to subjects training with an identical program, but ingesting a placebo (PL) and this response could differ between men and women. Consequently, it was also hypothesized that subjects who supplemented with EVA would have an enhanced anabolic blood serum profile when compared to the PL group.

Methods

Subjects and Experimental Design

Forty-six healthy male and female volunteers from the University of Alberta and the Edmonton rowing community were randomly assigned by gender into one of two groups: elk velvet antler supplementation (EVA) (12 males, 9 females) or placebo (PL) (13 males, 12 females). The mean ± standard deviation for age, height, and initial body mass of all subjects was 25.3 ± 5.3 y, 174.3 ± 8.2 cm, and 73.0 ± 11.3 kg, respectively. The volunteers were required to have experience with strength and endurance training on indoor rowing machines and were not taking any other supplements. All subjects completed an informed consent and PAR-Q prior to participation. The study was reviewed and approved by the Research Ethics Committee of the Faculty of Physical Education and Recreation at the University of Alberta.

The study was a randomized, double blind, placebo-controlled, pre-, mid (5 wk) and post-test (10 wk) design. The experimental design included 10 consecutive weeks of training for both groups. All subjects performed identical regimes of strength and endurance training on alternate days (6 d/wk). All physiological testing was conducted before and after 5 (mid) and 10 wk of training in the same order at each testing period. All subjects were asked to refrain from any exercise outside of the structured training program for the duration of the study. Subjects in the EVA group consumed one 280 mg velvet antler capsule, twice per day, morning and afternoon, for the 10-wk training period, for a daily total of 560 mg. The EVA was processed utilizing the entire antler from farm-fed, penned Rocky Mountain stock using traditional air-drying, followed by scraping and singeing to remove the fine velvet covering and then ground, mixed, and encapsulated by Royal Elk Products (Sangudo, Alberta). The EVA product was commercially available, harvested, and processed according to industry standards of the Canadian Food Inspection Agency but was not independently analyzed for content. Subjects in the PL group consumed a whole-wheat flour mixture in capsules that were similar in color and texture and prepared by the same manufacturer as the EVA. Both the EVA and PL were packaged in identical bottles, with an independent technician ensuring each subject received the correct treatment.

Physiological Measures

Body mass and height were recorded using a calibrated scale (Sunbeam Products, Purvis, MS) and a wall-mounted tape measure with a set square. A sum of skinfolds was obtained from 6 sites (triceps, subscapular, iliac crest, front thigh, chest, and abdomen (left)—rear thigh is substituted for chest in females) using Harpenden calipers and percentage fat was calculated according to Yuhasz (24). Skinfolds were not measured after 5 wk of training as this was considered to be too short of a time period to show any change in body composition given the type of subject (actively training) and the training program (off-season).

At each testing period, subjects performed, in order, a 2000 m timed simulated rowing race, an incremental exercise test to determine ventilatory threshold (VT) and maximal oxygen consumption (VO_{2max}), and a multiple repetition maximum (mRM) leg and bench press test. All tests were separated by a minimum of 24 h, with the exception of height, body mass, and skinfold measurements, which were performed immediately prior to the VO_{2max} test. The 2000 m rowing performance test involved a simulated rowing time trial on a Concept2 C rowing machine (Concept2, Inc., Morrisville, VT) in which the subjects completed 2000 m as fast as possible after a standardized warm-up (9). Total elapsed and 200 m interval split times, power output (W), stroke rates, and heart rates were recorded during and at the completion of the test.

The combined VT and VO_{2max} test was determined during a continuous incremental test to volitional exhaustion on a Concept2 C rowing ergometer using an established protocol previously reported from our lab (10). Briefly, this test protocol used an initial power output of 50 W and 100 W for women and men, respectively, and was increased by 50 W every 2 min for both genders. Expired gases were collected and analyzed with a Medgraphics CPX/D metabolic cart (Medical Graphics, St. Paul, MN) that was calibrated before and after each test

with known gas concentrations. Heart rate was determined using a Polar Pacer heart rate monitor (Polar Electro, Sweden). VT was determined as the lowest point preceding a systematic increase in the V_E/VCO_2 versus power output curve previously described by Bhambhani and Singh (4). Determination of VT was made by an experienced investigator and was used for prescribing training intensity and not used as a dependent measure in the present study. Criteria for VO_{2max} was a peak and plateau in oxygen uptake (< 100 mL/min) with increasing power output that was associated with secondary criteria including a respiratory exchange ratio greater than 1.1, attainment of age-predicted or known maximum heart rate, and volitional exhaustion.

To determine upper and lower body strength measures, all subjects underwent a multiple repetition maximum (mRM) bilateral machine incline leg press (LP) and a free weight bench press (BP) test, as previously reported by Syrotuik et al. (19). Briefly, this involved measuring the maximum weight that each subject could lift to failure for eight repetitions of each strength exercise using a standardized protocol. Predicted one-repetition maximum (p1RM) strength levels were calculated for bench press and leg press using the prediction equations in the same software package used for the strength training program prescription (B. E. Software, Lincoln, NE).

