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Deer antlers- Traditional use and future perspectives

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Antlers are bony skeletal protuberances of the skull, and consist mainly of the protein collagen and the mineral calcium hydroxyapatite. Antlers occur in most species of the deer family (Cervidae) and are grown and shed annually, typically only by males. Traditional medical reports and clinical observations show that antler is biologically active to cure various diseases. To make antler products acceptable as nutraceuticals and functional foods, chemical and biological properties of velvet antlers have to be clearly determined. Antlers are made of chemical components consisting of sugars, fatty acids, amino acids, and nucleotides as essential molecules, which become macromolecules such as polysaccharides, lipids, proteins and nucleic acids, respectively. For their physicochemical properties, each of these macromolecules is responsible for not only antler growth and development, but also biomedical and nutraceuticals uses of antlers. Therefore, understanding chemical and molecular characteristics of antlers is crucially important to elucidate the clinical and medicinal efficacies of antlers. Hence, the review highlights information about various species of deer, its farming, antler preparation, antler composition, its traditional uses and scientific substantiation to it, dose and its future scope.

Keywords: Deer antler, Velvet antler, Antler composition, Traditional knowledge, Traditional uses, Antler uses

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Antlers are bony skeletal protuberances of the skull, and consist mainly of the protein collagen and the mineral calcium hydroxyapatite (Ca_5 $(PO_4)_3OH$). Antlers occur in most species of the deer family (Cervidae) and are grown and shed annually (Fig.1). Evolutionarily, horn like structures developed in all 4 true ruminant families – Cervidae, Giraffidae, Antilocapridae and Bovidae. Unlike horns, antlers are secondary sexual characteristics, typically occurring only in males, and are functional only during the rutting (mating) season. The reindeer is the only deer species in which the females also sport antlers, but these are much less impressive than those of the males. Two species of Indian deer that do not have antlers are the musk deer and the Indian chevrotain or mouse deer, which belong to families other than the Cervidae. In these antlers-less species, the canines are very well developed and function as secondary sexual characteristics[1]. Deer antlers have many uses. Removal of antler from live deer has been a traditional practice in some Asian cultures for centuries. In the West however, velvet antler removal is a new form of animal utilization, evolving only since commercial deer farming began in the early 1970's. Velvet antler is the growing stage of the horns borne on the heads of male members of the deer family. They are called velvet antlers during the phase of rapid growth and development because of the velvet-like covering of skin.

Velvet antler has been one of the most prized health tonics in traditional oriental medicine for over 2,000 yrs. Today, in addition to its FDA supported use for arthritis treatment and its' proven enhancement of athletic performance, velvet antler's bioactivity probably has undiscovered medical potential for humans with regards to boosting immunity, preventing illness, and propagating longevity[2]. The use of deer antler continued at a modest level until the 12th century, when it became the subject of modern research methods. Both the Russians and the Chinese started subjecting deer antler to analysis by scientific methods, though those methods were relatively crude. About the same time, patent medicine factories sprung up and helped fill the growing demand for tonics made with rare ingredients such as deer antler and ginseng. Medicine factories now use more than 1,000 kg of deer antler each year. This increased interest and distribution, in turn, led to rapid build-up in the number and size of deer farms[3]. Species of deer (Table 1) have been enlisted[4,5].

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Fig.1(abc) *Sambhar, Barasingha,* and S*potted deer*

