ISO ANALYTICAL Laboratory Report

Client: Your Company

Contact(s): Your Name

Analysis: $\delta^{13}C$ and $\delta^{15}N$ of fish and mammal tissues

IA Ref. No.: Our LIMS Code

From: Tanith Allwood

Date: February 6, 2007

We have completed analysis of the tissue samples which arrived at our laboratory on the January 9, 2007. The results of analysis can be found attachment as an MS Excel worksheet.

Method

The samples were measured with a duplication rate of 20 % (1 in 5 samples analysed in duplicate) with results for both replicates being reported.

The technique used for this analysis was EA-IRMS (elemental analyzer isotope ratio mass spectrometry). In this technique, samples and reference materials are weighed into tin capsules, sealed, and then loaded into an automatic sampler on a Europa Scientific Roboprep-CN sample preparation module. From there they were dropped into a furnace held at 1000 °C and combusted in the presence of oxygen. The tin capsules flash combust, raising the temperature in the region of the sample to ~ 1700 °C. The combusted gases are swept in a helium stream over a combustion catalyst (Cr_2O_3), copper oxide wires (to oxidize hydrocarbons), and silver wool to remove sulphur and halides. The resultant gases (N_2, NO_x, H_2O, O_2, and CO_2) are swept through a reduction stage of pure copper wires held at 600 °C. This removes any oxygen and converts NO_x species to N_2. A magnesium perchlorate chemical trap removes water. Nitrogen and carbon dioxide are separated by a packed column gas chromatograph held at an isothermal temperature of 65 °C. The resultant chromatographic peaks enter the ion source of the Europa Scientific 20-20 IRMS where they are ionised and accelerated. Gas species of different mass are separated in a magnetic field then simultaneously measured on a Faraday cup universal collector array. For N_2, masses 28, 29, and 30 are monitored and for CO_2, masses 44, 45, and 46 are monitored.

Both references and samples are converted to gases and analysed in this manner. The analysis proceeds in a batch process, whereby a reference is analysed followed by a number of samples and then another reference.

Reference Standards

The reference material used during analysis of all samples was IA-R042 (powdered bovine liver, $\delta^{15}N_{Air}$ = 7.65 ‰, $\delta^{13}C_{V\text{-}PDB}$ = -21.60 ‰). IA-R042 is traceable to IAEA-N-1 (ammonium sulphate, $\delta^{15}N_{Air}$ = 0.40 ‰) and IAEA-CH-6 (sugar, $\delta^{13}C_{V\text{-}PDB}$ = -10.43 ‰). IA-R042 was chosen as the reference material as, with a carbon content = 48.97 % and nitrogen content = 10.05 %, it closely matches the organic matrix of your samples.

Reference standards IA-R042, IA-R045 (Ammonium Sulphate, $\delta^{15}N_{Air}$ = -4.71 ‰, traceable to IAEA-N-1), IA-R046 (Ammonium Sulphate, $\delta^{15}N_{Air}$ = 22.04 ‰, traceable to IAEA-N-1), IA-R005 (Beet Sugar, $\delta^{13}C_{V\text{-}PDB}$ = -26.03 ‰, traceable to IAEA-CH-6) and IA-R006 (Cane Sugar, $\delta^{13}C_{V\text{-}PDB}$ = -11.64 ‰, traceable to IAEA-CH-6) were measured as quality control check samples during analysis. Results of the quality control samples are included in the results file.

The International Atomic Energy Agency, Vienna, distributes IAEA-CH-6 and IAEA-N-1 as inter-comparison standards.

The remaining sample material will be returned to you upon request. Otherwise it will be remain in storage for a period of 3 months after which time it may be disposed of.

Please do not hesitate to contact us if you have any queries regarding the analysis of your samples.

Analysed and Reported by:

Tanith Allwood, BSc.

Verified by:

Steve Brookes, PhD.

For and on behalf of:

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Iso-Analytical Laboratory Report

Client Details

Name: Your Company
Contact(s): Your Name
P.O. No.: Your Order Code

Sample Details

Number: 160
Material: Fish & mammal tissue

Sample Tracking

IA Reference No.: Our LIMS Code
Date of Arrival: 09/01/2007

Analysis Details

Isotope(s): $\delta^{13}C$ & $\delta^{15}N$
Method: EA-IRMS
Report Date: 06/02/2007