Hormonal Assessment

Venous blood samples were obtained from an antecubital vein using venipuncture at rest, 5 min, and 60 min after completion of the 2000 m rowing test. Resting blood samples were obtained between 3 and 6 PM on the day prior to the 2000 m rowing test following 24 to 48 h of no training. No EVA or placebo ingestion was permitted on any of the blood sampling days. The late afternoon resting sampling was considered to be a period of relative stability in serum testosterone, when circulating levels are lowest during the 24-h cycle (7). Whole blood was allowed to clot at room temperature for approximately 30 to 45 min and immediately centrifuged thereafter at 3000 *g* for 10 min. Serum was aliquoted and stored frozen at –80 °C until final analyses. All samples were thawed once and analyzed in duplicate, using commercially available radioimmunoassay kits for free testosterone, human growth hormone (DiaSorin, Stillwater, MN), total testosterone, and cortisol (Diagnostic Products Corp., Los Angeles, CA). Samples were decoded after all analyses were completed to ensure a blinded procedure. The mean coefficients of variation between the duplicate samples of each RIA for growth hormone, total testosterone, free testosterone, and cortisol were 5.8, 9.5, 7.9, and 6.6%, respectively.

Physical Training

Subjects completed a 10-wk training program, consisting of three strength and three endurance training sessions per week. Strength training consisted of four core (bench press, lat pulldowns, seated rows, and bilateral incline leg press) and six supplemental (upright rows, bicep curls, triceps pushdowns, knee flexion, knee extension, and calf raises) exercises. Initial training loads were established from the mRM strength assessment on each exercise, as previously noted. Volume and intensity were progressively overloaded using a periodized program with the aid of a computer software program (B. E. Software) (19). Core lifts were progressively

overloaded using 70 to 95% of predicted 1RM and between 2 to 10 repetitions for 4 to 5 sets while supplementary lifts were overloaded using ranges of 65 to 85% of predicted 1RM, 8 to 10 repetitions for 2 to 3 sets. This strength training program was similar to previous prescriptions used in our lab and has been found to elicit significant strength improvements (2, 3, 10, 20).

Endurance training was performed 3 d/wk on alternate days to the strength training. This training consisted of two continuous and one interval training session per week on Concept2 rowing machines. The first continuous training session each week was set at an intensity equivalent to just below VT and the second was set at an intensity just above VT. Both of these intensities were upgraded by increasing the intensity by approximately 5% after 5 wk of training to insure a training overload occurred. The interval training sessions were 500 m of high intensity rowing interspersed with 500 m of moderate intensity rowing. The interval intensity was equivalent to that which was maintained during the 2000 m simulated rowing race and was upgraded in a similar manner to the continuous sessions after 5 wk of training. The weekly volume of endurance training increased every 2 wk, beginning at 20,000 m and increasing to 27,500 m after 10 wk. All subjects wore HR monitors during the endurance training; the sessions were supervised and training logs were used to record heart rate, average stroke rate, total time, 500 m split times, and total distance rowed.

Statistical Analyses

Performance and physiological data were analyzed using a 3-way ANOVA (gender × supplementation group × training period), which involved a comparison between gender and group (EVA and PL) over the course of the 10-wk training period (repeated measures) using a commercially available software package (Statistica, Inc., Oklahoma City, OK). Each hormone was analyzed with a separate 4-way ANOVA (gender × supplementation group × before and twice after an acute rowing exercise intervention × before and after training) with repeated measures on the last 2 variables (rowing exercise intervention and training period). Note that the acute rowing exercise intervention used was the 2000 m simulated rowing race. Post hoc comparisons were performed on significant F ratios using a Newman-Keuls multiple comparison procedure. Results were considered significant at $P < 0.05$ for all analyses. All data are means ± standard deviation unless otherwise noted.

Results

Effect of Training and EVA Supplementation on the Physiological and Performance Variables

The EVA and PL groups were similar in mean age, height, body mass, and body composition. Note that there were anticipated differences in various absolute dependent variables such as body mass, body fat, sum of skinfolds, VO_{2max}, and strength levels between males and females. This was the result of a significant main effect that was observed for gender that revealed a significant difference between body mass, percentage body fat, and the sum of skinfolds between males and females (Table 1). There was a significant main effect as well for the training period for sum

Table 1 The Effects of Elk Velvet Antler (EVA) and Placebo (PL) Supplementation on Body Mass (BM), Percent Body Fat (BF), and Sum of Skinfolds (SS) Before and After 5 and 10 Wk of Training

		Training	BM (kg)	BF (%)	SS (mm)
Male[a]	EVA	Before	76.0 ± 7.1	11.3 ± 5.0	75.1 ± 41.2
		5 wk	76.4 ± 6.6		
		10 wk	76.0 ± 6.3	10.6 ± 4.3[b]	68.4 ± 34.3[b]
	PL	Before	79.1 ± 10.6	11.6 ± 4.6	78.4 ± 43.5
		5 wk	79.1 ± 10.1		
		10 wk	78.4 ± 9.2	10.9 ± 4.4[b]	71.4 ± 40.9[b]
Female	EVA	Before	70.2 ± 12.2	27.7 ± 11.2	148.0 ± 51.5
		5 wk	71.3 ± 12.0		
		10 wk	70.8 ± 11.7	26.6 ± 11.0[b]	143.3 ± 50.8[b]
	PL	Before	65.3 ± 11.4	23.2 ± 9.4	125.7 ± 44.3
		5 wk	65.6 ± 10.8		
		10 wk	66.3 ± 11.7	22.2 ± 8.1[b]	121.2 ± 38.7

Table 2 The Effects of Elk Velvet Antler (EVA) and Placebo (PL) Supplementation on 2000 m Simulated Rowing Race Time Before and After 5 and 10 Wk of Training

