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DeerVelvet

Technical manual

New Zealand
Deer Products

17 ATHLETIC PERFORMANCE

17.1 Health Benefits

Sports people whether professional or amateur continuously strive to improve physical performance. The discipline of sports nutrition has arisen from the need to combine training, responses to injury and diet to ensure the best possible athletic performance. Velvet antler is well placed to impact on sports nutrition. In Russia, Korea and China, velvet antler is widely used by athletes to enhance performance. In the West, more and more athletes are looking to velvet antler as a training aid, a promoter of recovery after physical activity and injury, and possibly an injury preventive.

17.2 Suggested Physiological Rationale

Athletic performance is a very complex issue. Velvet antler could improve athletic performance in many different ways, for example by assisting strength and endurance (stamina), by enhancing the oxygen-carrying capacity of the blood, by facilitating minor tissue damage occurring either during training or competition, and by boosting the immune system of athletes whose immune system has been compromised as a result of extreme exertion. These broadly reflect the protective and restorative effects of velvet antler.

The effects of velvet antler on athletic performance are likely to be complex and they will be influenced by many factors, such as the type of velvet antler extract and the dose. Not all athletes are likely to benefit from taking velvet, and individual variation in response coupled with the requirements of the athlete will also affect the outcome.

17.3 Research Support

A strong body of evidence supporting the use of deer velvet for enhancement of athletic performance is developing. Importantly, the research includes double-blind studies conducted in humans, as well as animal studies.

Efficacy studies in humans

In Russia, Yudin and Dobyrakov (1974) studied the effect of alcohol velvet antler extracts on the static load-bearing capacity (holding a weight at rest above a gymnasium bench) of healthy sportsmen. The velvet extracts increased the time of work by 2–4 seconds compared with control sportsmen. In tests of dynamic work using a veloergometer, velvet antler alcohol extract (Pantocrine) treatment increased the work output of sportsmen 4- to 5-fold compared with the work output of sportsmen not treated with extract.

Taneyeva (quoted by Brechman, undated) tested the effect of Pantocrine in athletes running 3,000 metres. The time for 50 men aged between 18 and 23 years old to each complete the run was recorded. A single administration of 20 ml velvet antler extract 30 minutes before a repeat of the run lowered the average time to complete the event from 14 minutes 48 second to 14 minutes 4 seconds. In a second experiment the alcohol velvet antler extract was administered for 12 days and the race was re-run 24 hours after the last treatment. The time taken to complete

the event was reduced in the majority of subjects. Interestingly, improvement was noted in above-average as well as below-average athletes.

Strength training study 1

More recently, a collaborative trial was carried out in New Zealand by AgResearch Invermay and the School of Physical Education at the University of Otago in Dunedin (Sleivert *et al.* 2003). The aim was to determine whether velvet antler could improve gains made during strength training in male athletes. Thirty eight active males were randomly assigned in a double-blind fashion to either velvet extract (n=12), velvet powder (n=13) or placebo control groups (n=13). The velvet was given at a rate of 300 mg extract or 1,500 mg powder daily, which were approximately equivalent doses based on yield of extract. Subjects were tested prior to beginning supplementation and a 10-week strength programme and again immediately post-training. All subjects were measured for circulating levels of testosterone, IGF-I, erythropoietin, red cell mass, plasma volume and total blood volume. Additionally muscular strength and endurance, and oxygen-carrying capacity (VO_{2max}) were determined.

All groups improved equivalently (by 41 ± 26%) in the six-repetition maximum (6 RM) strength test, which determines the maximum weight the subject can lift six, but not seven, times in a row. However, there were significant differences between improvements in isokinetic knee extensor strength (30 ± 21% *vs* 13 ±15%) and muscle endurance (21 ± 19% *vs* 7 ± 12%) in the velvet powder group compared to the control group, respectively. There were no endocrine, red cell mass or VO_{2max} changes in any group. Thus the findings did not support an erythropoietic or aerobic ergogenic effect of deer velvet in these athletes. Given that the subjects were all healthy and did not undergo any aerobic training, these results were not surprising. The effects of deer antler velvet powder supplementation on muscle strength and endurance, though, were supportive of the earlier Russian results.

