

Table 1

Concentration of domoic acid in hepatopancreas of four size groups of king scallop from February 2003 to February 2004

	Small			Medium			Large			Very large		
	<i>n</i>	Mean \pm S.D. ($\mu\text{g g}^{-1}$)	R.S.D. (%)	<i>n</i>	Mean \pm S.D. ($\mu\text{g g}^{-1}$)	R.S.D. (%)	<i>n</i>	Mean \pm S.D. ($\mu\text{g g}^{-1}$)	R.S.D. (%)	<i>n</i>	Mean \pm S.D. ($\mu\text{g g}^{-1}$)	R.S.D. (%)
26 February 2003	10	1066.8 \pm 242.5	22.7	12	323.2 \pm 68.6	21.2	12	272.6 \pm 59.8	21.9			
3 April 2003	11	330.8 \pm 272.8	82.5	12	452.3 \pm 200.4	44.3	11	698.0 \pm 156.6	22.4	12	599.5 \pm 234.1	39.0
23 May 2003	12	414.0 \pm 112.7	27.2	12	467.4 \pm 167.2	35.8	12	457.7 \pm 134.6	29.4	12	524.0 \pm 65.5	12.5
3 July 2003	11	228.6 \pm 89.5	39.1	12	209.5 \pm 72.6	34.7	12	216.5 \pm 107.2	49.5	11	261.2 \pm 89.4	34.2
30 July 2003	12	277.3 \pm 83.3	30.0	11	297.3 \pm 44.7	15.0	12	332.7 \pm 140.6	42.3	12	364.9 \pm 75.5	20.7
3 September 2003	12	220.8 \pm 70.1	31.7	12	219.7 \pm 84.8	38.6	12	305.0 \pm 69.4	22.8	12	245.0 \pm 59.5	24.3
25 September 2003	12	236.3 \pm 83.8	35.5	12	226.2 \pm 81.9	36.2	12	223.7 \pm 65.4	29.2	12	210.5 \pm 47.6	22.6
12 November 2003	12	81.1 \pm 38.8	47.8	12	186.3 \pm 86.5	46.4	12	298.3 \pm 89.4	30.0	12	270.4 \pm 109.1	40.3
4 December 2003	12	59.9 \pm 24.6	41.1	12	230.3 \pm 90.7	39.4	12	239.0 \pm 109.4	45.8	12	241.5 \pm 69.8	28.9
11 February 2004	12	49.6 \pm 15.9	32.0	11	170.9 \pm 42.5	24.9	11	245.2 \pm 43.8	17.8	12	211.8 \pm 62.0	29.3

hepatopancreas exceeded the regulatory concentration of $20 \mu\text{g g}^{-1}$ in all size groups from all samples and ranged from a maximum of $1066.8 \pm 242.5 \mu\text{g g}^{-1}$ to a minimum of $49.6 \pm 15.9 \mu\text{g g}^{-1}$. The highest concentration of DA recorded in hepatopancreas of an individual scallop was $1348.1 \mu\text{g g}^{-1}$ in this study. Considerable inter-animal variation of DA concentration in hepatopancreas in sample batches was detected, R.S.D.s ranged from a minimum of 12.5% to a maximum of 82.5%.

The mean, standard deviation and R.S.D. of DA concentration in gonad samples of each size group on each sampling date, based on triplicate analysis of a composite of gonad tissue, are shown in Table 2. DA concentration in gonad ranged from a maximum of $9.18 \pm 0.15 \mu\text{g g}^{-1}$ to a minimum of $0.16 \pm 0.00 \mu\text{g g}^{-1}$ over the study duration. On several occasions the gonad composite from small-sized scallops provided sufficient tissue for only one 4 g sample for analysis. The highest concentration of DA recorded in a gonad composite sample was $9.59 \mu\text{g g}^{-1}$. Higher than anticipated R.S.D.s recorded in some instances were attributed to the low concentrations of DA present and poor tissue homogeneity due to inadequate blending of the limited tissue available.

DA concentrations in composite samples of adductor muscle never exceeded the limit of quantification ($\text{LOQ} = 1.00 \mu\text{g g}^{-1}$).

3.2. Variation with scallop size

During the study from February 2003 to February 2004, mean shell length and standard deviation of scallops in the four size groups were as follows: small 81.63 ± 6.91 mm, medium 96.92 ± 5.61 mm, large 108.75 ± 3.90 mm and very large 119.98 ± 5.07 mm. Scallop shell length, shell height, shell depth, total tissue weight and weight of hepatopancreas, gonad and adductor muscle were recorded for each scallop. Individual analysis of the hepatopancreas of each scallop was performed to provide data on variability in DA concentration within each sample batch, to allow comparison of variability both within a sample, within a size group and between size groups to highlight any significant differences between small, medium, large and very large scallops. Triplicate analysis of composite gonad and composite adductor muscle samples of each sample batch were performed because preliminary studies suggested that differences in DA concentration between scallops of different size, if present, would be more difficult to confirm in these tissues due to the lower concentrations present.