		Training	2000 m time (s)
Male[a]	EVA[d]	Before	461.8 ± 37.3
		5 wk	437.7 ± 24.2[b]
		10 wk	427.6 ± 22.4[c]
	PL	Before	463.3 ± 38.0
		5 wk	438.2 ± 25.6[b]
		10 wk	430.3 ± 22.1[c]
Female	EVA[d]	Before	515.6 ± 34.3
		5 wk	490.0 ± 27.1[b]
		10 wk	480.0 ± 21.5[c]
	PL	Before	561.1 ± 41.1
		5 wk	523.4 ± 30.0[b]
		10 wk	509.6 ± 29.7[c]

Note. Values are means ± standard deviation. [a]males significantly different from females, $P < 0.05$; [b]significantly different from before training, $P < 0.05$; [c]significantly different from before and after 5 wk of training, $P < 0.05$; [d]significantly different from the PL group, $P < 0.05$.

of skinfolds and percentage body fat. The multiple comparison analysis showed that the sum of skinfolds and percentage body fat before and after 10 wk of training for both groups was reduced. No significant changes were detected in total body mass between the start of training and after 5 and 10 wk of training.

There was a main effect for gender on the 2000 m performance times that illustrated that males simulated rowing race times were significantly faster than female rowers. There was a main effect for training period and the subsequent multiple comparison analysis showed that both male and female rowers decreased performance times after 5 and 10 wk of training (Table 2). No interaction effect was observed between groups and 2000 m rowing time, indicating that the improvements in 2000 m rowing time were not different between the EVA and PL groups. As a product of the randomization to the EVA and PL groups, there was a significant main effect for group with the EVA group exhibiting faster 2000 m times at baseline and this difference was maintained after 5 and 10 wk of training.

There was a main effect for gender with males generating significantly higher relative and absolute $VO_{2\,max}$ scores than females at all time periods (see Table 3). Compared to baseline, there was a significant main effect for training period that illustrated an increase in both relative and absolute VO_{2max} scores after 5 and 10 wk of training regardless of gender and experimental group. No other significant effects were observed.

Table 3 The Effects of Elk Velvet Antler (EVA) and Placebo (PL) Supplementation on $VO_{2\,max}$ Before and After 5 and 10 Wk of Training

		Training	$VO_{2\,max}$ (L/min)	$VO_{2\,max}$ ($mL \cdot kg^{-1} \cdot min^{-1}$)
Male[a]	EVA	Before	3.5 ± 0.4	46.4 ± 5.8
		5 wk	3.9 ± 0.3[b]	51.2 ± 4.0[b]
		10 wk	4.2 ± 0.5[c]	55.0 ± 4.0[c]
	PL	Before	3.7 ± 0.5	47.3 ± 8.3
		5 wk	4.1 ± 0.4[b]	52.1 ± 6.9[b]
		10 wk	4.4 ± 0.4[c]	56.7 ± 7.0[c]
Female	EVA	Before	2.7 ± 0.3	39.0 ± 5.1
		5 wk	3.0 ± 0.4[b]	43.1 ± 5.3[b]
		10 wk	3.3 ± 0.3[c]	46.6 ± 4.5[c]
	PL	Before	2.3 ± 0.5	36.0 ± 5.0
		5 wk	2.8 ± 0.5[b]	42.2 ± 6.2[b]
		10 wk	2.9 ± 0.5[c]	44.3 ± 6.6[c]

Note. Values are means ± standard deviation. [a]males significantly different from females, $P < 0.05$; [b]significantly different from before training, $P < 0.05$; [c]significantly different from before and after 5 wk of training, $P < 0.05$.

As expected, there was a main effect for gender for males and females in bench and leg press scores and a main effect for the training period (Table 4). Males had a significantly higher bench press and leg press strength scores than females at all time periods. The multiple comparison analysis showed that both male and female rowers increased strength in both bench and leg press scores after 5 and 10 wk of training regardless of the experimental group to which they were randomly assigned.

Effect of Training and EVA Supplementation on Serum Hormone Concentrations

Figures 1, 2, 3, and 4 illustrate the effects of EVA supplementation and the PL condition on serum hormone concentrations at rest as well as 5 and 60 min after the acute rowing exercise intervention (i.e., the 2000 m simulated rowing race), before, mid-way (5 wk) and after 10 wk of training in both genders. Overall, EVA supplementation was not significantly different from the PL supplementation group in any of the serum hormone measures for both genders.

Total and Free Testosterone

There was a significant main effect for gender and rowing exercise intervention and a significant interaction between these 2 levels (gender × rowing exercise intervention) for total and free testosterone. The main effect for gender indicated that as

Table 4 The Effects of Elk Velvet Antler (EVA) and Placebo (PL) Supplementation on Bench Press (BP) and Leg Press (LP) Predicted One-Repetition Maximum (p1RM) Strength Before and After 5 and 10 Wk of Training

		Training	p1RM BP (kg)	p1RM LP (kg)
Male[a]	EVA	Before	72.0 ± 15.6	293.0 ± 43.1
		5 wk	78.3 ± 17.4[b]	329.6 ± 62.1[b]
		10 wk	80.8 ± 15.1[c]	344.8 ± 56.1[c]
	PL	Before	79.0 ± 10.3	293.3 ± 56.2
		5 wk	80.6 ± 12.4[b]	323.0 ± 61.1[b]
		10 wk	82.9 ± 11.2[c]	330.1 ± 61.0[c]
Female	EVA	Before	39.7 ± 6.3	145.3 ± 38.7
		5 wk	42.0 ± 6.9[b]	173.2 ± 49.6[b]
		10 wk	44.7 ± 8.4[c]	195.8 ± 56.7[c]
	PL	Before	37.9 ± 8.7	139.8 ± 69.0
		5 wk	40.3 ± 8.1[b]	157.8 ± 53.2[b]
		10 wk	44.3 ± 9.0[c]	175.9 ± 47.4[c]

