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A Review of the Literature Relevant to the Toxicity of Deer Co-products

Prepared for VARNZ

September 2007

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Stephen R Haines

Client Report

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TABLE OF CONTENTS

LIST OF TABLES

EXECUTIVE SUMMARY

The objectives of the current review were to collate relevant published and commercial data relating to the safety of deer co-products, and to highlight any information gaps.

The review was prompted by legislation that was introduced by the Hon Annette King (Minister for Food Safety and for State Services) in December 2006. This proposed a new regulatory environment for control of medicines, including complementary medicines, in New Zealand. The Bill would result in the establishment of a new joint Australia-New Zealand agency charged with responsibility for overseeing the new regulations, and would require that complementary medicines underwent a risk assessment process before being allowed for sale in either country. Although a significant body of information relevant to the safety of velvet and velvet extracts was readily available to facilitate this process, the same could not be said of the major deer co-products produced in this country (deer blood powder, pizzles, sinews and tails). This review was commissioned in order to assess and begin to address this deficiency.

Data have mainly been collated from articles published primarily in Chinese books, journals or conference proceedings, together with analytical reports provided by a range of New Zealand producers of co-products.

Where possible, co-product compositions have been compared to venison, deer velvet and velvet extracts, which are all products of demonstrably low risk.

The major findings were:

- A thorough search of the scientific literature, using online databases as well as other search engines, failed to uncover any formal studies on the toxicology of the co-products.
- There is, however, a long recorded history of medicinal use of deer co-products in the Chinese literature. This dates back to at least A.D. 659 in the case of deer blood, pizzles and sinews. Deer tails were added to the list of Traditional Chinese Medicine ingredients more recently, first appearing in the *Encyclopaedia of Chinese Materia Medica* in 1977.
- A Russian deer blood product, “Pantogematogen”, has been registered for use as a pharmaceutical in Russia and a number of other Eastern European countries. Pantogematogen has been used extensively by Russian sports teams during their preparation for major international sporting events, such as the 2000 Olympic Games.
- “Cervusen”, a product containing deer sinews (in combination with deer velvet and ginseng), has been registered by the Australian Therapeutic Goods Administration (TGA) for use as a medicine. Cervusen has been tested in a double-blind, placebo-controlled human clinical trial, and was

shown to be an effective product for alleviation of the symptoms of arthritis.

- More composition data are available for deer blood powder than for any other co-product. These demonstrate it to broadly be very comparable in composition to venison.
- The other three co-products have compositions that show similarities to venison and/or deer velvet and/or velvet extract. This is not unexpected, given that they are simply other tissues derived from the carcasses of deer.
- The limited nature of the available data, however, makes it difficult to interpret some of the inconsistencies that exist in some instances (particularly in the case of steroid hormone levels). More composition data is required to address this issue.

Recommendations

- That well designed trials be conducted to address the deficiencies identified in the available composition data, and to provide information on the effect of production and processing factors on the variability of co-product composition.
- Some toxicology studies, performed according to FDA or OECD guidelines, may need to be considered depending upon feedback from Medsafe.

1. BACKGROUND

1.1. The Therapeutic Products and Medicines Bill

On 5 December 2006 the Hon Annette King (Minister for Food Safety and for State Services) introduced an omnibus Bill for consideration by the New Zealand (NZ) Parliament. The Bill proposed two separate Bills that would 1) establish a joint trans-Tasman regulatory scheme for the regulation of therapeutic products, and 2) repeal the Medicines Act 1981 and replace it with updated legislation for controls on medicines. If passed, the Bill would result in harmonisation of the NZ and Australian regulatory systems for control of therapeutic products. A new joint agency, Australia New Zealand Therapeutic Products Authority (ANZTPA), would then replace the Australian Therapeutic Goods Administration (TGA) and the New Zealand Medicines and Medical Devices Safety Authority (Medsafe).

The regulatory activities of the ANZTPA would include:

- pre-market evaluation and assessment;
- product licensing;
- controls on manufacture;
- post-market monitoring and surveillance; and
- setting standards.

1.2. Impact of the proposed legislation on the deer industry

Given that the current regulatory environment in Australia is much more rigorous for products such as deer velvet and co-products than is the case in NZ, the proposed changes would have significant implications for the NZ deer industry. Deer Industry New Zealand (DINZ) has made submissions to the Government Administration Committee and to the ANZTPA Team at Medsafe that effectively detail the key issues (Crowley 2007; O'Connor 2007).

Under the new system, a risk-based evaluation of products would be performed and the level of regulation applied to the products would be commensurate with the identified level of risk. Medsafe anticipate that most complementary medicines would be classified as low risk (Class 1) medicines, while higher risk products like most over-the-counter and all prescription medicines would be Class 2.

Medsafe have already performed a risk assessment of deer velvet products, using extensive information provided by Velvet Antler Research New Zealand (VARNZ) on the composition and toxicology of deer velvet and water- and alcohol-based extracts. These products were judged to be of low risk and would (reportedly) be automatically classed as

Class 1 medicines under the new legislation (Ooi 2007)[1]. The legislation's impact on deer velvet products should thus be relatively minor.

For deer co-products, though, the potential impact on the manufacture and sale of deer co-products could be much greater. Currently these products are regulated as food products. Under the new regulations, unless sufficient data were available to justify them being regarded as being of low risk, deer co-products could be classed as Class 2 medicines. Registration for each product would then need to follow the normal registration for standard medicines. This would be a time consuming and expensive process that could see many of these products having to be taken off the market. To avoid this damaging situation, it is imperative that the deer industry accumulate sufficient data to demonstrate the safety of deer co-products.

1.3. Current status of the Bill

On 16 July 2007 it was announced by Annette King that the "Government is not proceeding at this stage" with the Therapeutic Products and Medicines legislation, owing to a lack of Parliamentary support. As a result, the ANZTPA establishment project is on hold, and the *status quo* prevails regarding the regulation of the manufacture and sale of deer co-products. Despite this, the imperative remains for the deer industry to put together a significant package of safety data on deer co-products in case the bill is revived by Parliament in future, and to support their current marketing efforts.

2. OBJECTIVES

The current review of data on the composition and toxicology of deer blood, pizzles (penis and testes), sinews and tails was commissioned be VARNZ to address the relative lack of information that is generally available on these deer co-products.

The objectives of the review were to collate relevant published and commercial data for provision to Medsafe and/or ANZTPA if required, and to identify any information gaps.

Consideration of microbiological safety of the co-products was outside the scope of the current review, as appropriate consideration of hygiene and adequate microbiological testing of final products will necessarily form part of Risk Management Programmes for their manufacture.