Strength training study 2

The results of the above study of Sleivert *et al.* also backed up those of an earlier double-blind pilot trial, conducted in 24 healthy male university students by the University of Otago (Gerrard *et al.* 1998). The design of the two studies was similar, except that in the pilot study only velvet extract was compared to placebo control (*i.e.* no third group was given velvet powder), and the dose administered was lower (70 mg extract/day as opposed to 300 mg/day). The pilot study also focussed on the measures of muscle strength and endurance, without the endocrine and aerobic endurance testing. Most of the strength measures improved with training but no significant differences due to the velvet extract were detected. There were some strong trends however. The increase in the total work done by extensor muscles of the extract-treated group was about twice that of the placebo group. There was some evidence that endurance of the extension muscles was also improved. The lack of a statistical significant result may have been related to the relatively low dose of velvet given, as evidenced by significant results subsequently being obtained using similar-sized groups of subjects supplemented with higher doses.

Strength training study 3

In a double-blind study carried out in the United States, Broeder *et al.* (2004a; 2004b) investigated the physiological and potential performance enhancing effects of New Zealand deer velvet supplementation in men. Thirty-two males between the ages of 18 and 35 with at least 4 years of

weight lifting experience were randomly assigned into either a placebo (control) or velvet treatment group.

Control group members received placebo capsules, while the velvet group received 1,350 mg velvet powder once in the morning and again immediately prior to bed-time (*i.e.* 2,700 mg/day). Random assignment was done in matched pairs (1 placebo; 1 velvet). Prior to and immediately following a 10-week period of supplementation, each subject participated in a series of measurements. These procedures included the measurement of maximal aerobic capacity (VO_{2max}), maximal power output on a cycle ergometer, a determination of maximal strength (1-RM) for the bench press and squat, a comprehensive blood chemistry profile, body composition analyses (DEXA), and a 3-day dietary recall. Of the original 32 subjects recruited for this study, 56% of the subjects properly completed all aspects of the study. Dropouts were evenly divided between the two treatment groups, leaving the placebo and the velvet groups each with 9 subjects. At the start of the study, there were no significant differences between the groups in their respective body composition profile variables.

For the placebo group, only the absolute 1-RM values for the bench press and the squat improved after the intervention period. When normalized for kilograms of total body weight, the placebo group did not show any significant differences for the 1-RM measurements in either the bench press or the squat exercises. In contrast, the velvet group showed significant improvements in the 1-RM values, both in absolute terms and relative to total body weight. In absolute terms, the 1-RM for the bench press of this group increased 4.2% while the squat 1-RM improved 9.9%. When expressed relative to total body weight, 1-RM values for the bench press and squat also significantly improved by 4.0% and 10.1%, respectively, in the velvet group.

One of the most interesting findings of this study was the fact that there was also a significant improvement in aerobic capacity in the velvet treatment group. In litres, VO_{2max} increased significantly by 9.8% from the pre- to post-treatment period. When expressed relative to total body weight in kilograms, VO_{2max} was also significantly elevated by 9.4% in the velvet group following the training-supplement intervention. These results differ from those of Sleivert *et al.* (2003), who found no effect of velvet on VO_{2max} in their experiment. The reason for the difference is unclear. Possibly, though, this could be related to the use of a supervised training programme in the study of Sleivert *et al.*, as compared to the self-determined training programme of the present experiment. Further research, including specific aerobic training, is warranted to clarify the potential effect of velvet on aerobic capacity during exercise.