Note. Values are means ± standard deviation. [a]males significantly different from females, $P < 0.05$; [b]significantly different from before training, $P < 0.05$; [c]significantly different from before and after 5 wk of training, $P < 0.05$.

anticipated, females had lower serum concentrations of total testosterone and free testosterone compared to males (Figure 1 and 2). The multiple comparison procedure performed on the interaction between gender and rowing exercise response revealed a significant increase in total and free testosterone at 5 min after an acute 2000 m simulated rowing exercise intervention in both the EVA and PL groups. This response was observed in the males only. Sixty minutes after exercise, these values were significantly lower from the 5-min post-rowing exercise measurements for the males. Females did not exhibit any significant changes in testosterone with the rowing exercise intervention nor were there any significant effects of training or EVA supplementation on total or free testosterone in either gender.

Growth Hormone

Growth hormone (GH) exhibited a significant interaction effect for gender and acute rowing exercise response (Figure 3). Both genders regardless of group (EVA vs. PL) and training, had a significant elevation in GH, 5 min after the acute rowing exercise intervention that was significantly lower 60 min post-exercise but this latter value remained elevated ($P < 0.05$) above the pre-exercise value in males but not females.

Cortisol

A significant interaction effect for the acute rowing exercise intervention and training was observed for serum cortisol concentration (Figure 4). Cortisol concentrations at 5 and 60 min post-rowing exercise were significantly higher than rest in both genders and treatment groups compared to before training. The 5 min post-rowing exercise serum cortisol levels were significantly elevated after 5 and 10 wk of training. The 60 min post-rowing exercise serum cortisol value was significantly greater after 10 wk of training compared to before or after 5 wk of training.

Discussion

The primary aim of this study was to investigate the effects of EVA supplementation during 10 wk of concurrent strength and endurance training on resting and post-rowing exercise-stimulated serum hormone levels and other physiological adaptations and also to determine if gender responses differed. Based on the limited research that has been published on the possible ergogenic effects of supplementation with deer velvet antler products, we speculated that EVA possesses inherent properties that would possibly influence endogenous endocrine function and potentially augment the training effect beyond that of training alone. The main finding from this investigation was that the daily ingestion of 560 mg of EVA during a 10 wk concurrent strength and endurance training program did not alter any measured hormonal or physiological response compared to a placebo condition using a double blind, randomized study of male and female athletes (rowers). Acute rowing exercise and training did, however, exhibit some predictable physiological changes in hormonal responses and performance indicators. Therefore, the data from the present study does not support an ergogenic effect of EVA for resting or rowing exercise-stimulated hormone concentrations or for any training-induced physiological or performance adaptation measured in this study beyond

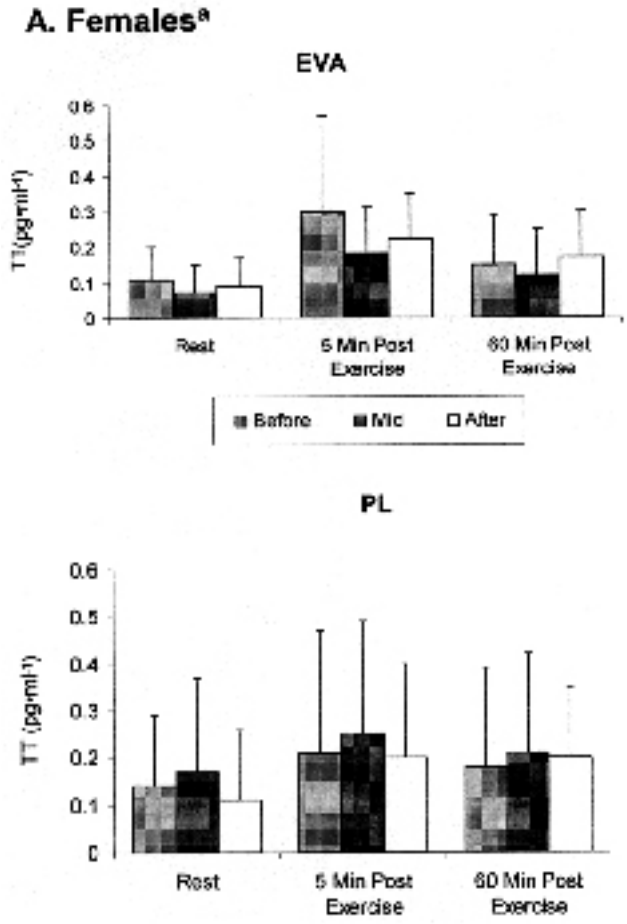

Figure 1—The effect of 5 and 10 wk of physical training combined with velvet antler (EVA) supplementation or placebo condition on serum total testosterone (TT) response at rest and after 5 and 60 min of exercise in females (A) and males (B).
All values are means ± standard deviation.
a = main effect for gender indicating that females were different from males ($P < 0.05$).
b = different from rest ($P < 0.05$).
c = different from 5 min after exercise ($P < 0.05$).

that which occurs from physical training based on the type of EVA product used in this experiment.