[1] *It should be noted, though, that DINZ have previously been advised by Medsafe that deer velvet powder would still be able to be sold as a food product. To the best of the author's knowledge, neither this, nor the information conveyed in the cited personal communication from Khay Ooi (Medsafe), have yet been confirmed in writing to DINZ.*

3. METHODOLOGY

A search of the scientific literature was conducted using OVID[2], which provided simultaneous access to the following online databases:

- BIOSIS Previews (1969 to present)
- CAB Abstracts (1910 to present)
- Food Science and Technology Abstracts (1969 to present)
- Ovid MEDLINE(R) and Ovid OLDMEDLINE(R) (1950 to present)
- Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations (to present).

Patents were searched using the Patent Lens search engine[3], and general internet searches were performed using Google[4] and Scirus[5]. In addition, the FDA website[6] was individually searched using the search engine provided. Webpages in non-English languages were translated online by use of Google Translate[7].

Conference proceedings and books that contained relevant information in English and/or Chinese were accessed from the personal libraries of the author and Drs Jimmy Suttie and Chunyi Li.

In addition a number of companies were directly contacted by phone and email for permission to use their composition data relating to relevant co-products.

Data that is presented for the composition of NZ co-products were derived from the analytical reports of the NZ laboratories that performed the analyses. Protein was calculated from total nitrogen values by multiplication with standard factors. In the case of products containing high levels of collagen, the factor for gelatine (5.55) was used; for other products the factor generally applied to meat products (6.25) was used (Paul *et al.* 1978). Composition data for non-NZ products was obtained from published papers, abstracts, and books.

4. DEER CO-PRODUCTS

The first recorded medicinal use of deer parts in Traditional Chinese Medicine (TCM) was found on a silk scroll dating back to 168 B.C., which was excavated from a Han Tomb in the Hunan Province of China. This included details of a number of prescriptions that involved

[2] *http://gateway.tx.ovid.com*

[3] *http://www.patentlens.net/patentlens*

[4] *http://www.google.co.nz*

[5] *http://www.scirus.com*

[6] *http://www.fda.gov*

[7] *http://translate.google.com*

the use of deer antlers and venison for the treatment of diseases. Since then, the medicinal properties of a wide range of deer parts have systematically been recorded in a series of over 2,000 publications first published in A.D. 200 and collectively known as *pênts'ao*.

Deer penis and testes, sinews and blood had all been added to the list of deer parts used for medicinal purposes by the time of the first official *pênts'ao* volume commissioned during the Tang dynasty (A.D. 659). The use of these three co-products, along with 16 other deer products including deer tails, still featured in the much more recent *Encyclopaedia of Chinese Materia Medica* (1977). This long history of application of a wide range of deer parts has resulted in deer being regarded as the most valuable of the medicinal animals in TCM, on a par with ginseng as the most prized medicinal plant (Kong *et al.* 1985, and references cited therein).

The processing, composition and usage of the key deer co-products produced in NZ (blood, pizzles, sinews, and tails) are discussed in the following sections.

4.1. Blood Products

4.1.1. Processing

In China deer blood is dried by either naturally in the sun, in an oven at 70-80°C or by vacuum drying (Wang *et al.* 1993; Tuckwell 2001; Zhao 2003). Patented processes for the freeze drying of deer blood, either in the presence or absence of ethanol, have been developed for use in New Zealand (Lee *et al.* 1996; Lee *et al.* 1997).

Preparations from Maral deer blood taken during the velvet antler growth season were first developed in Russia in 1955 (Frolov 2007). A sterile vacuum drying process has been in use since 1996 to produce one such product, "Pantogematogen siccum" (Pantogematogen dry, hereafter simply referred to as Pantogematogen) (Frolov *et al.* 2000; Frolov 2007; Lviv *et al.* undated).

4.1.2. Composition

A Chinese report gives the proximate composition of deer blood as 95.8% protein, 0.1% lipid, 3.0% ash and 1.7% moisture (Zhao 2003). These data agree fairly closely with NZ data for freeze dried deer blood (Table 1), once the higher residual moisture content of the NZ sample is taken into account.

Of the mineral elements, iron was present in relatively high concentration in NZ deer blood while calcium, in contrast, was found in low concentration (Table 2). The amino acid composition of Chinese deer blood (Table 3) is unremarkable in comparison to the average proportions of individual amino acids in a wide range of proteins (Creighton 1983).

Relatively high levels of both insulin-like growth factor 1 (IGF-1) and IGF-2 were found in NZ stag blood powder, which is typically produced from blood collected during the

spring and summer when deer velvet is actively growing (Table 4). Plasma IGF-1 concentrations are known to be elevated at this time (Suttie *et al.* 1985). Both growth factors were also present in similar concentrations in hind blood powder. Steroid levels, in contrast, were very low in both stag and hind blood (Table 4), with estradiol being undetectable in stag blood powder. The amount of vitamin B_3 measured in stag blood powder was comparable to the levels found in meat (Paul *et al.* 1978).

4.1.3. Usage

Deer blood is used in TCM as a tonic for anti-aging, to prevent fatigue, as a blood supplement, and to treat impotence, emission, weakness, lower back pain, palpitation, insomnia, lung and women's diseases (Wang *et al.* 1993; Tuckwell 2001; Zhao 2003). Typical dosages are in the form of pills or powders (1g/day) (Tuckwell 2001) or with herbs in deer blood wine (10-30ml/day of wine containing ~22% deer blood) (Zhao 2003).

In Russia, there are more than 20 types of biologically active food supplements, physiotherapy products, cosmetics and dietary products of Maral deer blood and deer velvet that are currently in industrial production. These products, including Pantogematogen, have undergone multiple clinical trials in patients over many years and are in use in health spas and resort for the treatment of humans (Frolov 2007; Rodriguez 2007). Clinical trials have been performed in Ukraine, Kazakhstan, Czech Republic, Bulgaria, and Norway as well as Russia, and Pantogematogen was approved for import in South Korea (although it is not currently shipped there for commercial reasons) (Frolov 2007). A list of references from Nickolay Frolov's recent book (in Russian) "*Deer Velvet Products*", in which these products and trials are described, is appended to this report.

Pantogematogen was registered as a biologically active food supplement in Russia in 1996. Extensive use has been made of Pantogematogen to enhance physical work capacity by numerous Russian youth and adult sports teams at international competitions since 1997. These have included wrestlers, golfers, boxers, and sportsmen at winter Olympic games. The Olympic Committee of Russia also adopted Pantogematogen as a sport diet supplement used by the Russian Olympic Team in preparation for the 2000 Olympic Games in Sydney (Frolov *et al.* 2001).