Duplicate results shown in **BOLD**

Sample Identification	Nitrogen (%)	$\delta^{15}N_{AIR}$ (‰)	Mean $\delta^{15}N_{AIR}$ (‰)	Carbon (%)	$\delta^{13}C_{V\text{-}PDB}$ (‰)	Mean $\delta^{13}C_{V\text{-}PDB}$ (‰)
A9	12.87	15.33		45.04	-16.75	
A10	12.83	12.24		44.51	-18.63	
A11	12.98	14.39		45.93	-18.02	
A12	**13.21**	**12.62**		**40.44**	**-18.23**	
A12	**14.44**	**12.66**	**12.64**	**45.43**	**-17.99**	**-18.11**
A14	13.10	12.89		52.16	-18.67	
A16	13.33	12.92		43.77	-18.26	
A17	13.70	12.93		43.60	-18.26	
A18	15.68	13.37		46.90	-18.12	
A19	**14.22**	**10.92**		**45.92**	**-19.13**	
A19	**12.80**	**10.95**	**10.94**	**44.64**	**-19.00**	**-19.07**
A20	15.08	13.30		48.05	-17.91	
A21	13.57	11.56		43.80	-18.60	
A22	15.18	12.77		47.67	-17.69	
A23	13.94	12.93		44.41	-18.09	

A24	**15.53**	**11.32**		**48.82**	**-18.71**	
A24	**13.42**	**11.30**	**11.31**	**42.10**	**-18.68**	**-18.69**
A25	14.47	12.65		46.33	-18.23	
A26	14.86	12.54		47.58	-18.57	
A27	12.94	12.95		42.40	-16.25	
A28	12.99	14.35		42.07	-16.96	
A29	**13.25**	**12.35**		**42.16**	**-16.49**	
A29	**13.15**	**12.40**	**12.37**	**43.82**	**-16.64**	**-16.56**
A30	12.18	13.63		39.65	-17.36	
A31	12.76	14.67		41.46	-16.81	
A32	11.46	13.37		36.55	-17.06	
A33	13.79	12.11		43.15	-17.17	
A34	**13.29**	**12.58**		**42.52**	**-17.33**	
A34	**13.58**	**12.50**	**12.54**	**43.45**	**-17.29**	**-17.31**
A35	12.77	12.73		42.41	-18.68	
A36	13.39	12.73		47.75	-18.84	
A37	15.04	13.05		53.50	-19.07	
A38	11.78	13.33		43.36	-18.95	
A39	**13.41**	**13.30**		**45.40**	**-18.85**	
A39	**12.91**	**13.39**	**13.34**	**47.46**	**-19.01**	**-18.93**
A40	12.99	13.43		43.75	-18.72	
A41	12.20	12.95		49.31	-19.38	
A42	12.58	13.31		45.30	-18.53	
A43	12.22	13.32		41.65	-18.49	
A44	**13.55**	**12.67**		**44.17**	**-18.62**	
A44	**13.70**	**12.59**	**12.63**	**44.37**	**-18.74**	**-18.68**
A45	14.36	13.86		46.50	-17.64	
A47	12.94	14.32		43.88	-17.59	
A49	13.92	14.09		43.58	-17.61	
A50	13.40	14.07		45.61	-17.47	
A51	**13.28**	**14.87**		**44.62**	**-17.15**	
A51	**14.24**	**14.74**	**14.81**	**45.26**	**-17.14**	**-17.14**
A52	14.48	14.56		46.36	-18.02	
A58	13.30	14.87		43.89	-18.32	
A59	13.69	13.25		46.48	-17.96	
A60	12.53	13.61		43.93	-17.95	
A61	**10.97**	**13.26**		**49.79**	**-19.49**	
A61	**11.96**	**13.36**	**13.31**	**51.05**	**-19.27**	**-19.38**
A63	12.92	13.39		49.44	-19.07	
A65	13.41	13.17		43.90	-17.72	
A66	14.35	13.73		48.80	-17.87	

