COMPARATIVE COMPOSITION OF VELVET ANTLER

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SUMMARY

The objective of this work was to provide data on the chemical composition of a wide sample of top grade NZ Red velvet antler and to compare this with velvet antler from other sources The influence of stage of growth of the antler was also compared in velvet antler from 2 year old NZ Red stags cut at different times after casting of the hard antler

The average ash and lipid contents of the top grade NZ Red antler (n = 17) were 34 0 ± 1 96 (SD)% and 2 50 ± 0 56% respectively By comparison the NZ Red 2 year old 55 day antler (n = 6) contained 33 1 ± 1 24% ash and 3.16 ± 0.49% lipid and the Russian antler (n = 6) contained 35 5 ± 1 69% ash and 1 48 ± 0 28% lipid The differences in ash content were not statistically significant but those in lipid content were, with the NZ Red 2 year old being significantly higher than the top grade NZ Red and the Russian being significantly lower than both the NZ Red groups There were insufficient antlers analysed to make conclusions about the other types analysed

Stage of growth had a very marked influence on chemical composition in the NZ Red 2 year old velvet antler (one antler was cut at 55 days from 6 stags and the contralateral antler cut at various stages from 43 to 67 days after hard antler casting) While total weight increased over time, the ash, calcium and phosphorus contents increased and the content of lipid decreased, indicating the increasing mineralisation with time after casting

There was a significant relationship between whole antler lipid and whole antler ash contents in the NZ Red top grade group, such that a 1% unit increase in ash content was associated with a 0 15% unit decrease in lipid content. Generally the NZ Red 2 year old day 55 antlers had higher lipids while the Russian antlers had markedly lower lipid contents for their particular ash contents There was no relationship between the grade of NZ Red velvet antler and composition This is not surprising since it was all harvested at approximately the same stage of growth

INTRODUCTION

The production of velvet antler is a very important aspect of deer farming in New Zealand Over the last few years, production has increased rapidly, such that in the 1990-91 season, levies were collected on 307 tonnes (C Isaacs, pers. comm) compared with 122 tonnes 3 years earlier (GIB Report, 1988) The major market for NZ velvet antler is South Korea, where the major competitor is product from China and Russia

The study reported here is financed by the NZ Game Industry Board and is part of a larger scale approach to the evaluation of velvet antler relevant to market development both in Korea and elsewhere The objective of this study was to obtain basic information on the chemical composition of NZ velvet antler and to compare this with velvet from other sources Minerals and total lipid were analysed, the ash and mineral composition being of interest in terms of the stage of maturity and mineralisation of the velvet antler while the lipid content is of interest because of the association between lipid and one indicator of biological activity, the hypotensive assay (Fennessy 1991)

ANTLERS AND ANALYSIS

The NZ velvet antlers were obtained from farms throughout New Zealand, mainly from the 1989 harvest Velvet antlers from two-year-old stags were obtained from the Invermay 1990 harvest The Chinese and Russian velvet antlers were purchased in Hong Kong and the Australian velvet antler was obtained from Australian pools (see Table 1).