In 2000, "Pantogematogen siccum" and "Kropanol" (which contains Pantogematogen and glucose in gelatine capsules) were registered as a pharmaceutical substance and as a finished pharmaceutical product, respectively (Frolov 2007). Kropanol is indicated as a tonic (adaptogen) for improving mental and physical performance, to aid convalescence after illness and surgery, and to treat weakness or debility (Anon 2007b; Sweetman 2007; Lviv *et al.* undated). Contraindications are listed as hypersensitivity, increased excitability, epilepsy, apnoea condition, acute infectious disease, hypertension, expressed heart failure, high blood coagulability, and kidney failure. Pantogematogen is also marketed in the United States , with a suggested dose rate of 50-150mg/day (Anon 2007a). Some recent

studies demonstrating positive effects of Pantogematogen on impaired haemopoiesis in mice have been translated to English (Gol'dberg *et al.* 2000; Provalova *et al.* 2002a; Provalova *et al.* 2002b; Provalova *et al.* 2003; Provalova *et al.* 2004; Zhdanov *et al.* 2005). Further studies published in Russian journals were also found during the search of online databases (Ratner *et al.* 1999; Zhdanov *et al.* 2002; Stuchilov *et al.* 2003; Gorchakov *et al.* 2005; Gur'iantseva *et al.* 2006).

4.1.4. Tables – Deer Blood Powder

Table 1. Proximate composition of NZ deer blood powder.

Data were obtained by standard analysis of a single sample of freeze dried red deer blood. Protein was calculated as Total Nitrogen (%) x 6.25 (Paul *et al.* 1978), and carbohydrate was calculated by difference.

Component	Amount (%)
Protein	83.7
Fat	0.5
Ash	5.8
Carbohydrate	1.1
Moisture	8.9
Total	**100.0**

Table 2. Elemental composition of NZ deer blood powder.

Data presented are either the level of elements determined in a single sample of freeze-dried red deer blood, or are the individual values from two samples.

Component	Unit	Amount
Calcium	%	0.02, 0.02
Iron	%	0.22, 0.25
Magnesium	%	0.01, 0.01
Nitrogen	%	13.4, 14.5
Phosphorus	%	0.08, 0.09
Potassium	%	0.67, 0.70
Sodium	%	0.78, 1.04
Sulphur	%	0.49, 0.51
Cobalt	ppm	0.04
Copper	ppm	9
Manganese	ppm	1
Molybdenum	ppm	0.02
Selenium	ppm	0.38
Zinc	ppm	6

Table 3. Amino acid composition of Chinese deer blood powder.

Data presented are the means and ranges of individual amino acids as percentages of total sample weights of three samples of traditionally-dried or freeze-dried deer blood (Wei *et al.* 1996; Zhao 2003).

Amino Acid	Symbol	Amount (%)
Alanine	Ala	6.43 (6.01 - 6.75; n=3)
Arginine	Arg	3.57 (3.46 - 3.64; n=3)
Aspartic Acid	Asp	8.39 (8.04 - 8.61; n=3)
Cysteine	Cys	0.48 (0.44 - 0.51; n=2)
Glutamic Acid	Glu	7.09 (6.82 - 7.51; n=3)
Glycine	Gly	2.84 (2.73 - 2.96; n=3)
Histidine	His	4.56 (4.47 - 4.67; n=3)
Isoleucine	Ile	0.49 (0.46 - 0.54; n=3)
Leucine	Leu	10.27 (9.97 - 10.63; n=3)
Lysine	Lys	6.32 (6.22 - 6.40; n=3)
Methionine	Met	0.59 (0.55 - 0.64; n=3)
Phenylalanine	Phe	5.48 (4.86 - 5.96; n=3)
Proline	Pro	2.58 (2.56 - 2.60; n=3)
Serine	Ser	3.16 (2.89 - 3.38; n=3)
Threonine	Thr	4.54 (4.29 - 5.03; n=3)
Tyrosine	Tyr	1.85 (1.74 - 1.92; n=3)
Valine	Val	6.17 (5.76 - 6.84; n=3)
Total		**74.66 (74.22 - 74.91; n=3)**

Table 4. IGF-1, IGF-2, steroids and vitamin B3 (nicotinic acid) in NZ deer blood powder.

Data given are either the levels in a single sample of freeze-dried stag or hind blood, or are the means and ranges of the indicated number of samples.

Component	Unit	Stag	Hind
IGF-1	µg/g	0.28 (0.11 – 0.47; n=12)	0.19
IGF-2	µg/g	0.23	0.23
DHEA	ng/g	108	211
Estradiol	pg/g	nd* (n=8)	42
Progesterone	ng/g	23.5	26.6
Testosterone	ng/g	2.59 (0.06 – 9.3; n=8)	0.2
Vitamin B_3	µg/g	70.4	-

* not detected (<4-33pg/g)

4.2. Sinews

4.2.1. Processing

After attached muscle and fat is removed, sinews are thoroughly washed. Drying is performed either naturally or in an oven at 70-80°C (Wang *et al.* 1993; Tuckwell 2001; Zhao 2003).

4.2.2. Composition

Table 5 contains the proximate composition data that were available for two samples of NZ deer sinews. Although fat and ash were similar in the two samples, there was a marked difference in their protein contents (as calculated from total nitrogen levels). As a consequence their carbohydrate contents, calculated by difference of the other four proximate constituents from 100%, were also in poor agreement. Analysis of further samples would help to clarify whether these differences between the two samples reflect product variability or were simply the result of a single poor nitrogen determination.

The ash content of the NZ deer sinews was higher at 8.0% (Table 5) than that reported for sinews from Chinese sika deer and wapiti (0.7% and 1.1%, respectively) (Deng *et al.* 1991). This is suggestive of a small piece of bone remaining attached and being processed with the NZ sinews. This conclusion is supported by the higher calcium content in the NZ sinews (Table 6) as compared to the Chinese sinews (Table 7). The reason for the higher content of other elements (particularly sodium, potassium, phosphorus and iron) in Chinese relative to NZ sinews, though, is not clear.

The amino acid compositions of Chinese deer sinews (Tables 8 and 9) reflect the predominance of collagen in sinews, with much higher than normal proline and glycine contents.

Glycosylaminoglycans have been found in moderately high concentration in NZ sinews (Table 10), consistent with their usage for joint health. Hexosamines, which are also common ingredients of joint health dietary supplements, were not present in measurable amounts in the NZ sinews.

4.2.3. Usage

Used in TCM as a tonic for building energy, curing weak body condition, strengthening tendons and bones, and for treating rheumatism, joint pain, muscle spasms and eyesight ailments. Typically 100-200g will be eaten after frying or boiling or being cooked in a soup (Bellaney 1993; Wang *et al.* 1993; Tuckwell 2001; Zhao 2003).