A67	13.32	13.62		47.55	-18.39	
A68	**14.19**	**13.63**		**48.63**	**-17.21**	
A68	**12.08**	**13.74**	**13.68**	**41.23**	**-17.15**	**-17.18**
A69	14.96	12.83		48.26	-17.30	
A70	14.12	12.86		48.03	-17.31	
A71	13.64	12.51		43.54	-17.78	
A72	14.79	11.20		47.11	-18.06	
A73	**16.80**	**12.33**		**53.75**	**-17.70**	
A73	**14.73**	**12.22**	**12.27**	**47.66**	**-17.68**	**-17.69**
A74	14.57	12.11		46.04	-17.90	
A75	13.89	11.31		43.36	-18.16	
A76	13.10	14.20		42.82	-16.06	
A77	14.28	11.96		46.66	-16.17	
A78	**14.12**	**12.63**		**45.92**	**-17.18**	
A78	**14.88**	**12.42**	**12.52**	**48.78**	**-17.29**	**-17.24**
A79	13.56	11.62		43.89	-16.88	
A80	12.47	12.64		41.36	-17.57	
A81	14.27	12.62		46.72	-16.80	
A82	14.49	13.60		47.57	-17.34	
A83	**12.21**	**12.34**		**40.37**	**-17.31**	
A83	**11.90**	**12.53**	**12.43**	**39.53**	**-17.34**	**-17.32**
A84	11.96	13.98		42.74	-18.94	
A85	11.65	13.76		40.22	-18.13	
A86	12.14	13.57		42.55	-18.06	
A87	12.52	13.99		45.68	-18.94	
A88	**11.92**	**13.70**		**41.87**	**-18.57**	
A88	**12.13**	**13.73**	**13.71**	**42.43**	**-18.68**	**-18.63**
A89	10.67	14.22		39.73	-17.89	
A90	13.45	13.70		45.26	-18.37	
A91	12.79	13.77		46.26	-18.78	
A92	14.58	13.61		42.51	-18.25	
A93	**14.10**	**13.43**		**44.27**	**-18.01**	
A93	**14.25**	**13.51**	**13.47**	**40.98**	**-18.04**	**-18.02**
A94	14.47	13.78		46.21	-17.67	
A96	14.47	14.91		43.76	-18.03	
A98	14.71	13.84		46.04	-17.73	
A99	15.24	14.35		50.67	-16.84	
A100	**16.33**	**15.84**		**48.33**	**-16.57**	
A100	**13.14**	**16.13**	**15.98**	**41.89**	**-16.58**	**-16.58**
A101	16.00	14.74		42.58	-16.98	
C1	12.79	13.01		44.84	-18.43	

C2	13.93	15.48		47.79	-16.70	
C3	15.45	13.43		47.44	-18.49	
C4	**16.34**	**12.84**		**47.20**	**-17.89**	
C4	**15.79**	**12.82**	**12.83**	**50.25**	**-17.89**	**-17.89**
C6	14.54	12.92		50.15	-19.02	
C8	15.59	13.30		49.86	-18.39	
C9	17.57	13.45		48.91	-17.74	
C10	16.93	12.60		47.93	-18.08	
C11	**19.44**	**13.65**		**48.90**	**-17.63**	
C11	**17.97**	**13.65**	**13.65**	**48.25**	**-17.59**	**-17.61**
C12	17.66	13.35		50.61	-17.48	
C13	17.18	12.37		48.50	-18.19	
C14	16.23	13.59		48.94	-18.14	
C15	15.88	12.99		49.01	-17.96	
C16	**16.26**	**12.79**		**46.00**	**-17.62**	
C16	**14.86**	**12.91**	**12.85**	**46.17**	**-17.61**	**-17.61**
C17	14.23	12.89		46.64	-17.80	
C18	13.96	12.87		46.80	-17.87	
C19	13.69	13.54		44.14	-16.71	
C20	13.35	12.93		40.69	-17.15	
C21	**11.45**	**12.92**		**45.20**	**-17.75**	
C21	**11.43**	**13.01**	**12.96**	**43.74**	**-17.92**	**-17.83**
C22	13.98	11.98		45.96	-17.37	
C23	14.57	12.86		44.11	-17.42	
C24	12.32	12.47		45.73	-17.17	
C25	14.85	12.59		44.13	-16.88	
C26	**14.91**	**11.95**		**45.62**	**-17.79**	
C26	**15.40**	**11.92**	**11.94**	**46.31**	**-17.77**	**-17.78**
C27	12.79	12.97		44.58	-19.00	
C28	13.27	12.65		45.49	-18.92	
C29	12.97	13.00		42.65	-18.47	
C30	13.59	13.43		46.36	-18.44	
C31	**14.62**	**12.97**		**49.00**	**-18.80**	
C31	**13.94**	**12.86**	**12.91**	**47.17**	**-18.85**	**-18.82**
C32	13.21	13.10		48.73	-19.07	
C33	13.31	12.80		44.28	-18.79	
C34	14.75	13.13		49.93	-18.66	
C35	14.33	13.73		48.99	-18.38	
C36	**14.93**	**12.86**		**47.93**	**-17.64**	
C36	**13.67**	**12.94**	**12.90**	**43.84**	**-17.58**	**-17.61**
C37	15.75	13.62		49.94	-17.73	

