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Amounts of Trance Elements Contained in Grasses Produced in Okinawa

T. HAYAKAWA* and Y. OGURA**

Chief, Feedstuff Appraisal Section, Tokyo Fertilizer and Feedstuff Inspection Office* and senior Researcher, Biochemical Laboratory, 3rd Research Division, National Institute of Animal Health**

Recent developments in studies of trace elements have revealed the physiological significance of trace elements, their role in the nutrition of life, and so on. Accordingly, trace elements have been recognized as an important factor in livestock breeding.

In Japan, too, the existence of several physiological disturbances of livestock attributable to excess or deficiency and imbalance of trace elements has been recognized,[4),6),7)] and attention has been given to the problem of amounts of trace elements in feedstuff.

Grasses are an important feedstuff for animals. But its value as a source of trace elements should be reexamined.

The authors analyzed trace elements in grasses produced in Japan and obtained some knowledge. The results have been published[5)]. They considered that future problem was trace elements in grasses produced in the tropical zone and other areas. Thus, they took an opportunity of conducting analysis of trace elements in grasses produced in Okinawa, and obtained a few very interesting results. They are summerized as follows.

Analyzing materials

Analyzing materials were collected from five districts of the Okinawa main island, i. e. Haneji and Nago Districts of the Northern Region, Ishikawa and Koza Districts of the Central Region, and Naha District of the Southern District, and sent to the authors with cooperation of the Economic Bureau of Okinawa Government, the Serum Producing Laboratory for Animal Diseases and other local agencies. They consisted of 122 samples of fodders and wild grasses. According to the names listed on the invoice they were classified into *Graminosae* (50 samples), *Leguminosae* (32 samples) and other species (15 species with 25 samples). 15 other samples could not be identified because of common or local names. The 25 samples of 15 species belonged to *Euphorbiaceae* and *Polygonaceae*, three each; to *Cyperaceae*, *Umbelliferae*, *Polypodiaceae*, *Moraceae*. *Compositae* and *Malvaceae*, two each; and to *Oxalidaceae*, *Musaceae*, *Cannaceae*, *Caprifoliaceae*, *Ranunculaceae*, *Urticaceae* and *rosaceae*, one each. For the sake of simplicity they were taken as one group. Table 1 shows the classification of the samples by harvested districts.

Method of Analysis

The analyzing materials were sent in air dried condition. They were immediately unpacked and further air dried in a well ventilated place for five or six days. Then they were cut into pieces and put into an electric oven. After drying for 72 hours at the temperature of 105°C they were pulverized by an electric crusher. The dry ashing method was adopted for ashing samples. This method consisted of incandescing in an electric furnance at 450°C for 32 to 48 hours. The amounts of trace elements were measured by the A. C. Arc Emission Spectrographic analysis. [3] However, a limited availability of samples precluded the analysis of cobalt : only five elements, i. e. copper, iron, manganese, lead and zinc were analyzed. It should be noted that analytical sensitivity of this method and a limited number of samples made it difficult to analyze zinc in those samples which had low zinc content. In such a case the polarographic analysis [2] was used jointly. Analysis was conducted twice. Arithmetical means of the two determinations was taken as analytical value, which was expressed in terms of p.p.m. per dry matter.

Table. 1. Cassification of samples according to the harvesting district and species of grass.

District	Graminosae	Leguminosae	Others	Unknown	Total
Haneji	2	3	4	4	13
Nago	8	5	6	1	20
Ishikawa	8		6	2	16
Koza	7	4	4	3	18
Naha	25	20	5	5	55
Total	50	32	25	15	122

Result of Analysis and Observation

Table 2 shows the amounts of trace elements which were obtained by averaging aggregated analytical results of each harvested district. The table indicates considerable regional differences.