In the velvet group, reductions in percentage body fat, fat weight, and trunk-to-limb fat weight ratio were either significant or neared significance. Also observed was a significant reduction in LDL cholesterol (12.2%), which improved the LDL/HDL ratio by 8.4%. These findings need to be treated with some caution, as diet was not controlled in the study, but the effect on cholesterol balance coincides with results of some animal studies (see Section 16 above). They are certainly worthy of closer examination in studies designed for the purpose.

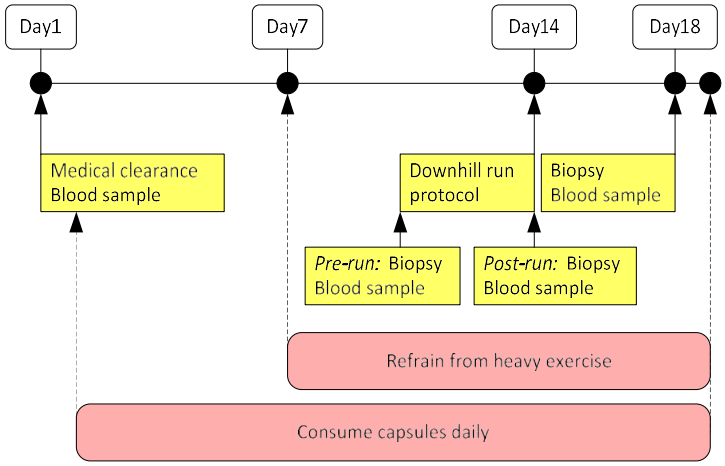
Overall, the results of this study suggested that New Zealand deer velvet may have positive effects on body composition and strength/power in men undergoing resistance training.

Recovery from muscle damage study

An experiment was performed by the University of Otago to determine if velvet products have an enhancing role in athletic performance by affecting repair of exercise induced muscle damage (Gerrard *et al.* 2000). Thirty students were allocated at random into three groups of 10 for the double-blind study (Figure 13). One group ('Powder') was given 1.5 g/day velvet antler powder for 2 weeks, and one group ('Extract') was given 300 mg/day velvet antler extract for 2 weeks. The third group ('Placebo') was included as a control, and took a placebo for 2 weeks. Damage to the quadriceps muscle group was then induced in all subjects by having them run for 35 min discontinuously on a motorised treadmill on a 12% downhill grade. A pre-run muscle biopsy and blood samples were taken before velvet supplementation, immediately after this exercise and again 4 days later. Immediately following completion of the 35 minute downhill run, and on each of the four subsequent days, participants performed five slow, controlled, non-supported squats and gave ratings of muscle soreness (MSR). For this, a scale of 1–10 was employed, where 1=normal, 5=moderately sore, and 10=very sore. Consumption of velvet or placebo continued throughout the 4 day post exercise period. Blood samples were tested for the serological markers of muscle damage, creatine kinase (CK), lactate dehydrogenase (LDH) and aspartate amino transferase (AST). The downhill treadmill run produced ultra structural muscle damage that was ranked in accordance with a scale of 1 (representing normal muscle) to 5 (indicating widespread muscle damage).

Figure 13. Muscle damage study design

The protocol of an experiment conducted by the University of Otago (Gerrard *et al.* 2000) to determine the effect of velvet on recovery from exercise induced muscle damage.



Participants were excluded from the analyses if their initial level of serum CK was greater than 2 standard deviations above the mean reference range for blood CK (140 ± 95 U/L); *i.e.* CK values of 330 U/L or above. This was done because elevated CK values generally indicate that an individual may have experienced strenuous exercise in the recent past or may have some undetermined myopathy. Because previous eccentric exercise may also provide protection against subsequent

damage from eccentric exercise it was necessary to exclude subjects who may have had a recent eccentric exercise experience. Twenty participants completed the study (6 each in the Placebo and Extracts groups, and 8 in the Powder group).

Significant minor to moderate ultra structural damage was reported for the post-exercise muscle biopsy sample. However, there were no significant differences between groups and the treated groups appeared to receive no significant benefit from powdered or extract forms of deer velvet.