Fig.2 Deer farming

Fig.3 Various stages of antler growth in spotted deer

Fig 4 Whole and sliced antler

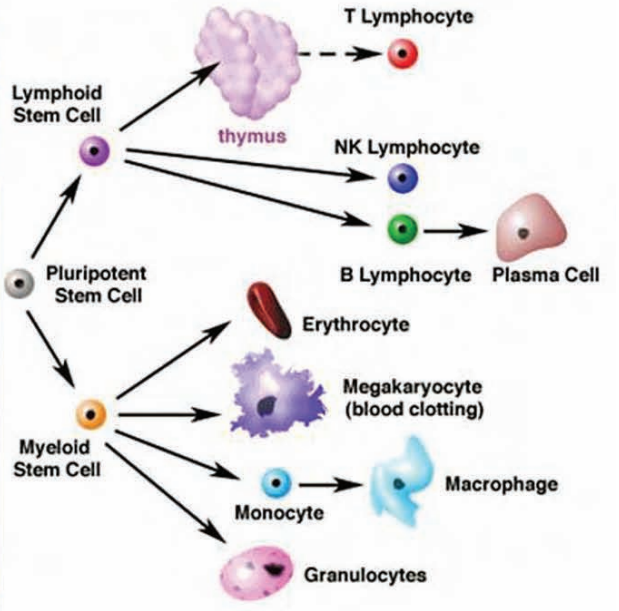

Fig.5 Production of blood cells from stimulated marrow stem

Deer farming

Deer farming has become a huge enterprise outside the Orient[6]. The animal meat is used as food, and the antlers are usually exported to the Orient, though there is a new industry in making antler-based health products for domestic consumption in Canada and other countries (Fig. 2). The primary material collected at the deer farms is called velvet. The term originally arose from the fine hairs on the antler, but is now used specifically to indicate the antler's stage of growth before it calcifies or ossifies (Fig. 3). In nature, antlers will fall off after they have ossified; thus, collecting fallen antler doesn't provide the desired 'velvet'. The older material is still valued; it is boiled to yield deer antler gelatin and used for certain applications, such as dispersing swellings. Deer velvet is removed while the deer is under local anesthetic. The antlers then grow back. The cut antlers are bathed

Table 1— Various species of deer

Family	Presence of antler
Tragulidae: *Moschiola mimenoides* (*Tragulus meminna*): Indian chevrotain or mouse deer	No antlers; tusks in male
Moschidae: *Moschus moschiferus,* Musk deer	No antlers; tusks in male
Cervidae: *Cervus elaphus hanglu,* Hhangul, *Rusa unicolor* (*Cervus unicolor*), Sambhar. (Fig.1a) *Recervus eldii* (*Cervus eldii*): Thamin or Brow antlered deer, *Recervus duvaucelii (Cervus duvaucelii*), Barasingha. (Fig.1b), *Axis axis,* Spoted deer. (Fig.1c), *Hyelaphus porcinus* (*Axis porcinus*), Hog deer.	Antlers present in male

in boiling water and air dried, and then further dried in the shade or by low temperature baking. The fine hairs may be removed before additional processing. A typical dried antler from the deer weighs about 150 gm.

These animals are very valuable and the welfare of the animal is therefore paramount. The removal of the velvet antler from the animal is carried in compliance with a strict Velveting Code of Practice by either veterinarians, or qualified persons under veterinary supervision, and the effect on the animal is minimized and minimal. It is a relatively quick and painless procedure and the animals are immediately released to graze. However, if the weather is inclement they are kept inside and hand fed to avoid any risk of infection or stress. Quite apart from removal of the antler for its health supplement properties, it has been accepted practice to remove it to avoid animals damaging or injuring each other by fighting; getting caught up in fences and injuring themselves, or perhaps causing their own death. It is also done to avoid risk to those farming and handling them.

Antler preparations

Traditionally, deer antler is sliced very thinly or ground to powder[7]. It is not commonly boiled in decoctions with herbs because the gelatins easily stick to the herb dregs or cooking pot, and so the loss of valuable material is considered too great. Therefore, the herb powder is usually taken separately. To make gelatin, ossified antlers (which are less expensive than velvet) are boiled for several hours to release the gelatin (protein components) from the hard matrix. Then, the antler gelatin can be added to an herbal decoction after all the boiling is done and the dregs have been strained. Or, it can be powdered and consumed directly. After removing the gelatin from the antler, the residual hard antler material is dried and powdered to make *lujiaoshuang* (degelatinized deer antler), which is mostly used for topical applications (treating boils, eczema, and skin ulcers, serving as an astringent and aid to faster healing). It is also considered of some limited value as a kidney yang tonic if taken at high enough dosage (Fig.4).