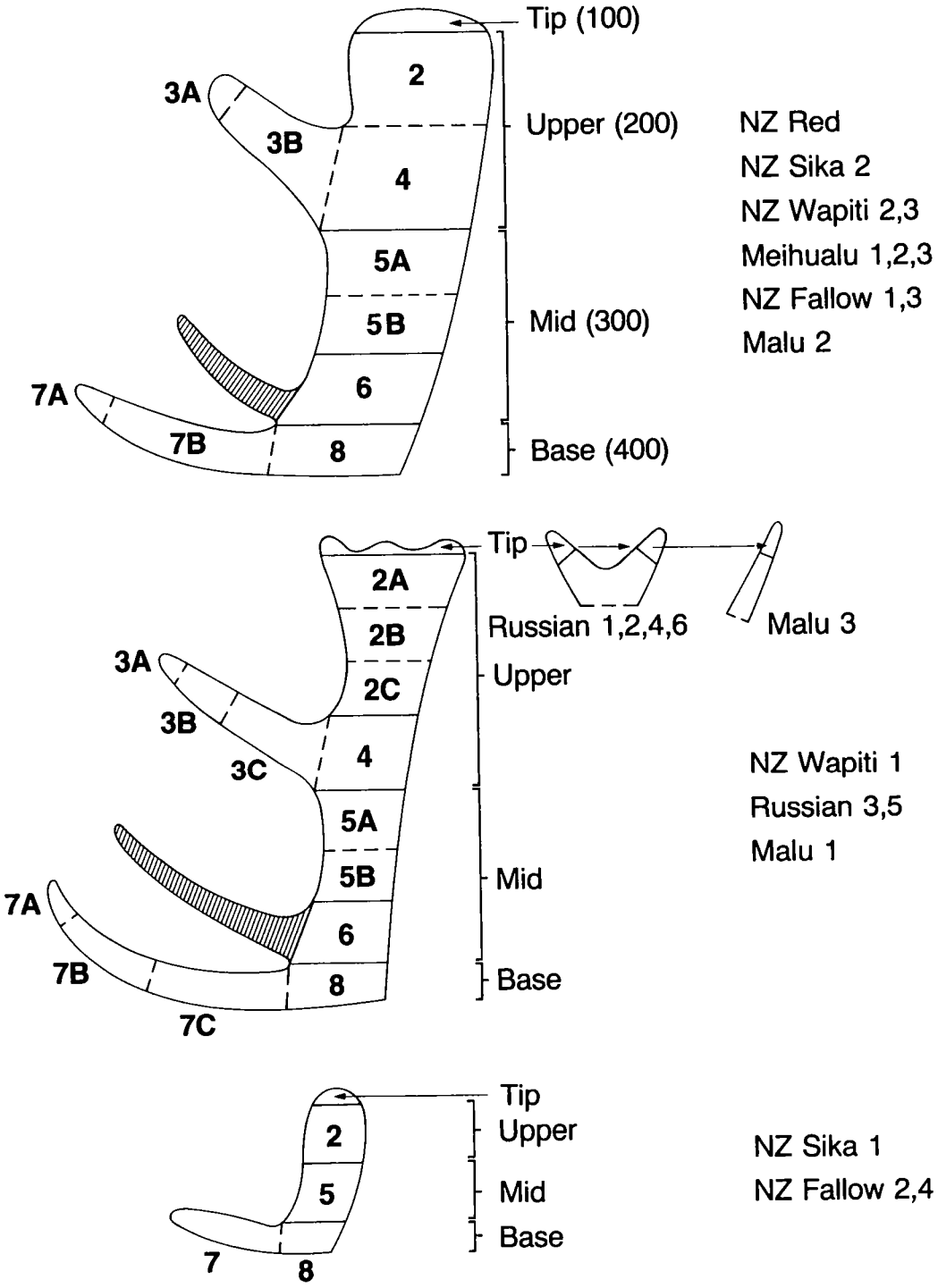

FIGURE 1. Diagram of velvet antlers as analysed by section

TABLE 1 Weight details of velvet antlers analysed (± SD for sample sizes of 6 or more individual antlers)

	Number	Processed dry weight (kg)[1] Mean ± SD	Range
Russian	6	1 37 ± 0 57	0 73 - 2 18
NZ Wapiti	3	0 92	0 65 - 1 34
NZ Red top grade	17	0 53 ± 0 14	0 32 - 0 92
Chinese Meihualu	3	0 51	0 44 - 0 57
Chinese Malu	3	0 48	0 42 - 0 56
NZ Red 2 year old	6	0 22 ± 0 05	0 13 - 0 25
Australian Rusa	3	0 22	0 19 - 0 25
NZ Sika	2	0 15	0 11, 0 18
NZ Fallow	4	0.066	0 044 - 0 079

[1] Processed antlers contain about 15% moisture

The antlers were cut into sections (Figure 1) and then analysed for ash (ie, minerals), lipid (fat), nitrogen and a number of major and minor minerals Selected data from the final report (Fennessy and Duncan 1992) are reported here The NZ Red 2 year old velvet antlers were taken from 6 stags at Invermay with one antler being harvested at 55 days after hard antler casting, and the other over the range from 43 to 67 days so that changes in composition with stage of growth could be analysed. All of the other NZ Red velvet antlers were harvested at the rounded main beam stage prior to eruption of the royal tines All but 3 of these were graded as super A (2) or A (12) The stage of growth of the other antlers analysed is shown in Figure 1 By the NZ Game Industry Board standards, the Russian and 2 of the 3 Chinese Malu velvet antlers were overgrown, but these are the preferred type of product in the Korean market, being a generally larger antler type This is especially so for the Russian product, the preference being reflected in Hong Kong wholesale prices (approximately $US900/kg dried for Russian compared with $US400/kg dried for NZ Red velvet for 1992, C Isaacs pers comm)

GROSS COMPOSITION

Sample sizes (except for the NZ Red velvet antler) were small and where less than 6 antlers were analysed, only the mean and the range are presented Table 2 provides a comparison of some of the major components for the two NZ Red groups and the Russian velvet antler group

TABLE 2 Comparisons of mean values for components (± SE) in the complete velvet antler where sufficient numbers were available for statistical comparisons (statistical significance levels NS, not significant, *P<0 05 and **P<0 01 when compared with the NZ Red top grade velvet antler).