In the subjects in all three groups, there was a demonstrable and significant rise in serum CK concentrations 4 days after exercise (Figure 14). However, the CK increase was significantly less 4 days after exercise in the group supplemented with velvet powder than the concentrations in the Extract and Placebo groups, suggestive of a lower degree of muscle damage in the Powder group. No significant differences in the activities of the other enzymes measured (LDH and AST) were evident between groups.

Qualitative measures of perceived muscular discomfort were reported by using a specific muscle soreness rating (MSR) scale. There was a clear pattern of increased MSR at 24 hour post-exercise (Figure 15). While the overall pattern of change in MSR was similar for all groups, the return to a normal level seemed to occur 24 hours earlier in the Powder group.

A regression analysis between MSR and muscle damage rating revealed significant positive slopes for the Placebo and Extract groups (Figure 16). This was to be expected because soreness would be expected to increase with increasing level of damage. However, the analysis produced a non-significant slope for the Powder group. There is no immediately obvious explanation for this although it may be indicative of some kind of analgesic effect specific to powdered velvet, as previously reported by Shin *et al.* (1989).

Thus, the study did not provide unequivocal evidence of protective or restorative effects of velvet products on post-exercise muscle stiffness after acute eccentric loading, but some indications of a beneficial effect of powdered velvet were noted. Relevant to this was the low number of participants that completed the study, which reduced its statistical power. Further research would be needed to determine if deer velvet can in fact accelerate recovery from exercise induced muscle damage.

Figure 14. Creatine kinase (CK) levels in the muscle damage study

Data are mean CK levels at pre-supplementation, post-supplementation, and 96 hours following the downhill run for the Placebo, Powder, and Extract groups in the study of Gerrard *et al.* (2000). Error bars show SEM. * = Significantly different from post-supplementation scores for the group; † = significantly different from placebo group pre-supplementation; # = significant difference in CK rise *vs* placebo group at 96 hours post-run.

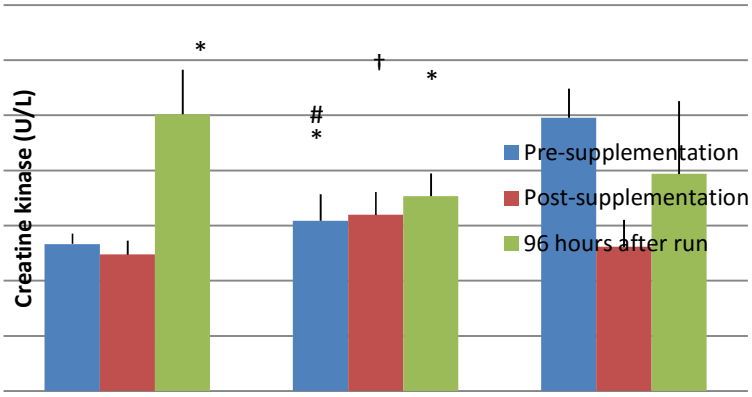


Figure 15. Muscle Soreness Rating (MSR) scores in the muscle damage study

Data are mean MSR scores immediately after, and 24, 48, 72 and 96 hours following the downhill run for the Placebo, Powder, and Extract groups in the study of Gerrard *et al.* (2000). Error bars show SEM. * = Significantly higher than immediately after the run (0 hours) for group; # = significantly lower than immediately after the run (0 hours) for group.