According to an analysis conducted by the authors, 166 samples of pasture crops produced in the Japanese mainland contained the following amounts of trace elements per dry matter on the average: copper 5.93 p.p.m. iron 199.9 p.p.m. manganese 167.6 p.p.m. and zinc 46.6 p.p.m. [5] To Compare the grasses of Okinawa had higher content of copper and iron but lower content of zinc. Especially copper exceeded 9 p.p.m. per dry matter on the average at Nago District and 6 p.p.m. at Koza and Naha Districts: 6 p.p.m. on a moisture-free basis is regarded as minimum copper requirements for ruminants. [1] Lead content was generally high, but no lead was detected from 16 samples of Ishikawa District. Table 3 shows the amouuts of trace elements by species, i. e. *Graminosae*, *Leguminosae* and the other species, and by harvested districts. At every district remarkable differences in the amount of trace elements can be seen among the three different groups of species.

Table 2. Analytical results of grass according to the harvesting district.
※ indicates not detectable.

District	No. of samples	Ash (%)	Analytical results (ppm/dry matter)				
			Cu	Fe	Mn	Pb	Zn
Haneji	13	9.0	5.45	137.9	63.5	2.37	11.9
Nago	20	14.1	9.23	547.9	127.8	4.60	12.9
Ishikawa	16	10.4	5.94	210.6	125.2	ND ※	11.8
Koza	18	11.9	7.93	300.2	185.3	7.63	21.2
Naha	55	10.4	6.76	480.3	180.3	7.28	26.8
Total	122	11.2	7.06	335.4	136.4	4.37	16.9

The amount of copper is the largest in *Leguminosae* in all the harvested districts except Nago District, averaging about 9 p.p.m. on a moisture-free basis. In Nago District the other species (6 samples) contain more copper. The amount of iron is the largest in *Graminosae* in all but Haneji District. However, it varies with the harvested district; extremely large in Nago and Naha Districts while small in Haneji and Ishikawa Districts.

It should also be noted that the other species have a high content of iron except in Haneji District.

It seems manganese has no definite tendency while zinc and copper show the same tendency; both of them are found most in *leguimnosae.*

Analytical value of lead shows very peculiar results. Its detection rate varies greatly with the harvested district; no lead was detected from 16 samples of Ishikawa, while 5 out of 13 samples of Haneji District, 12 out of 20 samples of Nago District, 13 out of 18 samples of Koza District and 47 out of 55 samples of Naha District contained lead. Analytical results of lead are shown in Table 4. It indicates that a fairly large percentage of grasses of Okinawa — 77 out of 122 samples or about 60.6% - contained lead and that the amount of lead was very large — 4.37 p.p.m. on the average. The relationship between lead content and species is not clear but grasses belonging to the other species have a high lead content in many cases. For example 30.0 p.p.m. for *Rumex Japonicus* (*Polygonaceae*) of Nago District and 19.8 p.p.m. for *sonchus oleraceus* (*Compositae*) and 18.8 p.p.m. for *Sambucus Sieboldiana* (*Caprifoliaceae*) of Koza District.

Such high lead content and regional difference are not accountable but they may be due to soil and other natural conditions. Further studies are required.

Tabel 3. Amounts of trace elements in different species of grass according to the harvesting district.

Element	Species	Haneji	Nago	Ishikawa	Koza	Naha	Average
Ash	*Graminosae*	(2) 11.3	(8) 11.9	(8) 8.5	(7) 8.5	(25) 11.0	10.4
	Leguminosae	(3) 6.2	(5) 11.8		(4) 7.5	(20) 9.7	9.4
(%)	Others	(4) 11.5	(6) 19.7	(6) 11.9	(4) 17.6	(5) 10.2	14.3
Cu	*Graminosae*	4.05	6.41	2.90	4.29	5.52	5.01
	Leguminosae	9.13	7.44		9.00	9.07	8.81
	Others	6.65	14.90	10.20	8.90	5.82	9.68
Fe	*Graminosae*	118.5	543.6	137.4	233.9	517.8	405.3
	Leguminosae	150.7	467.6		168.3	388.7	351.1
	Others	107.8	652.5	352.7	485.5	412.0	418.6
Mn	*Graminosae*	27.5	133.8	86.8	169.4	155.2	137.7
	Leguminosae	136.3	49.6		90.8	228.7	174.8
	Others	40.5	202.8	148.2	83.5	128.8	129.8
Pb	*Graminosae*	ND	2.40	ND	1.27	6.42	3.76
	Leguminosae	7.00	2.58		7.25	9.09	7.64
	Others	2.45	9.68	ND	12.93	4.06	5.60
Zn	*Graminosae*	10.0	11.4	10.8	19.4	22.1	17.7
	Leguminosae	13.7	13.2		26.3	34.7	28.4
	Others	12.8	18.0	13.7	21.8	22.0	17.5