C39	16.08	15.43		51.84	-17.10	
C41	14.84	14.53		47.77	-17.90	
C42	15.04	15.04		48.23	-17.45	
C43	**14.28**	**14.29**		**45.40**	**-17.89**	
C43	**14.95**	**14.14**	**14.22**	**47.50**	**-18.01**	**-17.95**
C44	14.75	14.00		48.00	-17.71	
C45	13.97	12.72		55.33	-18.95	
C46	14.42	12.94		51.67	-18.08	
C47	13.39	13.92		51.09	-18.08	
C48	**14.48**	**13.39**		**50.39**	**-18.07**	
C48	**13.79**	**13.34**	**13.36**	**47.32**	**-17.95**	**-18.01**
C50	14.05	13.78		48.19	-17.46	
C52	14.91	11.83		48.86	-17.15	
C53	12.59	14.42		47.88	-17.44	
C54	13.82	13.95		45.59	-16.81	
C55	**13.74**	**13.96**		**44.32**	**-16.48**	
C55	**13.77**	**14.03**	**14.00**	**44.20**	**-16.42**	**-16.45**
C56	13.24	14.15		42.99	-16.52	
C57	13.87	13.77		44.50	-16.94	
C58	13.75	13.22		44.43	-16.98	
C59	14.72	13.00		46.91	-17.01	
C60	**14.41**	**13.17**		**46.71**	**-17.00**	
C60	**14.10**	**13.14**	**13.16**	**45.59**	**-17.01**	**-17.00**
C61	14.95	13.05		48.45	-16.94	
C62	13.80	14.41		44.86	-16.80	
C63	14.34	12.44		46.41	-15.87	
C64	15.15	11.41		49.09	-15.97	
C65	**13.75**	**11.52**		**43.84**	**-16.38**	
C65	**13.47**	**11.49**	**11.51**	**42.96**	**-16.31**	**-16.35**
C66	12.87	12.06		42.18	-16.40	
C67	14.43	13.31		47.73	-16.72	
C68	13.99	13.17		47.86	-16.52	
C69	14.17	12.30		45.66	-16.76	
C70	**14.78**	**11.83**		**48.19**	**-16.09**	
C70	**15.04**	**11.95**	**11.89**	**48.94**	**-16.05**	**-16.07**
C71	13.31	13.41		43.98	-17.99	
C72	13.13	13.49		43.67	-17.98	
C73	13.51	13.61		47.42	-18.18	
C74	13.38	13.34		44.69	-18.08	
C75	**15.29**	**13.12**		**49.10**	**-18.21**	
C75	**14.12**	**13.32**	**13.22**	**45.56**	**-18.19**	**-18.20**

C76	12.81	13.31		42.52	-18.13	
C77	13.82	13.78		47.05	-17.61	
C78	14.71	13.01		49.49	-18.18	
C79	14.33	14.05		45.80	-18.28	
C80	**13.01**	**15.33**		**41.74**	**-16.74**	
C80	**14.52**	**15.10**	**15.22**	**46.54**	**-16.78**	**-16.76**
C81	13.45	15.58		43.49	-17.62	
C83	12.68	14.05		40.41	-17.00	
C85	14.05	13.86		44.73	-17.31	
C86	13.38	14.43		42.62	-17.11	
C87	**16.63**	**13.90**		**53.64**	**-17.52**	
C87	**15.02**	**13.91**	**13.90**	**48.28**	**-17.49**	**-17.50**
C88	13.45	15.36		42.89	-16.86	

Quality Control Check Samples

IA-R042 (Bovine Liver)		IA-R045 (Ammonium Sulphate)	IA-R046 (Ammonium Sulphate)	IA-R005 (Beet Sugar)	IA-R006 (Cane Sugar)
$\delta^{15}N_{AIR}$ (‰)	$\delta^{13}C_{V\text{-}PDB}$ (‰)	$\delta^{15}N_{AIR}$ (‰)	$\delta^{15}N_{AIR}$ (‰)	$\delta^{13}C_{V\text{-}PDB}$ (‰)	$\delta^{13}C_{V\text{-}PDB}$ (‰)
7.54	-21.65	-4.54	22.08	-26.15	-11.66
7.75	-21.54	-4.74	21.91	-26.07	-11.71
7.50	-21.59	-4.74	22.01	-26.13	-11.76
7.66	-21.53	-4.50	22.20	-26.07	-11.63
7.74	-21.54	-4.70	22.09	-26.09	-11.66
7.56	-21.63	-4.51	22.13	-26.10	-11.77
7.69	-21.56	-4.73	22.00	-26.02	-11.70
7.57	-21.59	-4.73	22.08	-26.08	-11.71
7.72	-21.57	-4.41	22.00	-26.03	-11.63
7.69	-21.52	-4.42	21.99	-25.94	-11.61
7.69	-21.45	-4.59	22.17	-25.95	-11.59
7.61	-21.57	-4.45	21.95	-26.09	-11.69
7.60	-21.69				
7.56	-21.51				
7.66	-21.70				
7.56	-21.51				
7.53	-21.64				
7.58	-21.67				
7.70	-21.57				
7.46	-21.67				
7.72	-21.52				

	7.69	-21.61				
	7.45	-21.61				
	7.60	-21.67				
	7.69	-21.63				
	7.61	-21.47				
Mean	7.62	-21.59	-4.59	22.05	-26.06	-11.68
St. Dev.	0.09	0.07	0.13	0.09	0.06	0.06
N	26	26	12	12	12	12
Accepted Value	7.65	-21.60	-4.71	22.04	-26.03	-11.64

end of results table