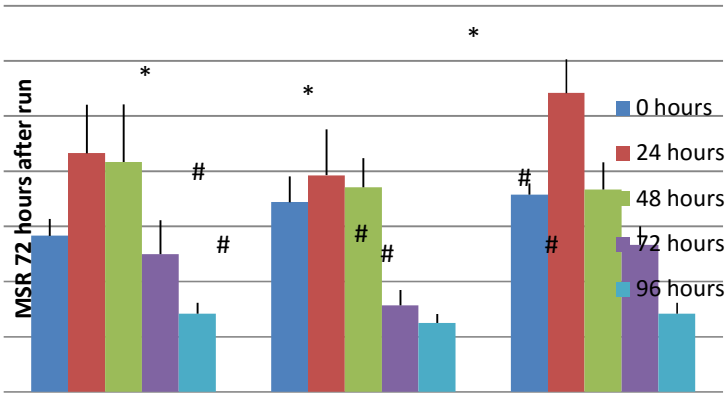
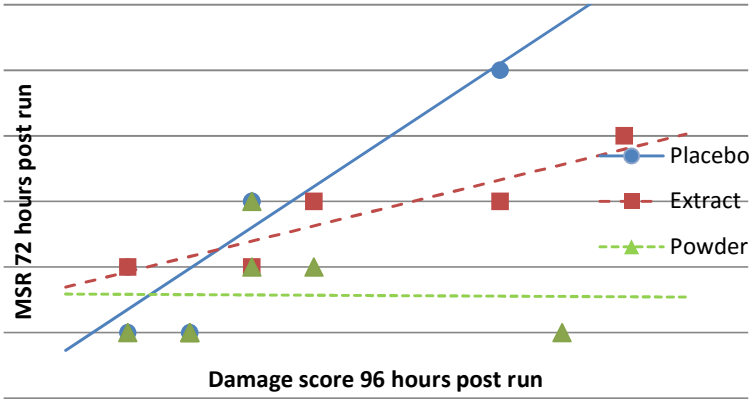


Figure 16. Regression analysis of MSR and ultra structural muscle damage scores in the muscle damage study

Data are individual MSR and ultra structural muscle damage scores, together with fitted linear curves obtained by regression analysis, for the Placebo, Powder, and Extract groups in the study of Gerrard *et al.* (2000). Positive non-zero slopes were fitted to the data for the Placebo and Extract groups, but the slope for the Powder group was not significantly different to zero.



Efficacy studies in animals

Scientists in China (Li *et al.* 2004) and Russia (Letchamo *et al.* 2004) have both shown by use of standardised forced swimming tests that velvet enhances the stamina of mice. The Russians classified velvet as an adaptogen that acts for a short term. They further showed that individual mice vary in their ability to respond to adaptogens (including velvet), and classified them as having high, medium or low adaption capacity.

Enhancement of performance in forced swimming tests has also been demonstrated by Korean researchers, as described in the following section.

Weight-loaded forced swimming performance test in mice

Shin *et al.* (2001) tested the effect of 96% ethanol and hot water extracts of velvet on the stamina of mice in forced swimming tests. ICR mice weighing 25-30 g were administered with test samples orally for 5 days consecutively and, 24 hours later, the swimming tests were performed. For each experiment, mice were divided into five groups of 9 animals each. Velvet treated groups were orally administered 50, 100 or 200 mg/kg velvet extract in distilled water daily for 5 days. A further group was similarly given tocopherol suspended in gum Arabic (5 g/L) as a positive control substance, and a control group given just water was also included. On the 6th day the swimming test was carried out with a weight attached to the tail of the animal. A weight [(bodyweight + 3 g) x 0.065] was attached 5 cm from the base of the tail. A stainless water tank was used that was equipped with a circulation pump and a thermostatically controlled heating unit, which maintained the temperature at 33°C. The swimming time was defined as the interval between the onset of swimming and the point at which the animal became fully submerged for 5 seconds.