"Cervusen" is a registered medicinal product that contains deer sinew in combination with deer velvet antler and Korean ginseng in gelatine capsules (Anon 2007c; Sweetman 2007). Cervusen was developed in Australia for treatment of arthritis and rheumatism

(Whitehouse *et al.* 1999). At the recommended dosage of 1-2 capsules/day, Cervusen delivers 25-50mg of deer sinew, and in a double-blind human clinical trial it has been shown to provide positive symptomatic relief of osteoarthritis (Edelman *et al.* 2000).

4.2.4. Tables – Deer Sinews

Table 5. Proximate composition of NZ deer sinews.

Data were obtained by standard analysis of two samples of dried NZ deer sinews. Protein was calculated as Total Nitrogen (%) x 5.55 (Paul *et al.* 1978), and carbohydrate was calculated by difference.

Component	Amount (%)	
Protein	51.4	75.5
Fat	1.7	2.8
Ash	8.0	8.0
Carbohydrate	22.3	4.3
Moisture	16.6	9.4
Total	**100.0**	**100.0**

Table 6. Elemental composition of NZ deer sinews.

Data presented are concentrations of various elements determined in a single sample of dried NZ deer sinews, or are the individual values from two samples.

Component	Unit	Amount
Calcium	%	2.86
Iron	%	0.004
Magnesium	%	0.06
Nitrogen	%	9.3, 13.6
Phosphorus	%	1.84
Potassium	%	0.02
Sodium	%	0.25
Sulphur	%	0.19
Copper	ppm	2
Manganese	ppm	3
Zinc	ppm	23

Table 7. Elemental composition of Chinese sika and wapiti deer sinews.

Data presented are elemental analyses of sinews from Chinese sika deer (meihualu) and wapiti (malu) (Deng *et al.* 1991).

Element	Symbol	Unit	Sika	Wapiti
Calcium	Ca	%	0.04	0.08
Iron	Fe	%	0.10	0.32
Magnesium	Mg	%	0.11	0.23
Nitrogen	N	%	15.6	17.6
Phosphorus	P	%	6.4	6.3
Potassium	K	%	6.4	5.4
Sodium	Na	%	9.1	8.1
Aluminium	Al	ppm	120	399
Barium	Ba	ppm	14.6	15.7
Cadmium	Cd	ppm	0.01	0.01
Chromium	Cr	ppm	7.3	40.1
Cobalt	Co	ppm	1.1	1.0
Copper	Cu	ppm	1.6	2.4
Lead	Pb	ppm	2.3	20.4
Lithium	Li	ppm	4.2	5.4
Manganese	Mn	ppm	4.4	7.6
Nickel	Ni	ppm	0.5	0.8
Strontium	Sr	ppm	3.4	5.5
Titanium	Ti	ppm	9.4	22.8
Vanadium	V	ppm	0.4	0.8
Zinc	Zn	ppm	26.8	19.9

Table 8. Amino acid composition of Chinese sika and wapiti deer sinews.

Data presented are percentages of total sample weight of representative amino acids in sinews from Chinese sika deer (meihualu) and wapiti (malu) (Deng *et al.* 1991).

Amino Acid	Symbol	Sika	Wapiti
Aspartic Acid	Asp	4.24	4.48
Glutamic Acid	Glu	8.83	7.67
Leucine	Leu	3.9	3.19
Lysine	Lys	2.84	3.10
Methionine	Met	0.55	0.46
Phenylalanine	Phe	2.74	1.94
Proline	Pro	28.62	19.84
Threonine	Thr	1.96	1.75
Tyrosine	Tyr	0.89	0.96

Table 9. Amino acid composition of Chinese deer sinews.

Data presented are percentages of total sample weight of individual amino acids in sinews of an unspecified species of Chinese deer (Zhao 2003).

Amino Acid	Symbol	Sinews
Alanine	Ala	2.87
Arginine	Arg	6.48
Aspartic Acid	Asp	11.33
Glutamic Acid	Glu	11.65
Glycine	Gly	12.78
Histidine	His	0.64
Isoleucine	Ile	1.16
Leucine	Leu	2.61
Lysine	Lys	2.73
Methionine	Met	0.66
Phenylalanine	Phe	1.54
Proline	Pro	11.78
Serine	Ser	2.48
Threonine	Thr	1.85
Tryptophan	Trp	3.03
Tyrosine	Tyr	2.52
Valine	Val	2.06
Total		**78.2**

Table 10. Glycosylaminoglycans and hexosamines in NZ deer sinews.

Data presented are individual levels of glycosylaminoglycans and hexosamines determined in two samples of dried NZ deer sinews.

Component	Amount (%)
Glycosylaminoglycans	1.6, 1.8
Hexosamines	Nil, <0.1

4.3. Pizzles (Penis & Testes)

4.3.1. Processing

Attached muscle and fat is first cut from the penis, testes, epididymis and foreskin, which are processed and sold together. These are pulled straight and fixed on a board for drying, either naturally or in an oven at 50-60°C (Bellaney 1993; Wang *et al.* 1993; Tuckwell 2001; Zhao 2003). The use of an additional heat treatment at 195-210°C, to reduce the "fish" smell and to facilitate grinding, has been reported by Deng and Yang (1990a). The frequency of use in China of this additional heat processing step is unknown.

4.3.2. Composition

The proximate compositions of NZ deer pizzles (combined penis and testes), and of separately analysed samples of penis and of testes, are given in Table 11. Some discrepancies are evident between the protein and carbohydrate values for the two individual pizzle samples, which may be due to a poor nitrogen determination for one of the samples. Fat was much higher in the testes alone, as compared to the penis alone. The fat content of the combined penis and testes, as usually consumed, was closer to that of penis alone. This result reflects the relative weight contributions of the penis and of the testes to the combined product.

The ash contents of Chinese sika deer and wapiti pizzles were comparable to NZ pizzles, and were unaffected by heat treatment at 195-210°C (Table 12). The latter processing step did, however, increase the yield of material extractable with 50% ethanol, presumably due to thermal degradation of protein to more soluble peptide fragments.

The elemental compositions of NZ and of Chinese deer pizzles were very comparable (Tables 13 and 14), and showed quite low content of mineral elements consistent with the low amounts of ash in the pizzles.

The amino acid compositions of Chinese sika deer and wapiti pizzles are shown in Table 15. Proline and glycine were both present in higher than usual proportions, indicative of a high collagen content in the pizzles (Creighton 1983). Heat treatment of the pizzles at 195-210°C resulted in 10-20% reductions in amino acid contents for reasons that are not immediately apparent.