Little research has been published examining the effects of any type of velvet antler supplementation on human physiological responses, especially using acute exercise and training, despite some research on the effects of velvet antler using animal models without exercise (17, 21, 22). Clifford and colleagues (6) examined the effects of an extract made from the antlers of Korean deer delivered

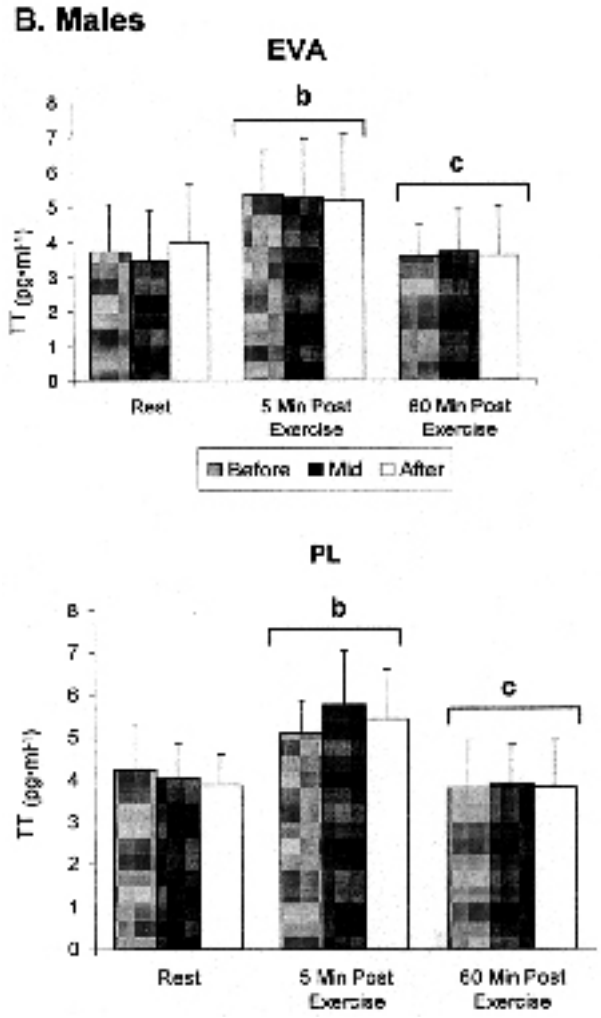

Figure 1—(*continued*)

intravenously on resting cardiovascular dynamics of dogs. They observed a significant elevation in stroke volume at rest during two time periods when the antler extract was administered. No other cardiovascular parameters were altered, however, leading these authors to conclude that deer antler extract did not have an acute effect on cardiovascular function. In the present study, there was no effect of EVA supplementation on any of the cardiorespiratory fitness parameters.

Wang et al. (21) reported an increase in resting plasma testosterone concentration and superoxide dismutase activity concurrent with a decrease in malonydialdehyde following repeated administration of deer antler extract in senescence-accelerated mice but other behavioral, appearance, or biochemical

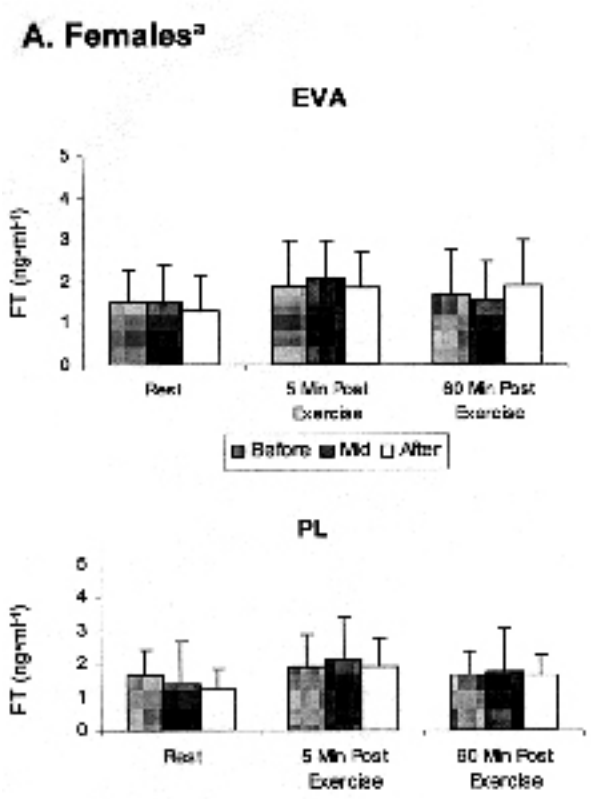

Figure 2—The effect of 5 and 10 wk of physical training combined with velvet antler (EVA) supplementation or placebo condition on serum free testosterone (FT) response at rest and after 5 and 60 min of exercise in females (A) and males (B).
All values are means ± standard deviation.
a = main effect for gender indicating that females were different from males ($P < 0.05$).
b = different from rest ($P < 0.05$).
c = different from 5 min after exercise ($P < 0.05$).

markers were not influenced by velvet antler administration. These authors were unable to explain the exact mechanism(s) of their findings and the increased resting total testosterone levels in the senescence-accelerated mice is in contrast to the lack of any change in free or total testosterone at rest or after exercise in the young, human subjects of the present study. In a separate report using the same animal model (senescence-accelerated mice), in vivo protein synthesis was stimulated in the liver and kidney of senile mice treated with deer velvet antler extract but no changes were observed in brain, testes, or heart tissue of the same animals (22). Unfortunately, skeletal muscle measurements were not performed. Body composition was unaltered with EVA in the present study, however, providing some indirect