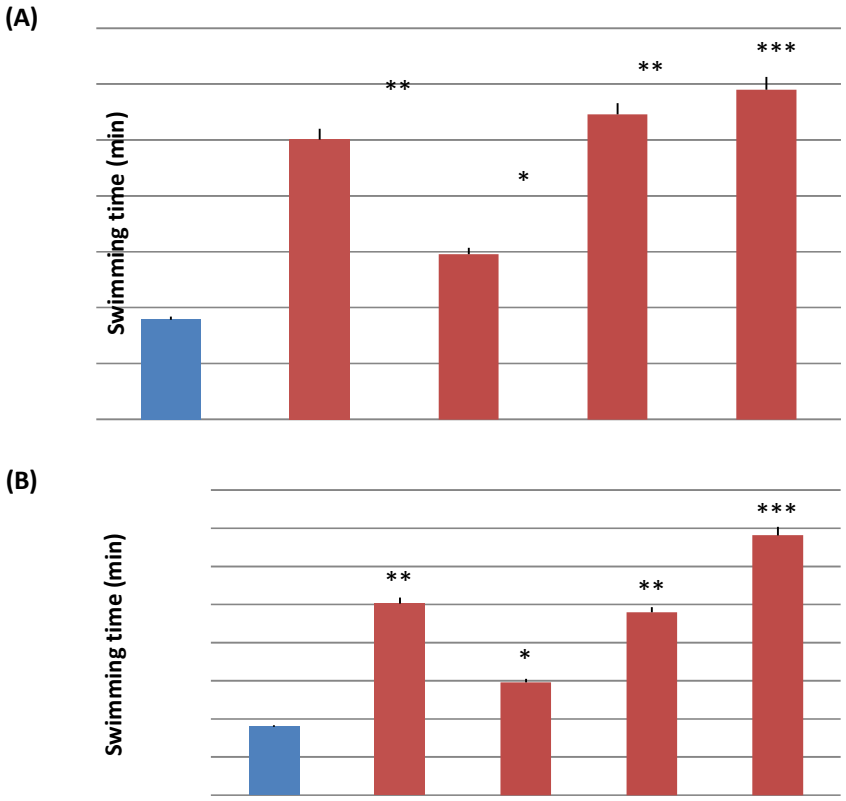
The mean durations of swimming times showed significant dose responsive increases for both the water and the ethanol extract of velvet (Figure 17). For each extract, the swimming performance

of the 100 mg/kg/day dose group was the same as the positive control tocopherol, having mean swimming durations that were over 250% of those of the negative control group.

These results suggest that the heat stable factors in deer velvet that enhance the stamina of animals are either soluble in both water and in ethanol, or else multiple factors are involved. Although evidence is lacking at this time, it is tempting to speculate that these might be small peptides since these are known to be soluble in both solvents.

Figure 17. Effect of velvet extracts on swim duration of mice

Mice were orally administered 50, 100 or 200 mg/kg/day of (A) water or (B) alcohol extract of velvet consecutively for 5 days. Swimming times were estimated 24 h after the last treatment of test samples (Shin *et al.* 2001). Tocopherol (5g/L) in gum Arabic was given to an additional group of mice as a positive control substance. Data are means ± SEM for groups of nine mice each. Significantly different from control group: *P < 0.05, **P < 0.01, *** P < 0.001.



13 AIDING RECOVERY AFTER TISSUE INJURY

13.1 Health Benefits

In Traditional Chinese Medicine, velvet antler is used to promote wound healing. Rapid recovery after tissue damage caused by surgery or trauma has obvious benefits for the person involved. It also has considerable social and economic benefits by expediting the return of injured people to a normal lifestyle and to the work force.

13.2 Suggested Physiological Rationale

As with athletic performance, no single effect of velvet antler is likely to explain any benefits it has in aiding wound healing. Any such effects could be mediated by some of the mechanisms discussed in other sections, such as healthy joint functions and blood health.

13.3 Research Support

A rapidly increasing amount of research is being conducted investigating the potential use of velvet for enhancing healing of a variety of types of wounds.