	NZ Red top grade	NZ Red 2 year old	Russian
Number of velvet antlers	17	6	6
Components (as % of DM ± SE)			
Ash	34 0 ± 0 48	33 1 ± 0 51^{NS}	35 5 ± 0 69^{NS}
Lipid	2 50 ± 0 14	3 16 ± 0 20*	1 48 ± 0 11**
Nitrogen (N)	8 4 ± 0 12	7 8 ± 0 07**	9 0 ± 0 16*
Calcium (Ca)	12 1 ± 0 27	11 2 ± 0 26*	12 9 ± 0 39^{NS}
Phosphorus (P)	5 8 ± 0 08	5 4 ± 0 20^{NS}	6 3 ± 0 23*
Sulphur (S)	0 43 ± 0 01	0 42 ± 0 01^{NS}	0 36 ± 0 01^{NS}
Magnesium (Mg)	0 25 ± 0 01	0 24 ± 0 01^{NS}	0 25 ± 0 01^{NS}
Sodium (Na)	0 83 ± 0 01	0 82 ± 0 02^{NS}	0 69 ± 0 02**
Potassium (K)	0 42 ± 0 10	0 47 ± 0 02^{NS}	0 33 ± 0 01^{NS}
Trace mineral components (as mg per kg of DM ± SE)			
Manganese (Mn)	3 4 ± 0 1	3 1 ± 0 3^{NS}	2 5 ± 0 2**
Zinc (Zn)	69 ± 2 2	57 ± 1 9**	66 ± 4 6^{NS}
Copper (Cu)	5 3 ± 0 1	3 6 ± 0 1**	4 0 ± 0 1**
Iron (Fe)	319 ± 17	267 ± 14*	366 ± 39^{NS}
Selenium (Se)	0 18 ± 0 02	0 16 ± 0 01^{NS}	0 15 ± 0 02^{NS}

Compared with the NZ Red top grade velvet antler, the NZ Red 2 year old had a significantly higher lipid and lower nitrogen, calcium and phosphorus contents The Russian velvet antler had significantly lower lipid and higher phosphorus and nitrogen contents than the NZ Red top grade product The differences in the composition of the two NZ groups are probably a reflection of the differences in the stage of maturity at harvest Similarly, the higher ash, calcium and phosphorus of the Russian compared with the NZ Red product reflects the more advanced stage of growth of the Russian product at harvest

Table 3 presents some selected data for the three types as in Table 2, along with data for the other types analysed While direct comparisons are questionable because of sample size, the differences between the different types in total lipid and total ash may well be indicative of real differences, but firm conclusions would require considerably more velvet antlers to be analysed

TABLE 3 Comparative composition of NZ Red velvet antler and others (± SD for sample sizes of 6 or more antlers or range for less than 6 antlers)

	Components (mean ± SD or range, % of DM)			
	Ash	Lipid	Nitrogen	Calcium
NZ Red (17)	34 0 ± 1 96	2 50 ± 0 56	8 4 ± 0 51	12 1 ± 1 11
NZ Red 2 yo (6)	33 1 ± 1 24	2 81 ± 0 53	7 8 ± 0 17	11 2 ± 0 63
Russian (6)	35 5 ± 1 69	1 48 ± 0 28	9 0 ± 0 39	12 9 ± 0 95
NZ Wapiti (3)	33 6 (30 9-37 9)	2 07 (2 06-2 08)	8 8 (8 3-9 7)	11 7 (10 8-13 3)
Chinese Meihualu (3)	35 7 (35 0-36 9)	2 46 (2 00-2 71)	8.8 (8 4-9 2)	13 0 (12 0-14 3)
Chinese Malu (3)	34.1 (31 3-37 7)	1 39 (1 17-1 64)	9 2 (8 3-9 8)	11 9 (10 6-13 6)
Australian Rusa (3)	37 9 (35 4-39 9)	1 21 (1 09-1 33)	8 6 (8 3-8 8)	13 6 (12 8-14 3)
NZ Sika (2)	36 9 (34 6, 39 1)	2 21 (1 77, 2 65)	8 4 (7 9, 8 9)	12 3 (11 0, 13 6)
NZ Fallow (4)	32 0 (31 6-32 4)	2 64 (2 16-3 57)	9 3 (9 1-9 6)	9 9 (9 4-10 2)

SECTIONAL COMPOSITION

The antler is a rapidly growing and differentiating tissue at the stage when it is harvested as high quality velvet antler This is reflected in the differences in composition between different parts of the antler Table 4 and Figure 2 present the data for selected components for the seven sub-sections making up the NZ Red 2 year old velvet antlers

TABLE 4 Mean values (± SD) for the percentage of antler in each sub-section (refer Fig 1) and the percentage composition for ash, lipid, nitrogen, calcium, zinc, selenium and iron in the NZ Red 2 year old velvet antler (n=6)