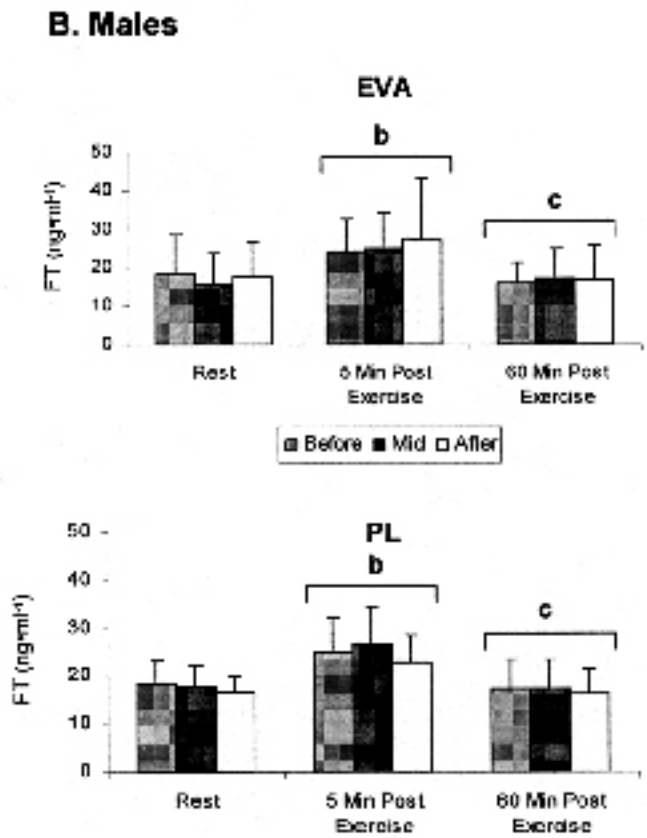

Figure 2—(*continued*)

support that an accelerated increase in lean body mass beyond that stimulated by physical training alone was not observed.

Zhou et al. (26) showed accelerated fracture healing through a stimulation of chondrocytes and osteoblast precursors in cultured cells that were incubated with velvet antler. In addition, repeated administration of deer velvet antler extract was shown to inhibit analgesic tolerance to morphine administration in mice (11). Kim et al. (11) speculated that this effect of velvet antler might be due to increased detoxification through elevated glutathione levels brought about by an increase in precursors (cystine/cysteine found in keratin of velvet antler) for glutathione production. This pathway, however, was not assessed and remains to be examined. These findings suggest that EVA stimulated some physiological effects in animals but these are few and noted in limited experimental models (senescence-accelerated

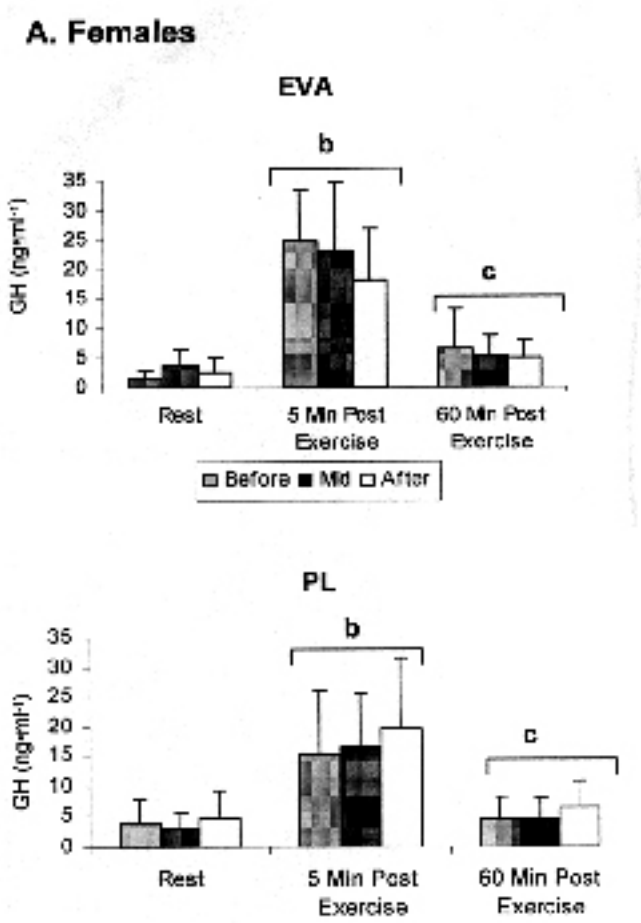

Figure 3—The effect of 5 and 10 wk of physical training combined with velvet antler (EVA) supplementation or placebo condition on serum growth hormone (GH) response at rest and after 5 and 60 min of exercise in females (A) and males (B).
All values are means ± standard deviation.
b = different from rest ($P < 0.05$).
c = different from 5 min after exercise ($P < 0.05$).

mice, cell cultures). Little empirical evidence supports any role of velvet antler for enhancing human physiological processes especially when coupled with exercise, despite anecdotal claims.