Constituents

Antler is a simple extension of bone, so it has a calcium phosphate matrix of hydroxyapatite, $Ca_{10}(PO_4)_6(OH)_2$, integrated with smaller amounts of calcium carbonate (CaCO3); its composition is similar to that of human bones[8,9]. Thus, one of the therapeutic roles of taking deer antler is as a source of calcium to help prevent or treat osteoporosis, which is consistent with the traditional bone strengthening action of deer antler. An analysis of the ossified antler showed that 73% is hydroxyapatite and related mineral compounds, while 27% is organic materials. If consumed as a powder (rather than a decoction), a person taking 3 gm of deer antler will get about 800 mg of calcium. Hydroxyapatite is considered one of the most efficiently absorbed forms of calcium available.

Deer antler also has a substantial amount of gelatinous components though from other source materials; glucosamine sulfate, chondroitin sulfate (which is a polymer of glucosamine), and collagen. These compounds have been shown to benefit the joints in cases of osteoarthritis by providing substrate materials useful for regenerating the body's connective tissues (collagens) found in joints and sinews. In addition, they may have some antiinflammatory action, useful for arthritis and tendonitis. These actions of the gelatin portion support the traditional concept that antler benefits joints and ligaments. In a 3 gm dose of ossified deer antler powder, one will obtain about 750 mg of these substances, which is low compared to therapeutic amounts taken as supplements for osteoarthritis (about 1,500 mg/day); 3 gm of velvet antler will provide the desired 1,500 mg. If deer antler gelatin is

consumed, there is an even higher proportion of these ingredients, though some of the components may be transformed during the prolonged boiling into less active forms, so the dosage of gelatin to use is higher than for antler velvet.

Recently, the traditional use of antler to nourish the bone marrow and blood has been validated by studies in which the active components responsible (monoacetyldiglycerides) were identified. These are small molecules that stimulate the marrow stem cells that produce blood cells (Fig.5). Inhibition of hematopoiesis (blood cell production) occurs with several cancer drugs and with radiation therapy; some disease processes, such as myelodysplastic syndrome (MDS), involve progressive decline in stem cell activity with undetermined causes. If further research confirms the therapeutic importance of the monoacetyldiglycerides, they can be synthesized in large quantity. In the meantime, deer antler is the main therapeutic source for them. Stem cells leading to various blood lines. The basic marrow stem cell differentiates during early fetal development into two types of stem cells, the lymphoid (which produces lymphocytes) and the myeloid (which produces all the other blood cells). Platelets (thrombocytes) are not true blood cells, but are cytoplasmic fragments of the megakaryocytes. T-cells are lymphoid cells that differentiate via action of the thymus gland. All the cell lines except erythrocytes (red blood cells) and megakaryocytes are involved with immune responses. Thus, deer antler, when used to stimulate the stem cells in patients with bone marrow depression, may improve immune responses, as indicated by laboratory animal studies[10]. Deer antler also has essential fatty acids, making up about 2.5% of the velvet antler (not enough to be clinically active) and insulin-dependent growth factor (for which it is not known whether there is any clinical effect). Other organic compounds have been detected, but in miniscule amounts. The biochemical composition of deer antler includes lipids (omega-6 fatty acid) 2.5%; protein 52%; ash (minerals) 32%; Moisture 1%; Nitrogen (N) 8.4%; Calcium (Ca) 12.1%; Phosphorus (P) 5.8%; Sulphur (S) 0.43%; Magnesium (Mg) 0.25%; Sodium (Na) 0.83%; Potassium (K) 0.42% (Table 2)[11, 12].

Traditional medicinal uses

No one knows exactly when antler velvet was first used for medicinal purposes in Asia but Traditional Chinese Medicine (TCM) has used as a medicinal herb for centuries and its use in therapeutic formulas is second only to ginseng. It is said to fortify the Yang and to increase the natural flow of chi (vital energy) through the kidneys thereby assisting to regulate the function of the adrenal cortex and restore a person's natural vitality. The first documented evidence of the use of velvet deer antler as a medicine was found on a silk scroll recovered from a Han tomb in the Human Province in China. The scroll is believed to be about 2,000 yrs old and recommends medical treatments and prescriptions for 52 different diseases using deer antler[13-15]. Velvet deer antler, warm in nature and sweet and salty in flavour, was used as supplements for kidney, for strengthening bones, boosting the bone marrow and for nourishing the blood. It was used for patterns of vacuity detriment, such a kidney deficiency and cold limbs, soreness of the limbs,