Steroid levels in NZ deer pizzles are shown in Table 16, and as reported by two different authors in Chinese deer pizzles in Tables 17 and 18. There is significant discordance between the three sets of values for testosterone and estradiol concentrations. Those reported by the two Chinese authors differ by over three orders of magnitude for each of the two hormones. The NZ value for estradiol tends to agree with the lower of the two Chinese values, while the converse is true for testosterone. It should be noted, though, that the levels of the androgenic hormones (testosterone, DHEA and

androstenedione) in NZ pizzles were reported with ambiguous units, and it is possible the actual levels in the NZ sample may have been 200-fold lower than in Table 16 (i.e. 58 ng/g instead of 12 µg/g for testosterone). In rabbit testes, levels of testosterone ranging from 37-522 ng/g have been found (Castro *et al.* 2002). This agrees better with the lower testosterone values in deer pizzles, given that testicular tissue in deer pizzle powder is diluted with penis tissue.

Analysis of further samples is required to clarify the ambiguity regarding the levels of both androgenic and estrogenic steroids in deer pizzles.

The levels of a number of vitamins, prostaglandins, phospholipids and free amines and polyamines reported in Chinese deer pizzles are also given in Table 18.

4.3.3. Usage

Pizzles are taken to increase libido, treat male impotency and female infertility, and as a tonic to reinforce the "Yang", to nourish the kidneys and to overcome fatigue. Dosage is approximately 7-20g consumed as a concoction in rice wine, as a ground powder or simply as a food after cooking (Bellaney 1993; Wang *et al.* 1993; Tuckwell 2001; Zhao 2003).

4.3.4. Tables – Deer Pizzles

Table 11. Proximate composition of NZ deer pizzles.

Data presented were obtained by standard analysis of two samples of dried NZ deer pizzles (combined penis and testes), of a single sample of deer penis alone, or of two samples of deer testes alone. Protein was calculated as Total Nitrogen (%) x Factor, where Factor was 5.55 for combined penis and testes and for penis alone, and 6.25 for testes alone (Paul *et al.* 1978). Carbohydrate was calculated by difference.

Component	Combined		Penis	Testes	
Protein	87.5	51.9	77.9	60.9	70.0
Fat	2.9	1.5	1.6	15.3	10.7
Ash	1.1	7.7	1.4	1.4	4.6
Carbohydrate	1.4	21.4	*<1*	2.1	1.6
Moisture	7.1	17.5	20.3	20.3	13.1
Total	**100.0**	**100.0**	***>100***	**100.0**	**100.0**

Table 12. General composition of Chinese sika and wapiti deer pizzles.

Data presented are the amounts of various components of pizzles from Chinese sika deer (meihualu) and wapiti (malu) before and after heat treatment at 195-210°C (Deng *et al.* 1990a).

		Sika		Wapiti	
Component	**Unit**	**Before**	**After**	**Before**	**After**
Ash	%	3.6	3.2	3.5	3.5
Nitrogen	%	15.6	16.8	17.6	17.7
50% Ethanol extract*	% yield	8.7	22.8	8.8	19.5
Chloroform extract*	% yield	2.06	3.52	1.92	1.62

* Extractions performed according to the Chinese Pharmacopeia, 1985.

Table 13. Elemental composition of NZ deer pizzles.

Data presented are elemental analyses of up to three samples of NZ deer pizzles (comined penis and testes), or of separate single samples of deer penis or testes.

Element	Unit	Combined	Penis	Testes
Calcium	%	0.07 (0.02 - 0.14; n=3)	0.02	0.02
Iron	%	0.01, 0.02	0.02	0.01
Magnesium	%	0.01 (0.01 - 0.02; n=3)	0.01	0.06
Nitrogen	%	12.88 (9.36 - 15.77; n=3)	14.0	9.7
Phosphorus	%	0.16 (0.14 - 0.17; n=3)	0.06	0.84
Potassium	%	0.15 (0.05 - 0.21; n=3)	0.01	1.17
Sodium	%	0.29 (0.16 - 0.44; n=3)	0.38	0.66
Sulphur	%	0.30 (0.26 - 0.34; n=3)	0.22	0.45
Cobalt	ppm	-	0.08	0.05
Copper	ppm	2.0, 2.6	1	4
Manganese	ppm	1, 2	1	2
Molybdenum	ppm	-	0.05	0.15
Selenium	ppm	0.15	0.07	1.00
Zinc	ppm	17, 23	12	59

Table 14. Elemental composition of Chinese sika deer pizzles.

Data presented are elemental analyses of pizzles from Chinese sika deer (meihualu) (Dong *et al.* 1996).

Element	Symbol	Unit	Amount
Calcium	Ca	%	0.04
Iron	Fe	%	0.01
Magnesium	Mg	%	0.03
Phosphorus	P	%	0.52
Potassium	K	%	0.43
Sodium	Na	%	0.59
Aluminium	Al	ppm	24.0
Barium	Ba	ppm	1.7
Boron	B	ppm	6.0
Cadmium	Cd	ppm	0.005
Chromium	Cr	ppm	1.4
Cobalt	Co	ppm	0.4
Copper	Cu	ppm	3.5
Lead	Pb	ppm	0.8
Lithium	Li	ppm	0.04
Manganese	Mn	ppm	2.4
Molybdenum	Mo	ppm	1.7
Nickel	Ni	ppm	2.3
Strontium	Sr	ppm	1.2
Titanium	Ti	ppm	3.9
Vanadium	V	ppm	0.2

Table 15. Amino acid composition of Chinese sika and wapiti deer pizzles.

Data presented are percentages of total sample weight of individual amino acids in pizzles from Chinese sika deer (meihualu) and wapiti (malu) before and after heat treatment at 195-210°C (Deng *et al.* 1990a).

		Sika		Wapiti	
Amino Acid	**Symbol**	**Before**	**After**	**Before**	**After**
Alanine	Ala	9.49	7.65	6.88	5.37
Arginine	Arg	6.37	5.1	5.81	3.57
Aspartic Acid	Asp	4.89	4.83	3.78	3.47
Glutamic Acid	Glu	7.93	7.5	6.79	5.18
Glycine	Gly	9.16	8.96	8.58	6.94
Histidine	His	0.72	0.98	0.6	0.62
Isoleucine	Ile	1.42	1.76	1.26	1.2
Leucine	Leu	2.78	3.45	2.86	2.24
Lysine	Lys	3.11	3.24	2.51	2.42
Methionine	Met	0.53	0.61	0.43	0.42
Phenylalanine	Phe	1.81	2.04	1.79	1.34
Proline	Pro	21.37	15.16	20.82	15.35
Serine	Ser	2.26	2.26	2.01	1.58
Threonine	Thr	1.86	2.06	1.52	1.43
Tryptophan	Trp	-	-	-	0.05
Tyrosine	Tyr	0.94	1.43	0.7	0.94
Valine	Val	2.28	2.58	2.39	1.74
Total		**76.92**	**69.61**	**68.73**	**53.86**

Table 16. Steroids in NZ deer pizzles.