		Composition (in antler dry matter)						
		% of DM				mg/kg of DM		
Sub-section	Percentage of antler	Ash	Lipid	Nitrogen	Calcium	Zinc	Selenium	Iron
Tip	2 5 ± 0 6	8 0 ± 1 1	6 3 ± 0 75	11 8 ± 0 3	0 08 ± 0 06	40 ± 4	0 29 ± 03	432 ± 139
2	9 9 ± 4 5	20 4 ± 5 5	4 3 ± 0 37	9 3 ± 1 3	5 6 ± 2 4	45 ± 10	0 25 ± 02	366 ± 66
3 + 4	19 0 ± 3 4	27 3 ± 3 6	3 6 ± 0 59	8 4 ± 0 7	9 0 ± 1 7	61 ± 7	0 24 ± 02	408 ± 16
5	15 5 ± 1 3	33 6 ± 1.6	2 9 ± 0.35	7 6 ± 0 3	11 3 ± 0 8	65 ± 7	0 19 ± 03	368 ± 108
6	14 1 ± 1 3	37 0 ± 3 1	2 5 ± 0 26	7 4 ± 0 3	13 1 ± 1 0	62 ± 6	0 13 ± 03	232 ± 113
7	18 5 ± 3 0	34 8 ± 2 4	3 8 ± 0 65	7 6 ± 0 5	10 9 ± 1 8	57 ± 5	0 13 ± 02	157 ± 34
8	20 6 ± 4 9	42 4 ± 0 9	1 9 ± 0 36	6 9 ± 0 5	15 7 ± 1 1	59 ± 4	0 09 ± 01	128 ± 30

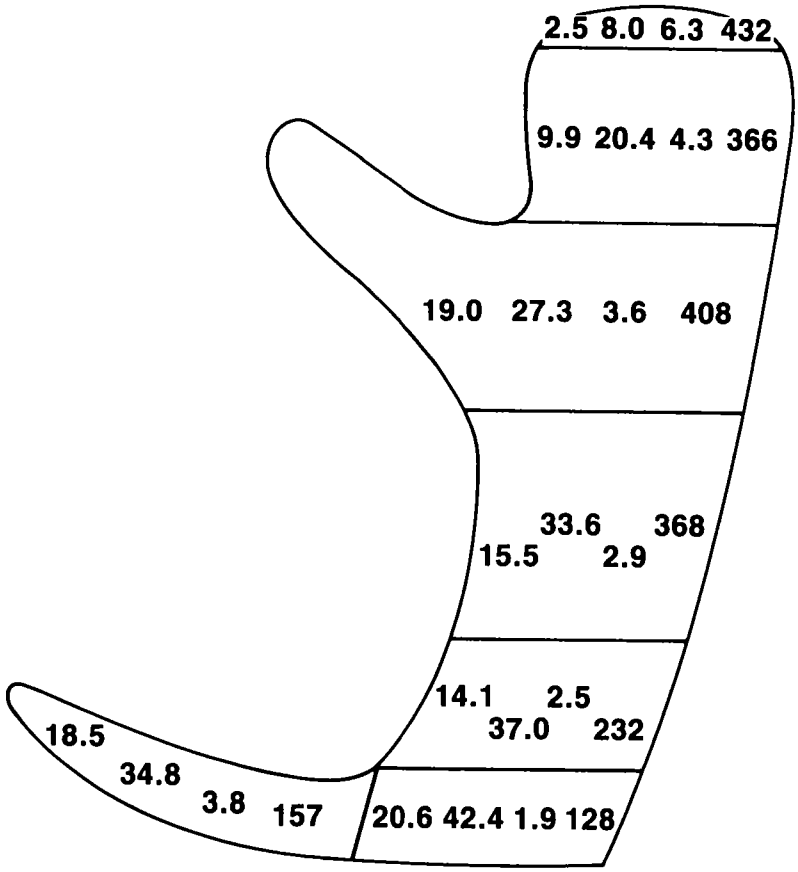

FIGURE 2 Mean values for selected components of NZ Red 2 year old day 55 velvet antler, percentage of dry matter in sub-section, percentage ash and percentage lipid in dry matter (DM) and iron content (mg/kg of DM), note the relatively high lipid content (3 8%) of the brow tine

The low ash and calcium and the higher lipid content of the tip are readily apparent, although this has little influence on the total composition as the tip makes up only a very small proportion of the total antler. Other noteworthy points are the increase in ash and calcium contents and the decrease in lipid and nitrogen from the upper to the lower portions of the antler The higher mineralisation and calcification of the lower parts of the antler are simply a reflection of the pattern of growth and differentiation of the antler The notable exception to this trend is the significantly higher lipid content of the brow tine compared with the adjacent main beam. This would appear to be a general phenomenon as it was apparent in several antler types analysed (eg, NZ Red top grade, 3 67 and 1 44 (SED ± 0 48) % lipid and Chinese Malu, 2 48 and 1 16 (SED ± 0 61) % lipid)