Table 2

Concentration of domoic acid in gonad of four size groups of king scallop from February 2003 to February 2004

	Small		Medium		Large		Very large	
	Mean \pm S.D. ($\mu\text{g g}^{-1}$)	R.S.D. (%)	Mean \pm S.D. ($\mu\text{g g}^{-1}$)	R.S.D. (%)	Mean \pm S.D. ($\mu\text{g g}^{-1}$)	R.S.D. (%)	Mean \pm S.D. ($\mu\text{g g}^{-1}$)	R.S.D. (%)
26 February 2003	4.91 \pm 0.25	5.10	2.26 \pm 0.19	8.18	2.00 \pm 0.24	12.08		
3 April 2003	2.43 \pm 0.46	18.95	0.35 \pm 0.03	8.70	5.35 \pm 0.64	12.03	2.77 \pm 0.16	5.79
23 May 2003	0.16 \pm 0.00	0.00	1.04 \pm 0.14	13.46	4.07 \pm 0.46	11.30	0.43 \pm 0.01	2.33
3 July 2003	3.66 \pm 0.00	0.00	3.51 \pm 0.16	4.65	3.00 \pm 0.43	14.43	4.51 \pm 0.19	4.21
30 July 2003	1.43 \pm 0.11	7.41	4.02 \pm 0.92	22.80	6.07 \pm 1.21	19.90	4.35 \pm 0.55	12.57
3 September 2003	4.24 \pm 0.29	6.79	5.98 \pm 0.61	10.16	6.72 \pm 0.21	3.08	3.79 \pm 0.09	2.35
25 September 2003	4.35 \pm 0.75	17.27	4.55 \pm 0.52	11.36	8.45 \pm 1.01	11.98	5.15 \pm 0.36	7.00
12 November 2003	3.70 \pm 0.00	0.00	2.47 \pm 0.68	27.42	3.55 \pm 1.12	31.38	6.03 \pm 2.59	42.92
4 December 2003	3.98 \pm 0.00	0.00	5.24 \pm 0.93	17.82	6.56 \pm 2.65	40.33	9.18 \pm 0.15	1.61
11 February 2004	2.79 \pm 0.00	0.00	5.96 \pm 0.75	12.58	4.02 \pm 0.66	16.43	3.03 \pm 0.46	15.19

The relationship between mean DA concentration in hepatopancreas and size group of scallop varied from February 2003 to February 2004 (Fig. 2). The first sample on 26 February 2003, which comprised only three of the four size groups due to unavailability of very large scallops, exhibited a negative correlation with scallop size. On 3 April 2003, the second sampling date; the data exhibited a positive correlation between small, medium and large size groups. The following five samples from 23 May 2003 to 25 September 2003 inclusive showed no significant relationship and the three samples from 23 November 2003 to 11 February 2004 inclusive exhibited a positive correlation with scallop size. Inter-animal variation in DA concentration in hepatopancreas within a size group resulted in large relative standard deviations ranging from 22.7% to 82.5% (mean 39.0%) for small scallops, 15.0% to 46.4% (mean 33.6%) for medium scallops, 17.8% to 49.5% (mean 31.1%) for large scallops and 12.5% to 40.3% (mean 28.0%) for very large scallops. The results demonstrated that based on sample batches comprising 12 scallops, a number exceeding that specified in EU regulations, the shell length of scallops can influence the mean DA concentration in the sample.

Because each scallop hepatopancreas was analysed individually on each sampling occasion rather than using composites of hepatopancreas of each size group, a more detailed investigation of the relationship between DA concentration and scallop size from February 2003 to February 2004 was possible (Fig. 3). There was a highly significant negative correlation between DA concentration in hepatopancreas and shell length on 26 February 2003 ($F_{1,32} = 77.54$, $p = 0.000$, $R^2 = 0.7079$). Highly significant positive relationships were recorded between DA concentration in hepatopancreas and shell length on 12 November 2003 ($F_{1,46} = 38.19$, $p = 0.000$, $R^2 = 0.4536$), on 1 December 2003 ($F_{1,46} = 24.33$, $p = 0.000$, $R^2 = 0.3459$) and on 11 February 2004 ($F_{1,44} = 38.47$, $p = 0.000$, $R^2 = 0.4665$) though correlations were not as high during this depuration phase as during the earlier high toxin concentration phase. DA concentration in hepatopancreas exhibited similar highly significant negative and positive relationships with both total tissue weight and hepatopancreas weight on the same sample dates though correlation coefficients were lower than those between DA concentration in hepatopancreas and shell length.

Variations in DA concentration in hepatopancreas depend not only on the mass of toxin present but also on the size of the hepatopancreas itself. Consider for example a unit mass of DA taken into a large