Data presented are the concentrations of steroids determined in a single sample of NZ deer pizzle.

Steroid	**Unit**	**Amount**
Androstenedione	µg/g	1.1
DHEA	µg/g	2.3
Estradiol	ng/g	0.063
Testosterone	µg/g	12

Table 17. Steroids in Chinese sika and wapiti deer pizzles.

Data presented are the concentrations of sex hormones in pizzles from Chinese sika deer (meihualu) and wapiti (malu) before and after heat treatment at 195-210°C, as reported by Deng and Yang (1990a).

		Sika		Wapiti	
Steroid	**Unit**	**Before**	**After**	**Before**	**After**
Estradiol	ng/g	810	810	550	560
Testosterone	µg/g	5.4	5.3	5.7	4.3

Table 18. Steroids, vitamins, and other components of Chinese sika deer pizzles.

Data presented are the concentrations of steroids, vitamins and other components in pizzles from Chinese sika deer (meihualu), as reported by Wang *et al.* (2003).

Component	**Unit**	**Amount**
Cortisol	ng/g	1.7
Estradiol	ng/g	0.48
Progesterone	ng/g	0.60
Testosterone	ng/g	3.5
Vitamin A	IU/g	36.7
Vitamin B_1	µg/g	0.64
Vitamin B_2	ng/g	0.08
Vitamin E	IU/kg	4.4
Prostaglandins	ng/g	79.0
Phospholipids	%	1.85
Polyamines	nmol/g	5.38
Monoamines	µg/g	1.73

4.4. Tails

4.4.1. Processing

The hair is removed from the tail and it is then washed briefly in 80-90°C water. Drying is performed in an oven at 50-60°C or naturally (during winter). Tails sold in Asian retail shops are waxed and polished to a bright jet-black colour, and have a distinctive odour similar to fermented soya (Kong *et al.* 1985; Bellaney 1993; Wang *et al.* 1993; Tuckwell 2001; Zhao 2003)

4.4.2. Composition

NZ deer tails were found to be moderately high in protein, high in fat, low in ash and moderately high in carbohydrate (Table 19). The ash contents of Chinese sika deer and wapiti tails were reported by Deng et al. (1990b) to be over twice that of the NZ deer tails (Table 20). In addition, a species difference was apparent between the two species of Chinese deer in terms of total nitrogen (and hence protein) and the yields of 50% ethanol and chloroform extracts (Table 20). The latter is indicative of total fat content, and was eight times higher for sika deer as compared to wapiti. The total nitrogen result for wapiti deer (18.5% N), however, needs to be regarded with some caution given that it implies a protein content of over 100% (Paul *et al.* 1978).

The elemental compositions of frozen and of processed NZ deer tails are given in Table 21 and demonstrate elevated calcium contents. This was probably due to the presence of the tail vertebrae. Iron was low, indicating a low amount of retained blood in the tails.

Partial amino acid compositions of Chinese sika deer and wapiti tails are shown in Table 22. Proline and glycine were both present in higher than usual proportions, indicative of a high collagen content (Creighton 1983). The amino acid compositions of the Chinese deer tails, however, did not show a species difference as reported for other components.

Androgens were relatively high in both NZ and Chinese deer tails (Tables 23 and 24, respectively), consistent with high fat content which accumulates steroids. The reason for the considerably (three orders of magnitude) higher estradiol levels reported in the Chinese deer tails as compared to the single NZ tail analysed is unknown. Potentially this could reflect a gender difference in the tails sampled, or be an analytical artefact.

IGF-1 in frozen NZ deer tail was below the detection limit of the assay (Table 23). In contrast, both glycosylaminoglycans and hexosamines were present in appreciable amounts in processed NZ deer tail (Table 23).

4.4.3. Usage

Tails are used to treat lower back pain, leg and knee pain, male impotency, spermatorrhea (involuntary discharge of semen), vertigo, tinnitus (noises or unpleasant sounds in the ears) and to improve virility. Dosage is typically 5-50g of tail, often taken as a wine concoction or added to food with other herbal or animal medicinal products (Bellaney 1993; Wang *et al.* 1993; Tuckwell 2001; Zhao 2003).

4.4.4. Tables – Deer Tails

Table 19. Proximate analysis of NZ red deer tails.

Data presented are the percentages of the major components in a single frozen NZ deer tail, or the means and ranges of the three samples of processed deer tails. Protein was calculated as Total Nitrogen (%) x 6.25 (Paul *et al.* 1978), and carbohydrate was calculated by difference.

Component	Frozen	Processed
Protein	28.6	59.4 (46.5 - 68.5; n=3)
Fat	6.9	6.0 (1.9 – 9.3; n=3)
Ash	2.0	4.9 (4.2 – 5.3; n=3)
Carbohydrate	3.2	17.8 (12.7 - 25.8; n=3)
Moisture	59.3	11.9 (9.4 – 16.8; n=3)
Total	**100.0**	**100.0**

Table 20. General composition of Chinese sika and wapiti deer tails.

Data presented are the amounts of various components of pizzles from Chinese sika deer (meihualu) and wapiti (malu) (Deng *et al.* 1990b). The reported nitrogen content of wapiti tails is very high, and should be treated with caution.

Component	Unit	Sika	Wapiti
Ash	%	12.6	13.7
Nitrogen	%	11.5	*(18.5)*
50% Ethanol extract*	% yield	8.6	16.0
Chloroform extract*	% yield	27.1	3.3

* Extractions performed according to the Chinese Pharmacopeia, 1985.

Table 21. Elemental composition of NZ deer tails.

Data presented are the concentrations of major elements and trace elements in a single frozen NZ deer tail, or in up to four samples of processed deer tails. Individual values are given if data were available for less than three samples; otherwise the means and ranges of the specified number of samples are presented.

Component	Unit	Frozen	Processed
Calcium	%	0.30	1.12 (0.69 - 1.34; n=3)
Iron	%	0.01	0.01, 0.02
Magnesium	%	0.02	0.04 (0.02 - 0.05; n=3)
Nitrogen	%	4.60	10.7 (8.38 - 12.34; n=4)
Phosphorus	%	-	0.76 (0.56 - 0.88; n=3)
Potassium	%	0.12	0.35 (0.32 - 0.38; n=3)
Sodium	%	0.07	0.21 (0.14 - 0.26; n=3)
Sulphur	%	0.38	0.74 (0.66 - 0.85; n=3)
Cobalt	ppm	0.02	-
Copper	ppm	1	3, 6
Manganese	ppm	<1	2, 2
Molybdenum	ppm	0.07	-
Selenium	ppm	0.22	0.18
Zinc	ppm	11	18, 31

Table 22. Amino acid composition of Chinese sika and wapiti deer tails.