The differences in the composition of the different sub-sections of the antler are highlighted further by a comparison of the mean ash content of the NZ Red top grade and the Russian velvet antler shown in Figure 3. The lower ash contents of both the antler tip and the tips of both the trez and bez tines compared with the adjacent sections are readily apparent The progressive increase in ash content from the tip to the base is also apparent The Russian velvet antler has a higher ash content than the NZ Red in all sections Such differences are also apparent in the comparison of both lipid and ash contents when the antler is divided into the four main sub-sections as shown in Figure 4 The lipid contents of all four sections of the NZ Red velvet antler were significantly higher than the corresponding sections in the Russian velvet antler, similarly the ash contents of the two mid sections were higher in the Russian product The differing distribution among the four sub-sections of the velvet antler between the Russian and NZ Red product reflects the later stage of maturity of the Russian product at the time of harvest (ie, higher proportion of the antler in the upper section of the Russian compared with the NZ product)

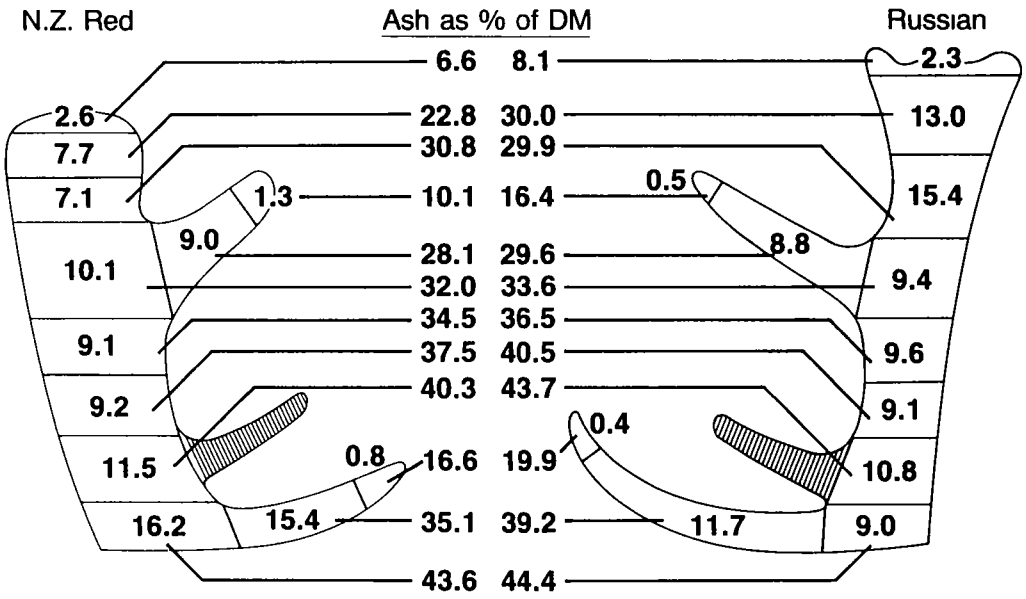

FIGURE 3. Comparative percentage of the velvet antler in each sub-section and the percentage ash in each sub-section for the NZ Red top grade and Russian velvet antler

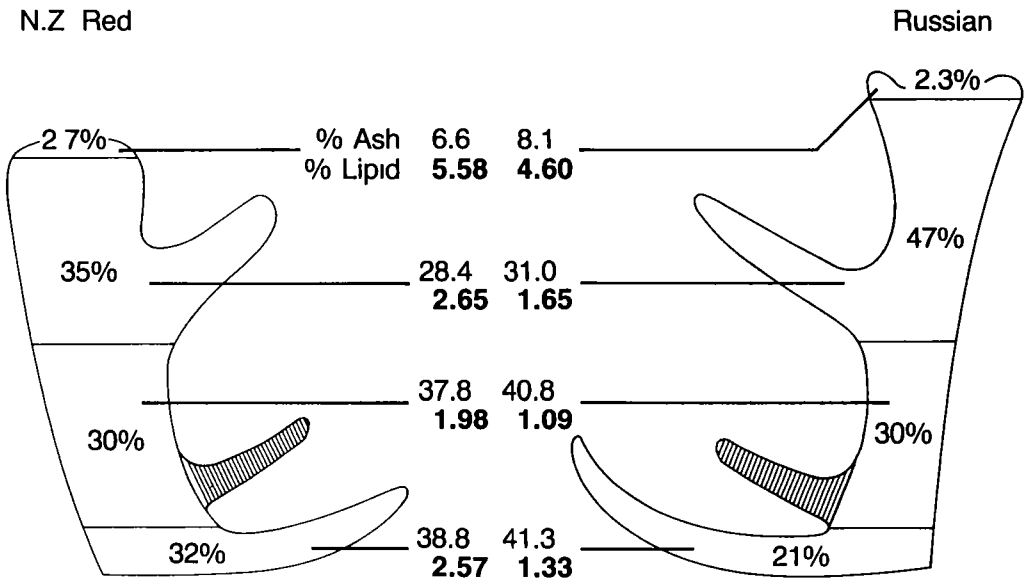

FIGURE 4. Comparative percentage of the velvet antler in each of the four main sub-sections and the percentage of ash and lipid, for the NZ Red top grade and the Russian velvet antler

STAGE OF GROWTH AND COMPOSITION AND COMPOSITIONAL INTER-RELATIONSHIPS

The influence of the stage of growth at harvest on the gross chemical composition of velvet antler was examined in the NZ Red 2 year olds In six stags, one antler was harvested at 55 days after casting (control) and the other was cut at 43 to 67 days The concentration of the chemical component in the latter antler was then expressed relative to the control antler and the regression of the relative concentration on days of growth derived The data are summarised in Table 5 and Figure 5.