Table 2— Composition elements and its description

Composition element	Description
Protein	Collagen II is found in antler. The decrease of this element can lead to both osteo- and rheumatoid arthritis.
Free amino acids	Antler contains all eight essential amino acids that must be supplied by food or supplements for normal metabolism and growth. It also contains some 15 nonessential free amino acids
Ash	Antler contains not only predominantly calcium, phosphorus and sodium, but also magnesium, manganese, selenium and iron.
Lipid fractions	Free fatty acids, gangliosides, lecithin, phospholipids, cholesterol, steroids and prostaglandins and others are found in antler. An important fact is that antler prostaglandins can induce vasodepression, smooth muscle contractions and influence lipid metabolism.
Complex carbohydrates	Glycosamino-glycans (GAGs), including the most prominent chondroitin sulfate, and less-prominent glucosamine sulfate are also present in antler. GAGs play an important metabolic role in connective tissue and joint health.
Other components	The growing antler also contains fibro- and chondroblasts (cells from which connective tissue and cartilages are developed, respectively); chondro- and osteocytes (cartilage and bone cells); growth factors (GF), which include epidermal and nerve GFs, insulin like GF I and II, and transforming alpha and beta GFs; and cytokines (an immune regulator).

dizzy head, blurred vision, seminal emission and impotence. Ossified deer antler, salty in flavour and warm in nature, was used as supplements for kidney and for strengthening bones. It has similar action and used as substitute for velvet deer antler, but it is less effective. Deer antler gelatin, sweet in flavour and warm in nature, was used as it warms and supplements for the kidney, frees the blood of the thoroughfare vessel, engenders essence and blood and stanches flooding (excessive uterine bleeding). It was mostly used for flooding and spotting, vaginal discharge, deficiency bleeding, and flat-abscess (lumps that are not red, swollen, hot, or painful).

Traditional Chinese Medicine, while having curative functions, focuses on promoting wellness as a medical goal in itself. In both Chinese and Korean medicine, velvet antler can be regarded as an effective promoter of health. This may be because the substances that promote rapid growth and regeneration of velvet are responsible for the tonic actions. Western medicine lacks a formal understanding of a tonic, but it is important for a potential user of velvet antler to accept in the context of seeking the benefits of velvet. In keeping with Chinese and Korean use of velvet, these are overall strengthening of the body, healing and improving tissue function. View velvet antler as a powerful restorer and strengthener but not a curative in itself. The mechanisms for this true tonic activity are yet only poorly understood.

Scientific substantiation

Due to its wide variety of chemical components, it makes sense that antler has a range of traditional uses many of which are only now being scientifically evaluated. Antler displays no evidence of antibacterial, antiviral or antifungal activities. Thus, it cannot cure by destroying active pathogens. The vast majority of research is in cells or on animals. The use of velvet antler by Koreans during winter months led researchers to believe it could strengthen the immune system. Injecting pantocrin, a specialized velvet extract, into the peritoneum at a dose of 0.52 mg/kg could stimulate the phagocytic function of macrophages in both normal and immune deficient mice[16]. High cholesterol level is a known risk factor for heart disease. Treatment with velvet lowered liver cholesterol from 1,610-1,311 mg/100 gm dry tissue. Spleen and brain cholesterol were also reduced. In contrast, cholesterol was increased in the kidneys' cortex and medulla (1,733-1,900 and 1,880-2, 190 mg/100 gm dry tissue, respectively). The researchers theorized that the velvet extract caused the cholesterol to be filtered from the blood, thereby increasing kidney levels but lowering levels elsewhere[17].