Data presented are percentages of total sample weight of selected amino acids in Chinese sika deer (meihualu) and wapiti (malu) (Deng *et al.* 1990b).

Amino Acid	Symbol	Sika	Wapiti
Aspartic Acid	Asp	4.95	4.29
Glutamic Acid	Glu	7.13	7.36
Glycine	Gly	10.94	10.49
Isoleucine	Ile	1.33	1.36
Leucine	Leu	2.98	3.09
Lysine	Lys	2.90	1.45
Methionine	Met	0.48	0.50
Phenylalanine	Phe	1.79	1.91
Proline	Pro	21.13	18.48
Serine	Ser	2.33	2.33
Threonine	Thr	1.63	1.82
Tyrosine	Tyr	0.77	0.94
Valine	Val	2.26	2.40

Table 23. IGF-1, steroids and glycosylaminoglycans in NZ deer tails.

Data presented are the levels of the components determined in a single frozen NZ deer tail or in a single sample of processed deer tail powder.

Component	Unit	Frozen	Processed
IGF-1	µg/g	<0.05	-
Androstenedione	µg/g		4.6
DHEA	µg/g		3.2
Estradiol	ng/g		0.060
Testosterone	µg/g	11	3.5
Glycosylaminoglycans	%		1.5
Hexosamines	%		0.56

Table 24. Steroids in Chinese sika and wapiti deer tails.

Data presented are the levels of sex steroids in Chinese sika deer (meihualu) and wapiti (malu) (Deng *et al.* 1990b).

Component	Unit	Sika	Wapiti
Estradiol	ng/g	290	450
Testosterone	µg/g	2.3	4.5

4.5. Comparative Composition

4.5.1. General and elemental composition

In Tables 25 and 26 the composition of NZ deer co-products are compared to venison, deer velvet, and velvet extract. The latter three products were chosen for the comparison since they are either a standard food product (venison) or have been assessed by Medsafe as being of low risk (velvet and velvet extract). All data are presented relative to sample dry matter, to remove the complicating influence of variable levels of residual moisture from the comparisons.

Blood powder, pizzles, and tails contained the least amount of ash. The ash content of sinews was similar to that of venison and velvet extract, and deer velvet contained by far the highest levels of ash.

Protein showed a fairly similar, but inverse, pattern to ash. Levels were lowest in velvet, intermediate in pizzles, sinews and tails, and very high in velvet extract, venison and blood.

Crude fat was high in tails and venison, and very low in blood and velvet extract. Pizzles, sinews and velvet all contained similar, moderately low, amounts of fat.

Calcium and phosphorus were highest in the three products (velvet, sinews and tails) containing or attached to bone, owing to its contribution of calcium phosphate. In other products these elements tended to be present in very low concentrations.

Iron content was highest in products expected to contain blood or serum proteins (i.e. haemoglobin). Thus, blood powder contained the highest levels of iron, followed by velvet extract and velvet. The remaining products all contained very low levels of iron.

Magnesium was elevated in velvet relative to the other products, and was at similarly low levels in all co-products and in velvet extract.

Potassium was elevated in blood, venison and velvet extract. Levels were low in pizzles and sinews, and slightly higher in tails and velvet.

Sodium was relatively high in blood, velvet and velvet extract. Pizzles, tails and sinews had very similar levels of sodium to venison.

Tails and venison contained the most sulphur, followed by velvet extract and blood. Pizzles, sinews and velvet contained the least sulphur.

Of the trace elements for which comparable data was available (copper, manganese, selenium and zinc), only zinc demonstrated any marked variation between products (Table 26). This was high in venison and velvet. Pizzles, tails and sinews had similar levels of zinc to velvet extract, while the concentration in blood powder was very low.

IGF-1 was highest in freeze-dried velvet extract, but was also present in appreciable concentrations in freeze-dried deer blood collected during the velvet season. Levels in deer velvet were very variable, and ranged from undetectable to moderately high. This reflected processing differences, with low levels in velvet exposed to heat during drying and higher levels in freeze-dried velvet. The lack of detectable IGF-1 in the single deer tail analysed may have been due to its low blood content, possibly combined with a seasonal effect (if it was collected during the autumn or winter when IGF-1 levels in deer blood are low).

4.5.2. Amino acid composition

Table 27 contains the amino acid compositions of co-products of Chinese origin compared to venison. Where data for co-products from both sika deer and wapiti have been available, that derived from sika deer have been included in the table.

Broadly speaking, the products displayed amino acid compositions patterns that split them into two groups. Deer blood and venison were comparable, with higher histidine, leucine, lysine, phenylalanine, threonine and valine than in sinews, pizzles and tails. In the latter three products glycine and proline were the major amino acids, which is consistent with high proportions of collagen in these products.

4.5.3. Tables – Comparative Composition

Table 25. Comparative composition of NZ co-products, venison, velvet and velvet extract (major components).

Data presented are the levels of major components of NZ co-products as compared to venison, deer velvet powder, and aqueous velvet extract. Data for the latter three products were derived from the blind test of commercial velvet products performed by AgResearch for the Game Industry Board in 1998. All data are expressed on a dry matter basis.