TABLE 5 Significant regression relationships between velvet antler components (relative concentration) and days of growth expressed relative to contralateral antler cut at 55 days after hard antler casting (see also Fig 5, statistical significance levels (*)P<0 10, *P<0 05, **P<0.01)

	Regression equation (± SE)	r^2	Mean concentration of component in DM
Positive relationships (increasing with time)			
Relative ash	= 0 0077 (± 0 0010) Days + 0 60	0 93**	33 1%
Relative calcium	= 0 0128 (± 0.0056) Days + 0 27	0 46(*)	11 2%
Relative phosphorus	= 0 0088 (± 0 0032) Days + 0 49	0.57*	5.4%
Negative relationships (decreasing with time)			
Relative lipid	= -0 0132 (± 0 0014) Days + 1 69	0 95**	3 16%
Relative sulphur	= -0 0142 (± 0 0024) Days + 1 79	0 87**	0 42%
Relative sodium	= -0 0062 (± 0.0019) Days + 1 36	0 67*	0 82%
Relative potassium	= -0 0154 (± 0 0049) Days + 1.86	0 64*	0 47%
Relative selenium	= -0.0123 (± 0 0035) Days + 1 65	0 70*	0.16 mg/kg

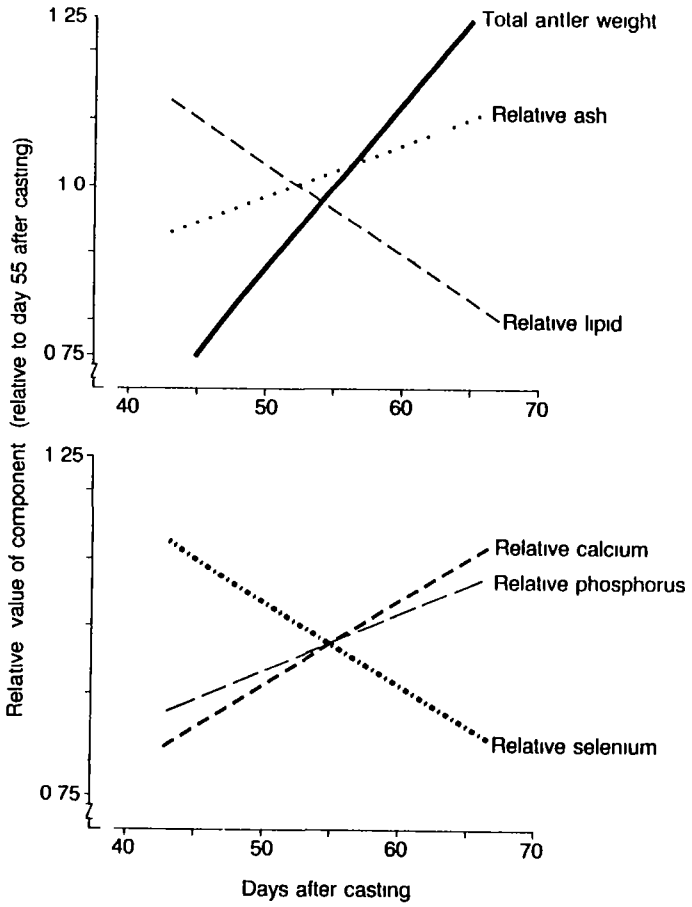

FIGURE 5 Regression lines for the relative relationships between velvet antler components and days of growth (ie, days after casting) for the 2 year old NZ Red stags (relative concentration expressed relative to that in the paired antler cut at 55 days after casting) Upper relative weight, relative concentration of total ash and total lipid Lower · relative concentration of total calcium, phosphorus and selenium

There were marked effects of stage of growth (days after casting) as reflected in the significant increases in the relative concentrations of ash, calcium and phosphorus as would be expected with an increasing degree of mineralisation In contrast, the relative lipid concentration declined along with sulphur, sodium, potassium and selenium Translated into actual concentrations, the ash content increased by 0 25% per day and the lipid content declined by 0.04% per day over the 43 to 67 day range The inverse relationship between the ash and lipid contents was also apparent in the group of NZ Red top grade antlers This regression relationship was

Antler lipid % = 7 42 (± 0 064) - 0 145 Antler ash %
(r^2 = 0 21, residual standard deviation ± 0 50)