Recently, Sleivert et al. (14) examined deer velvet antler (DVA) supplementation in humans with both an extract and powdered form combined with a strength training program and found no difference between the DVA and placebo supplement groups. Both groups significantly increased 6RM squat strength similarly at each testing session over the 10-wk training period. The researchers detected a

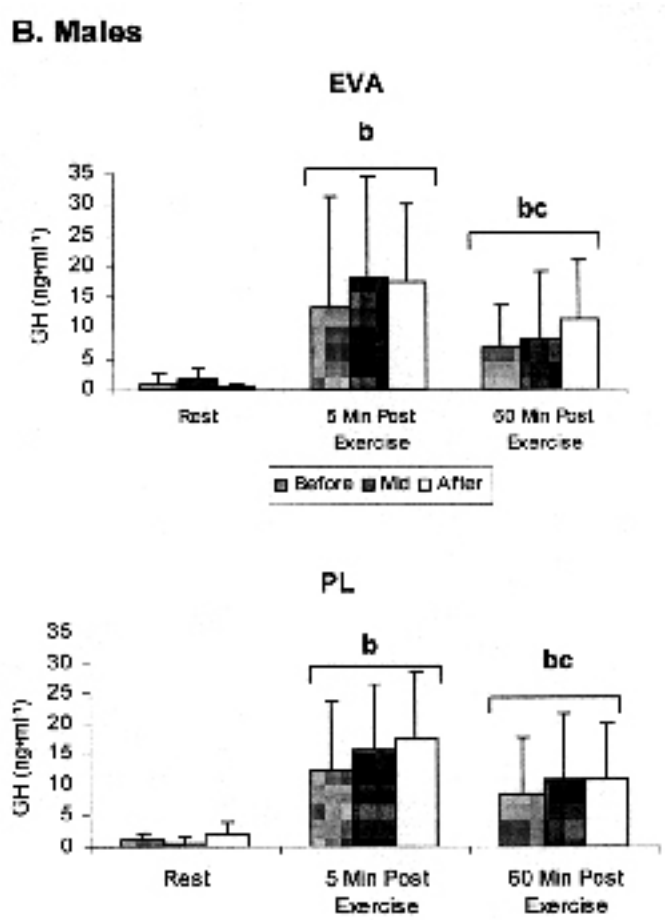

Figure 3—(*continued*)

significantly greater increase in isokinetic knee extension strength and endurance in the DVA-supplemented subjects compared to the placebo group. The improvements in isokinetic strength could not be linked to an enhanced anabolic hormonal environment, as there were no differences in total serum testosterone levels after training. This latter finding is in agreement with the results of the present study. These researchers did not elucidate the reason(s) for the significantly greater increase in isokinetic knee strength and muscular endurance but this might have been due to the lower initial isokinetic strength levels in the DVA group before the start of the training program compared to the other groups. As suggested by Sleivert et al. (14) it is known that when exposed to the same training stimulus, individuals with lower levels of physiological function can adapt to a greater extent than individuals starting at a higher level of initial physiological function (5). Another possible explanation for the increased muscular strength and endurance in the DVA group is

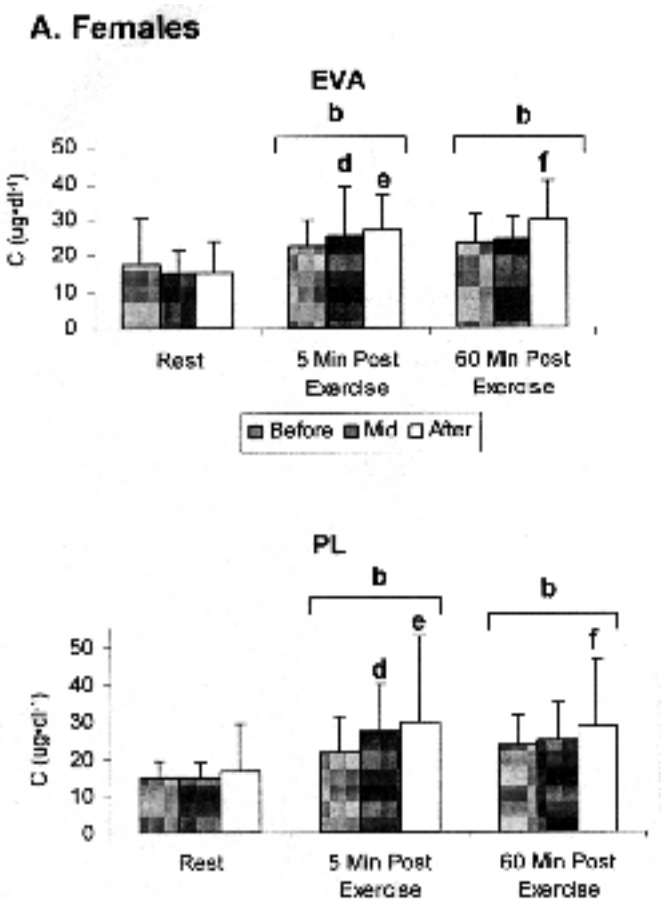

Figure 4—The effect of 5 and 10 wk of physical training combined with velvet antler (EVA) supplementation or placebo condition on serum cortisol (C) response at rest and after 5 and 60 min of exercise in females (A) and males (B).
All values are means ± standard deviation.
b = different from rest ($P < 0.05$).
d = the 5 min post-exercise value after 5 wk of training was different from before training ($P < 0.05$).
e = the 5 min post-exercise value was significantly different after 10 wk of training compared to before and after 5 wk of training ($P < 0.05$).
f = the values 60 min post-exercise were different after 10 wk of training compared to before and after 5 wk of training ($P < 0.05$).

in the differential processing methods used to create the powder and extract forms of deer velvet antler (14). The processing method used to create the powder form of deer velvet antler could have influenced the "active" properties of the supplement, resulting in greater training effects (14).