Component	Unit	Blood	Pizzles	Tails	Sinews	Venison	Velvet	Velvet Extract
Ash	%	6.4 (n=1)	5.3 (1.2 - 9.3; n=2)	5.4 (4.9 - 5.8; n=4)	9.2 (8.8 - 9.6; n=2)	11.1 (8.9 - 13.3; n=2)	38.2 (31.3 - 47.5; n=12)	9.0 (5.0 - 12.7; n=3)
Crude Fat	%	0.5 (n=1)	2.5 (1.8 - 3.1; n=2)	9.3 (2.1 - 17.0; n=4)	2.6 (2.0 - 3.1; n=2)	6.5 (5.1 - 7.8; n=2)	2.1 (1.7 - 2.8; n=11)	1.1 (0.3 - 2.7; n=3)
Protein	%	91.9 (n=1)	78.6 (63.0 - 94.2; n=2)	67.8 (62.7 - 75.8; n=4)	72.5 (61.7 - 83.3; n=2)	88.4 (86.3 - 90.5; n=2)	57.4 (49.2 - 64.9; n=11)	85.0 (80.1 - 93.6; n=3)
Calcium	%	0.02 (n=1)	0.11 (0.06 - 0.15; n=2)	1.02 (0.74 - 1.48; n=3)	3.43 (n=1)	0.02 (0.01 - 0.02; n=2)	14.2 (10.95 - 17.39; n=11)	0.21 (0.06 - 0.39; n=3)
Iron	%	0.24 (n=1)	0.02 (0.01 - 0.02; n=2)	0.02 (0.01 - 0.02; n=3)	0.005 (n=1)	0.01 (0.01 - 0.01; n=2)	0.03 (0.015 - 0.044; n=12)	0.09 (0.048 - 0.142; n=3)
Magnesium	%	0.01 (n=1)	0.02 (0.01 - 0.02; n=2)	0.04 (0.03 - 0.06; n=3)	0.07 (n=1)	0.10 (0.09 - 0.11; n=2)	0.32 (0.26 - 0.39; n=12)	0.04 (0.01 - 0.06; n=3)
Nitrogen	%	14.7 (n=1)	14.2 (11.35 - 16.98; n=2)	11.9 (10.07 - 13.65; n=4)	9.4 (2.0 - 15.0; n=3)	14.1 (13.80 - 14.48; n=2)	9.2 (7.87 - 10.39; n=11)	13.6 (12.81 - 14.97; n=3)
Phosphorus	%	0.10 (n=1)	0.19 (0.18 - 0.20; n=2)	0.83 (0.68 - 0.97; n=2)	2.21 (n=1)	0.86 (0.77 - 0.94; n=2)	5.74 (4.71 - 6.82; n=12)	0.40 (0.09 - 0.59; n=3)
Potassium	%	0.74 (n=1)	0.14 (0.05 - 0.22; n=2)	0.37 (0.29 - 0.42; n=3)	0.02 (n=1)	1.55 (1.49 - 1.60; n=2)	0.30 (0.13 - 0.42; n=12)	1.35 (0.62 - 2.02; n=3)
Sodium	%	1.14 (n=1)	0.25 (0.17 - 0.33; n=2)	0.20 (0.17 - 0.25; n=3)	0.30 (n=1)	0.21 (0.17 - 0.25; n=2)	0.81 (0.66 - 1.06; n=12)	2.37 (1.49 - 3.39; n=3)
Sulphur	%	0.56 (n=1)	0.34 (0.32 - 0.37; n=2)	0.89 (0.80 - 0.94; n=3)	0.23 (n=1)	0.82 (0.80 - 0.84; n=2)	0.37 (0.24 - 0.45; n=12)	0.69 (0.42 - 0.86; n=3)

Table 26. Comparative composition of NZ co-products, venison, velvet and velvet extract (minor components).

Data presented are the levels of minor components of NZ co-products as compared to venison, deer velvet powder, and aqueous velvet extract. Data for the latter three products were derived from the blind test of commercial velvet products performed by AgResearch for the Game Industry Board in 1998. All data are expressed on a dry matter basis.

Component	Unit	Blood	Pizzles	Tails	Sinews	Venison	Velvet	Velvet Extract
Copper	ppm	10 (n=1)	2.9 (2.8 - 3.0; n=2)	4.7 (3 - 7; n=3)	3 (n=1)	7.5 (6 - 9; n=2)	4.7 (4 - 6; n=12)	14.3 (7 - 23; n=3)
Manganese	ppm	1 (n=1)	1.5 (1 - 2; n=2)	2.1 (2 - 2; n=2)	3 (n=1)	1 (1 - 1; n=2)	2.1 (1 - 4; n=12)	1 (1 - 1; n=3)
Selenium	ppm	0.42 (n=1)	0.16 (n=1)	0.36 (0.20 - 0.53; n=2)		0.36 (0.33 - 0.38; n=2)	0.18 (0.05 - 0.30; n=12)	0.33 (0.17 - 0.42; n=3)
Zinc	ppm	7 (n=1)	22.4 (20 - 25; n=2)	27.7 (22 - 34; n=3)	27 (n=1)	196 (135 - 257; n=2)	68.2 (59 - 89; n=12)	27.7 (9 - 41; n=3)
IGF-1	µg/g	0.30* (0.12 - 0.52; n=12)	-	<0.1 (n=1)	-	0.001 (0.000 - 0.003; n=2)	0.055 (0.000 - 0.242; n=12)	1.12 (n=1)

* Based on an assumed 91.1% dry matter content of all 12 samples.

Table 27. Amino acid composition of Chinese co-products compared to venison.

Data presented are are percentages of total sample weight of amino acids in Chinese deer blood, sinews, pizzles (sika deer), and tails (sika deer), and are reproduced from Tables 3, 9, 15 and 22, respectively. Comparative values for venison are as reported in the book by Zhao (2003).

Amino Acid	Symbol	Blood[1]	Sinews[2]	Pizzles[3]	Tails[4]	Venison[2]
Alanine	Ala	6.43	2.87	9.49	-	5.05
Arginine	Arg	3.57	6.48	6.37	-	7.44
Aspartic Acid	Asp	8.39	11.33	4.89	4.95	7.34
Cysteine	Cys	0.48	-	-	-	-
Glutamic Acid	Glu	7.09	11.65	7.93	7.13	17.1
Glycine	Gly	2.84	12.78	9.16	10.94	3.66
Histidine	His	4.56	0.64	0.72	-	2.64
Isoleucine	Ile	0.49	1.16	1.42	1.33	4.17
Leucine	Leu	10.27	2.61	2.78	2.98	9.64
Lysine	Lys	6.32	2.73	3.11	2.90	8.41
Methionine	Met	0.59	0.66	0.53	0.48	6.26
Phenylalanine	Phe	5.48	1.54	1.81	1.79	3.63
Proline	Pro	2.58	11.78	21.37	21.13	3.74
Serine	Ser	3.16	2.48	2.26	2.33	2.95
Threonine	Thr	4.54	1.85	1.86	1.63	3.71
Tryptophan	Trp	-	3.03	-		-
Tyrosine	Tyr	1.85	2.52	0.94	0.77	2.95
Valine	Val	6.17	2.06	2.28	2.26	4.28
Total		**74.7**	**78.2**	**76.9**	**-**	**93.0**

[1] Wei *et al.* (1996) and Zhao (2003).

[2] Zhao (2003).

[3] Deng *et al.* (1990a).

[4] Deng *et al.* (1990b).

5. ACKNOWLEDGEMENTS

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6. APPENDIX – REFERENCES RELEVANT TO PANTOGEMATOGEN

The following is a list of 30 key references from the book "*Deer Velvet Products*", including ones describing clinical trials with Pantogematogen, translated from Russian by the author Nickolay Frolov (personal communication 2007). Most of these articles have not been sighted by the author of this report.

1. Alexandrov, V. and others. The Health and Preventive Medical Technologies of Using Deer Velvet Products. Study Guide. – Barnaul: The Altay State University Publisher, 2004. – 67 pages.

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