The relationship indicates that a 1 0% unit increase in antler ash was associated with a 0 15% unit decline in antler lipid content This rate of change is very similar to that of the NZ Red 2 year old velvet antlers Interestingly from an interpolation of the relationship between the relative lipid content and days of growth for the 2 year olds in Table 5, the lipid content of the NZ Red top grade velvet antler is equivalent to that of 66 day Red 2 year old velvet antler Based on the appearance of the top grade Red velvet, this is probably about the stage that it was actually harvested In contrast the ash content of the NZ Red top grade is what would be expected for the NZ Red 2 year old at 55 days That is the 2 year old antler is relatively more highly mineralised at 55 days than the Red top grade, it is also relatively highly mineralised for its lipid content

In order to compare further the various velvet antlers with the basic NZ Red top grade as a standard, the lipid and ash contents of the various antlers are plotted along with the regression for the NZ Red top grade velvet antler in Figure 6 These comparisons also indicate that the NZ Red 2 year old day 55 velvet antlers have a generally higher lipid content than would be expected for their particular ash content The Chinese Meihualu are similar to the NZ Red but both the Russian and the Chinese Malu are markedly below the NZ Red regression line. That is they have relatively low lipid contents for their ash contents

A comparison of the composition of velvet and hard antler would also indicate some aspects of the influence of stage of growth on composition Therefore Table 6 presents data for the comparative composition of the NZ Red velvet antler and that of Scottish hard antler The ash content of the velvet antler was about 60% of that of the hard antler, while the values for calcium and phosphorus were around 55% of that for hard antler The influence of the stage of growth on composition as reflected in both the number of antler branches and the time after casting is also apparent in some Russian data for Caspian (*C elaphus maral*) stags shown in Table 7

TABLE 6 Comparative composition of NZ Red velvet antler and hard antler (components as % of DM)

	Components (% of antler dry matter)			
	Ash	Calcium	Phosphorus	Magnesium
Velvet antler[1]	34 0	12 1	5 8	0 25
Hard antler[2]	57 1	22 6	10 6	0 34

[1] NZ Red top grade velvet antler
[2] Data from Hyvarinen *et al* (1977) for Scottish red deer stags (n=19)

TABLE 7 Comparative ash content of Caspian stag velvet antler (data from Gavrin, 1976) according to stage of growth at harvest (± SE ? , number of antlers analysed is not clear but other data in the same publication were for the mean of 5 antlers)

Type[1]	3-branch	4-branch	5-branch	6-branch
I	33 1 ± 0.5	35 7 ± 0 6	40 2 ± 0 8	40 9 ± 0 7
II	37 1 ± 0 4	40 4 ± 0 5	44 7 ± 0 6	45 1 ± 0 5
III	40 7 ± 0 4	43 6 ± 0 5	48 4 ± 0 5	50 5 ± 0 7

[1] The definitions of velvet antler type are Type I has a rounded end without signs of ossification, Type II has an insignificant sharpness at the tip with some signs of ossification and a slightly porous cut surface, Type III has sharp tips, with lumps and grooves on the surface, obvious signs of calcification and damaged velvet skin.

The Caspian Type III 5- and 6-branch velvet antler (Table 7) had ash contents of more than 48% compared with 33 to 36% for Type I 3- and 4-branch velvet antler The Russian velvet antler analysed in the present study had a mean ash content of 35 5%, calcium of 12 9% and phosphorus of 6 3%, a composition in the range of the Type I antler in Table 7, as would be expected from a visual examination of the Russian product analysed in the present study