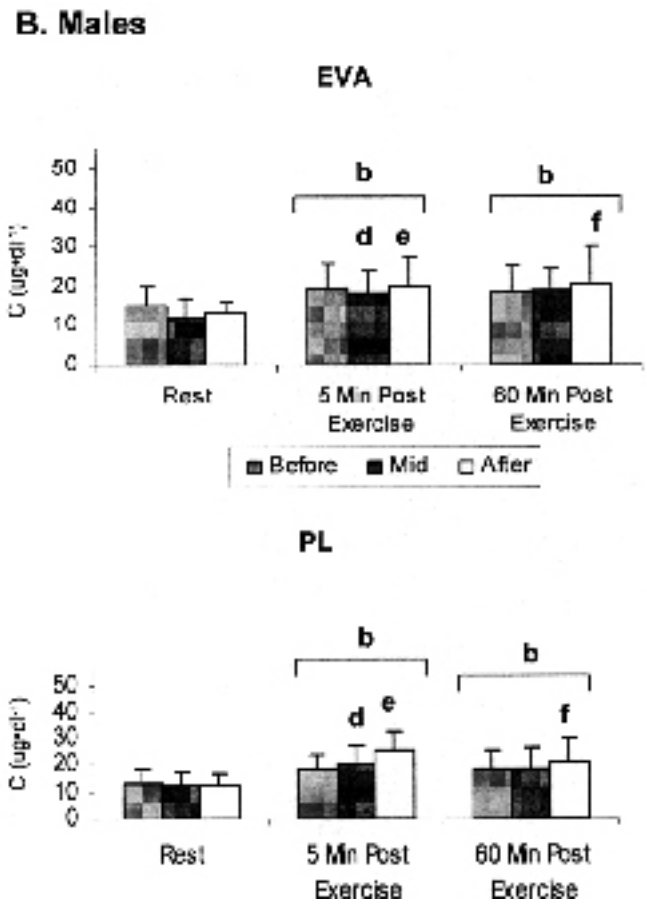

Figure 4—(*continued*)

Both genders in the EVA and PL supplementation groups in the present study achieved similar relative physiological and performance adaptations from the training program despite some observed predictable differences between genders in some of the hormonal responses to acute exercise. We observed similar changes between groups in body composition, strength, peak oxygen consumption, rowing performance, and both resting and post-exercise hormone concentrations. The type of training accompanied by these improvements is consistent with other research from our laboratory that has examined the effects of concurrent strength and endurance training in rowers (2, 3). Due to the double blind design and the precise control of the exercise training prescription and other experimental procedures, we conclude that EVA administration using the prescribed dosage did not influence specific hormone levels at rest or after exercise nor was it able to alter other body composition, cardiorespiratory, strength, or sport-specific performance variables beyond the placebo condition.

There are a few limitations in velvet antler research in humans and in our study that should be noted. First, there has not been an adequate dose-response study using elk velvet antler with human subjects. The exact dosage of velvet antler required to elicit an increase in the appearance of velvet antler components in the blood or peripheral tissues of human subjects is not currently known. Allen et al. (1) reported no significant differences in adverse events or health status of rheumatoid arthritis patients that were administered a daily total of either 430, 860, or 1290 mg of elk velvet antler in capsule form. Sleivert et al. (14) prescribed 1500 mg/d of deer velvet antler powder and 300 mg/d of the deer velvet antler extract to their research subjects. We used 560 mg/d; the maximal dosage permitted by our board of ethics that was also the recognized industry standard at the time of this experiment. It remains possible that the reported dosages used in the literature were not sufficient to trigger a particular response in human subjects. Zhang et al. (25) reports that either an acute (2 g/kg body weight) or chronic (90 d at a dose of 1 g/kg) dose of deer velvet antler powder given to rats significantly increased liver weight without toxicological or histopathological abnormalities in numerous targeted tissues. In relative terms, this latter dosage (1 g/kg) represents the ingestion of 70 g for a 70 kg human per day. This dosage greatly exceeds the highest dose used in humans reported in the literature (14). It should be noted that there has been some concern reported regarding the lack of information on the potential toxicology of velvet antler administration (18). Other limitations noted include the type of administration (e.g., oral, injection), the type of velvet antler (e.g., deer, wapiti) and the form (e.g., powder, extract) that is used in the research literature. Finally, the potency of the EVA used in the present study might have been negatively altered by the processing method. The EVA used in this study was processed using a traditional dry heat method, governed by the Canadian Food Inspection Agency guidelines of the time. Extended heat processing could have reduced the overall product quality compared to newer industry standards which now employ freeze-drying methods. Additional research is needed to address these limitations in human research with velvet antler supplementation.

Conclusion

Findings from the present study do not support the hypothesis that 10 wk of EVA supplementation at 560 mg/d combined with strength and endurance training enhances serum hormone or other physiological and performance indicators greater than training alone in male and female rowers. The EVA group did not demonstrate altered resting serum blood concentrations of testosterone or human growth hormone nor an enhanced overall anabolic environment compared to those who trained without EVA supplementation. Although both training groups experienced significant improvements in their 2000 m stimulated rowing times, the EVA group did not have significantly faster 2000 m rowing performance times at either the mid (5 wk) or post (10 wk) testing periods when compared to the PL group. Thus, although the EVA supplementation did not appear to enhance performance, neither did the supplementation hinder performance in either group. It is possible that the anecdotal claims made by some elite athletes concerning EVA supplementation are purely psychological or these purported benefits might be a result of a different elk velvet antler composition or processing method than the EVA used in the

current study. From a practical perspective, the short-term EVA supplementation used in this study, when coupled with training does not appear to give athletes a physiological advantage to rowing performance. Further research, however, is necessary to confirm these findings.

Acknowledgments

This study was supported by the Alberta Elk Farmers Association, Royal Elk Products, and the Sport Science Association of Alberta. The authors appreciate the editorial support of Carmen McConnell in the preparation of this article.

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