Summary

Five elements (Cu, Fe, Mn, Pb and Zn) were quantitatively analyzed on 122 samples of grasses including fodder crops collected at five districts of the Okinawa main island. The results showed that each element differed considerably according to harvested districts and to species of grasses. Especially variation in lead content was remarkable. Compared with fodder crops produced in Japan, avreage amounts of trace elements of grasses produced in Okinawa were larger for copper and iron and smaller for manganese and zinc.

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Table 4. Amounts of lead in different species of grass accorcing to the harvesting district.

District	Species	No. of samples	No. of detected	Average amounts of lead	Max.-Min.
Haneji	Graminosae	2	0		
	Leguminosae	3	3	7.00	13.0-3.3
	Others	4	2	4.90	5.7-4.1
	Unknown	4	0		
Nago	Graminosae	8	5	3.84	5.8-1.7
	Leguminosae	5	2	6.45	11.2-1.7
	Others	6	4	14.53	30.0-1.6
	Unknown	1	1	1.7	1.7
Ishikawa	Graminosae	8	0		
	Leguminosae	0	0		
	Others	6	0		
	Unknown	2	0		
Koza	Graminosae	7	2	4.3	5.0-3.6
	Leguminosae	4	4	7.22	9.2-4.2
	Others	4	4	12.93	19.8-2.6
	Unknown	3	3	16.07	29.5-2.9
Naha	Graminosae	25	22	7.29	13.5-1.6
	Leguminosae	20	17	10.69	21.0-1.6
	Others	5	3	6.77	9.8-1.0
	Unknown	5	5	7.54	13.0-1.5

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Flavor of Black Tea

T. YAMANISHI

Professor of Food Chemistry, Ochanomizu University, Tokyo

Black tea is the world's most popular beverage. One of the principal reason for such high acceptability is due to its mild and exquisite aroma.

The quantity of constituents which contribute to tea flavor is so small as around 0.017% in black tea, and consists of more than eighty components. [1)~6)]

It has been too difficult to study such a complicated minor components but recently the use of gas chromatography permits the rapid and detailed investigation of tea aroma.

Changes in Aroma constituents during the manufacture of black tea

The manufacturing process of black tea consists of four steps, ie. withering, rolling, fermentaition and firing. During withering the moisture content is reduced from 77% to 68% under normal circumstances. By rolling process, as soon as the green leaf begin to be damaged in the roller fermention starts. After rolling process, the tea leaves are transferred into the fermentation room to complete fermentation. Then the leaf is fired to stop fermentation and to dry. During these processing, considerable change of flavor occurs and the typical flavor of black tea is produced.

In our laboratory, changes in aroma constituents during these four steps has been investigated by means of gas chromatography [7)]

Teble 1. Change in the amount of individual component during withering, fermentation and firing

Component	During Withering	During Fermentation	During Firing
iso-Butanol	≒	≒	−
n-Butanol	≒	≒	+
1-Penten-3-ol	≒	++	−
iso-Amyl alcohol	+	+	−−
n-Amyl alcohol	≒	+	−
cis-2-Pentenol	−−	+++	−−−
n-Hexyl alcohol	++	+	−−−
cis-3-Hexenol	−	+	−−−
trans-2-Hexenol	+	−	−
Linalool oxide I (trans, furanoid)	≒	+	−
Linalool oxide II (cis, furanoid)	+	+	−−−