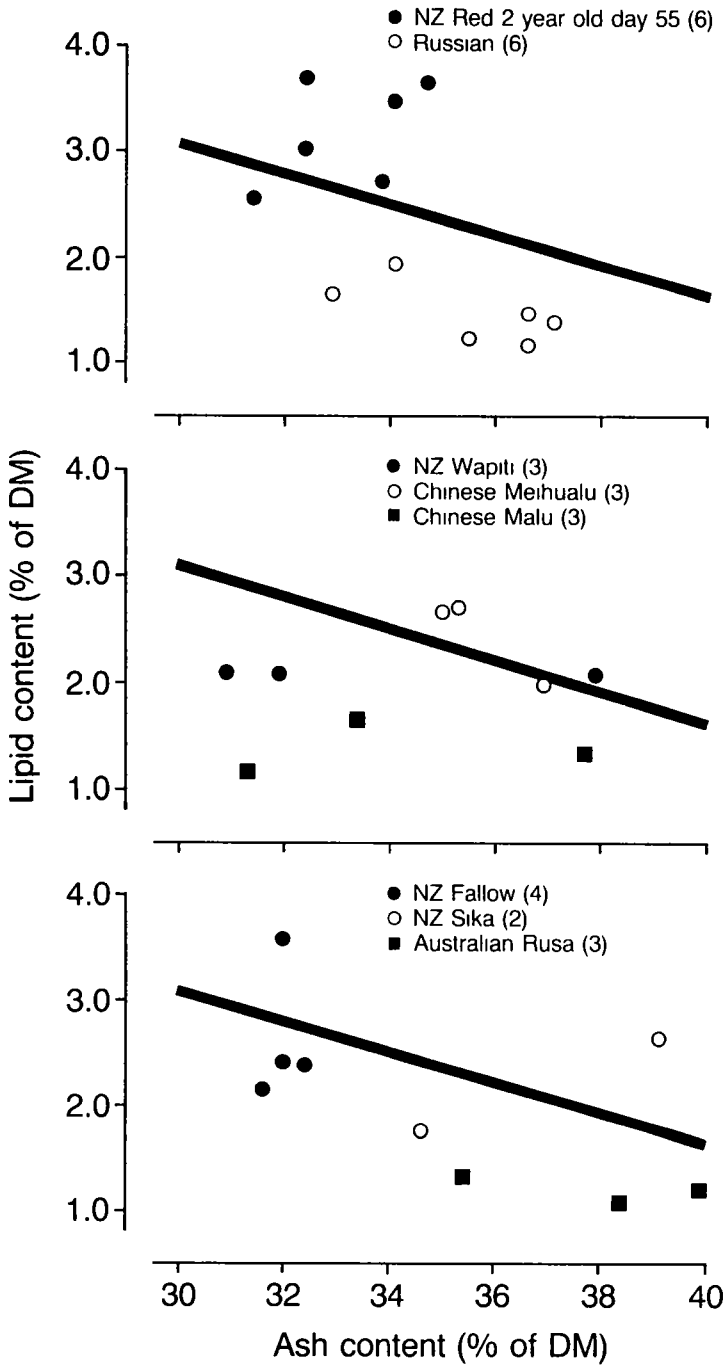

FIGURE 6 Comparison of the lipid and ash contents of the individual velvet antlers from the various sources with the overall regression relationship (the solid line) between lipid and ash for the NZ Red top grade velvet antler.

SOURCE, GRADE AND COMPOSITION

The current GIB Velvet Grading Guidelines are designed to group like with like in terms of size and stage of growth The grades are based on the stage of growth, as reflected in the shape of the top of the main beam, the beam circumference and the presence or absence of the bez tine The system has arisen out of the grading approach used by buyers reflecting Korean demands Traditionally the Korean velvet buyers have preferred the larger, thicker-beamed antlers from the Russian Maral, Siberian Wapiti and Chinese Malu. Consequently smaller velvet antler types (eg, NZ Red and Chinese Meihualu) have been regarded as being of poorer quality and therefore they have been required to be harvested at a less mature stage of growth

However, the total mineral and lipid data reported here suggest that the NZ Red velvet antler is at least of comparable quality to the Russian and Chinese Malu products If the lipid fraction is of particular importance (as suggested by some assay systems such as the hypotensive assay, see Fennessy 1991) then the higher concentrations of the lipid fraction in the NZ Red velvet antler may mean that the NZ product is of particularly good quality

TABLE 8 Weight and composition (± SD) of NZ Red antlers (n=23) classified by source and grade

		Weight (kg)		Components (% of antler DM)			
Source	N	Green	Processed[1]	Ash	Lipid	Nitrogen	Calcium
Invermay	4	1 69	0 60 ± 22	33 4 ± 2 8	2 9 ± 0 59	8 1 ± 0 40	12 0 ± 1.36
Invermay 2 year	6	0 63	0 22 ± .05	33 1 ± 1 3	3.2 ± 0 49	7 8 ± 0 17	11 2 ± 0 62
South Island	6	1 30	0 45 ± 09	34 8 ± 1 9	2 2 ± 0 39	8 7 ± 0 22	12 6 ± 1 31
North Island	7	1 55	0 55 ± 09	33 7 ± 1 6	2 5 ± 0 62	8 4 ± 0 66	11 7 ± 0 70
Grade							
SA	2	2 04	0 73	35 6	2 5	8 1	13 2
AL	6	1 56	0 56 ± 09	33 8 ± 2 0	2 4 ± 0 64	8 3 ± 0 64	11 6 ± 0 83
AM	6	1 45	0 49 ± 07	33.3 ± 2 0	2 5 ± 0 65	8 6 ± 0 38	11 8 ± 0 92
B, C	3	1 09	0 38 ± 09	35.1 ± 2 2	2 6 ± 0 58	8 5 ± 0 29	12 9 ± 1 55
2 year old							
B, C, D	6	0 63	0 22 ± .05	33 1 ± 1 3	3 2 ± 0 49	7.8 ± 0 17	11 2 ± 0 62

[1] Processed dried antler contains about 15% moisture

The NZ Red velvet antler has been compared with respect to source and grade and the data are summarised in Table 8 There were some significant differences in composition between the different sources, with the Invermay velvet antler having a higher lipid and lower nitrogen content than the remainder of the South Island velvet antler These gross differences may be a function of stage of growth at harvest There were no significant effects of grade on gross composition, with all grade groups being very similar, with the exception of the Invermay Red 2 year old, which again highlights the importance of stage of growth on composition

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