Surgical and internal wounds

In Russia, Arapov (1969) used Pantocrine in surgical practice. Pantocrine was given orally, subcutaneously or it was applied locally in impregnated bandages. Large groups of patients of various ages and both genders were treated. Arapov reported there were a number of positive effects, including a pronounced general tonic effect, and normalisation of both the arterial pressure and the blood picture. Some of the patients were elderly and emaciated by chronic disease such as gastric and duodenal ulcers and malignant tumours of the stomach and rectum. Surgery of such patients is often followed by complications such as distension of the intestine and constipation. During preparation for surgery, they were given Pantocrine (1 ml intramuscularly for 7 to 10 days before surgery). Following surgery the patients remained almost completely free from the usual complications, and became active relatively early. Suppuration of the operation wounds was seldom observed. While the results of this study are interesting they carry little weight as there was no control (untreated) group of patients.

In the laboratory of Wang Ben Xiang in China, polysaccharides isolated from velvet were shown to have anti-ulcer activity in three separate gastric ulcer models in rats (Wang *et al.* 1985; Wang 1996). The effect appeared to involve effects of the polysaccharides on prostaglandin metabolism, as well as a reduction of gastric acid secretion, protecting the mucous membrane from injury.

Bone fractures

Wang's group also showed that velvet from Chinese sika deer (*Cervus nippon* Temminck) contained polypeptides that enhanced the proliferation *in vitro* of rabbit and human chondrocytes and osteoblast precursor cells of embryonic chick calvaria (Guo *et al.* 1998). They further showed that bone fracture repair was accelerated in rats when the polypeptides were injected at the site

of injury (Zhou *et al.* 1999) *(see the Strong Bones section on page 53 for more discussion of these in vivo and in vitro results)*.

Skin wounds

Further work by Wang's group went on to show that the total polypeptides fraction from red deer (*Cervus elaphus* Linnaeus) velvet accelerated healing when topically applied to skin wounds on rats (Weng *et al.* 2001b). It also strongly enhanced the *in vitro* proliferation of epidermal cells and fibroblasts, and a 32-amino acid polypeptide that was considered responsible for this activity was purified from the mixture. After identification of its sequence, the polypeptide was synthesised and its mitogenic effects on epidermal cells and fibroblasts were confirmed (Weng *et al.* 2001b; Weng *et al.* 2002). The pure polypeptide also promoted the growth of chondrocytes (Weng *et al.* 2001a; Weng *et al.* 2001b), supporting the earlier results related to bone fracture repair (Zhou *et al.* 1999).

New Zealand studies have shown that antler extracts have certain angiogenic properties (Clark *et al.* 2004; Suttie *et al.* 2005). This research laid the foundation to explore applications of specific velvet extracts in wound healing, which are produced utilising a novel extraction procedure (Haines 2009). Ongoing work has indicated that velvet is a potential source tissue for the production of extracts with angiogenic activity that have the potential to be used in commercial wound healing treatments, and patent protection has been sought (Coates *et al.* 2004).

In Canada, Mikler *et al.* (2004) investigated the effects of oral and topical elk antler velvet on cutaneous wound healing in an animal model of streptozotocin-induced diabetes mellitus. Wound healing was assessed in the controlled experiment by measuring daily wound contraction and histological and growth factor analysis of wound biopsies. The study found that topical treatment did increase wound contraction speed.

Recently, Gu *et al.* (2008a) investigated the effects of red deer velvet extract on the speed of full-thickness skin wound healing and on the expression of IGF-I, TGFβ , and EGF in the skin wounds during healing. Three groups of rats were topically administered a high concentration of antler ointment, a low concentration of antler ointment, or ointment without velvet. At post-injury days 0, 2, 4, 8, 16, 20, 32, 40 and 60, the skin wound area was measured, the expressions of IGF-I, TGFβ, and EGF mRNA were detected by reverse transcriptase polymerase chain reaction (RT-PCR), and collagen formation by Sirius red dye and the localization of IGF-I, TGFβ, and EGF peptides were inspected by immunohistochemical techniques. Healing of wounds was significantly more rapid in antler treated skin wounds. In addition, the wounds treated with a high concentration antler ointment, low concentration antler ointment or the control ointment closed completely at post-injury day 40, day 44 and day 60, respectively. As shown by RT-PCR, the expressions of IGF-I (days 8 and 16), TGFβ (days 8, 16 and 20) and EGF (days 4, 8, 16 and 32) were obviously up-regulated in high concentration antler-treated wounds compared to control wounds. Similar results could be seen in the histological detection of dye-stained collagen and detection of IGF-I, TGFβ and EGF by immunohistochemistry. These results showed that deer velvet was able to accelerate the repair of cutaneous wounds, and that this may (at least in part) have been due to stimulation of the local expression of growth factors known to be important in the normal healing process.