In two uncontrolled clinical trials, velvet antler demonstrated hypotensive (blood pressure lowering) effects. In an experiment, 32 patients with high blood pressure caused by obesity or early-onset menopause were treated with either 4.5 ml/day oral or 2 ml/day injectable alcohol velvet antler extract for 20 or 30 days, respectively. They were then examined by a physician. Out of 26 patients, eight were getting oral treatment and 18 were getting injections had measurably lowered blood pressure and reported an improvement Those reporting no improvement had diagnosed high blood pressure for 9-10 yrs[18]. The effects of the same injectable extract on 13 patients with hypertension caused by heart disorders such as palpitations, murmurs and arrhythmia were studied. Pantocrin extract counteracted the effect of previously administered adrenaline. Velvet acted in a manner similar to the neurotransmitter acetylcholine, which causes cardiac inhibition and vasodilation[19].

Velvet antler has a use in TCM as an anti-aging preparation. Using mice genetically selected to die of natural causes at an early age v/s normal controlled mice, Chinese researchers found that in selected mice, an alcohol velvet antler extract increased plasma testosterone, decreased oxidative activity in the liver and brain, increased liver protein content and liver superoxide dismutase (SOD) activity, and increased RNA production. Basically, the extract significantly altered the metabolism of the selected but not of controlled mice, concluding the best evidence of a measurable restorative function for velvet antler[20]. Investigating velvet antler benefits for sports performance is ongoing, and it is likely that the extract type and dose will be linked to a particular sport. In the late 1960s, pantocrin was observed to increase the endurance of laboratory animals[21]. This led researchers to compare the effects of pantocrin, rantarin (reindeer antler) and placebo on healthy athletes riding an exercise bike. Participants given pantocrin exhibited 740 Nm (Newton meters, a unit of work), while those given rantarin displayed 1,030 Nm and the controls only 150 Nm. No explanations were given for the better performance of rantarin[21]. Several studies since have failed to demonstrate statistical significance and show only a positive trend toward increasing athletic strength.

It is difficult to give a dosage for antler because little is known about relating illness to type of antler preparation and individual requirements[22]. In Russia, 1.25-2.0 ml alcohol velvet extract is taken two times per day 30 minutes before each meal. In Korea, a typical dose is 1,200 mg of dried velvet slices each day. In China, a recommended dose is 900-1,200 mg/day of velvet powder with 3,000-4,500 mg/day of the ground powder boiled in water. Typically, doses greater than 1.2 gm/day of either extract or powder appear to be therapeutic, while lower doses are prophylactic. Russian scientists determined the median lethal dose (LD_{50}) of alcohol velvet antler extract as 4.5 ml/kg, equating to a 1,059 ml dose for 72.72 kg per person. The contraindications listed in Russian literature were; serious atherosclerosis, heart or kidney disease, or a high stroke risk. The one known side effect is diarrhoea.

In a new millennium of supplement trends and designer foods fads, another brand new, next best and must have nutraceuticals may justly receive some skepticism. Perhaps there is some validity to a 2,000 yrs old brand new, next best, must have completely natural, prized health tonics of traditional oriental medicine. Seemingly, velvet antler acts as an adaptogen in the body; it adapts to the bodies deficiencies to provide the raw material for the body to attain optimum health: a nontoxic, non-habit forming nutrient. Research so far supports a therapeutic role for velvet antler in a number of conditions. The FDA has supported velvet antler use for arthritis treatment. Numerous experiments have shown that it enhances athlete's performance and research suggests significant clinical implications to the entire system including the immune system, the cardiovascular system, and the nervous system. However, more scientific understanding is necessary to define that nature of velvet antler's bioactive components and their independent and synergistic effects in animal systems. The research, though considerably complex, is likely to be very rewarding: velvet antler's rejuvenative and tonic actions may benefit athletes, the elderly and disease patients alike. If it is true that time will tell, velvet antler speaks volumes from the past that echo into the future.

Conclusion

Traditional medical reports and clinical observations show that antler is biologically active to cure various diseases. To make antler products acceptable as nutraceuticals and functional foods, chemical and biological properties of velvet antlers have to be clearly determined. Antlers are made of chemical components consisting of sugars, fatty acids, amino acids, and nucleotides as essential molecules. For their physicochemical properties, each of these macromolecules is responsible for not only antler growth and development, but also biomedical and nutraceutical uses of antlers. Therefore, understanding chemical and molecular characteristics of antlers is crucially important to elucidate the clinical and medicinal efficacies of antlers.

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