Nerve regeneration

Early experiments by Takikawa *et al.* (1971; 1972a; 1972b) investigated the effects of the Russian alcohol extract, Pantocrine, on rabbits and rats with experimentally induced whiplash injury. Pantocrine administered as an intra-muscular injection (~1.5 mg/kg/day) from the 3rd to the 21st day after injury significantly improved abnormalities in electronystagmogram (ENG) patterns, and decreases in cerebrospinal glycolysis and enzyme activities of cerebral and spinal tissues, that were caused by the whiplash.

The effect of pre-treatment with velvet extract on regeneration of peripheral nerves was investigated by Chang *et al.* (2002). Groups of rats were orally administered velvet extract or saline (as control) daily for periods of 1, 2, or 3 weeks, after which the sciatic nerve of each leg of the rats was transected. Six hours later, sciatic nerves were taken from the proximal parts of the transected regions for analysis by transmission electron microscopy. A larger proportion of nerve fibres examined showed axonal sprouts at the nodes of Ranvier in rats pre-treated with velvet extract compared to the saline-treated control animals. This was particularly evident in animals given velvet for 2 or 3 weeks and, although most sprouts were short in all groups, some longer sprouts were observed in rats of these two treatment groups. The results indicate that deer antler may be effective for the regeneration of peripheral nerves.

More recently, two Chinese groups have also reported beneficial effects of Wang's velvet antler polypeptides (see discussion above) on nerve regeneration in rats.

Li *et al.* (2008) evaluated the effects of different doses of velvet polypeptide on motor function, behaviour and pathological changes of spinal cords of rats with spinal cord injury. After seven days significantly more motor activity was recovered in the velvet polypeptide treatment group compared to the control group, and the effect was dose-dependent. Similarly, a dose-dependent reduction of tissue oedema and inflammatory infiltration of the spinal cord was observed, especially at the highest dose (15 mg) of velvet polypeptide.

Lu *et al.* (2008) evaluated the effect of velvet polypeptide in a nerve damage model, in which the sciatic nerve of rats was surgically sectioned and then rejoined. Four groups, each of 18 rats, were either left untreated (control), were injected intramuscularly with 10 µg velvet polypeptide every other day for up to 6 weeks, or were implanted at the surgery site with a PLGA[4] copolymer containing either 3 or 15 mg/g of velvet polypeptide. The recovery rate of the evoked potential of the triceps surae was significantly better for all treatment groups compared to the control group, with the greatest recovery being shown by the 15 mg/g PLGA-velvet polypeptide group. Similarly, all treatment groups showed significantly more nerve regeneration than the control group, as revealed by immunohistochemical analysis of TGFβ1 and IGF expressed in the nerve fibre axons and myelin sheaths of the rats, as well as horseradish peroxidise (HRP) staining of myelinated nerve fibres. Again, the best response was shown by the 15 mg/g PLGA-velvet polypeptide group.

[4] *Poly(lactic-co-glycolic acid), a biodegradable copolymer which is used in a host of Food and Drug Administration (FDA) approved therapeutic devices.*

Sciatic nerve adherence was also reduced by the injection of velvet polypeptide, and eliminated by treatment with either dose of the PLGA-velvet polypeptide compound.