



Icelandic Fisheries Laboratories

ORGANIC AND INORGANIC CONTAMINANTS IN FARMED ATLANTIC SALMON (*Salmo salar*) FROM MJÓIFJÖRÐUR, E-ICELAND.

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Table of content

Table of content	1
Summary	1
Sampling and analysis.....	1
Results.....	3
PCDD/Fs and dioxin-like PCBs (DL-PCBs)	3
Summary of the discussions on PCDD/Fs and DL-PCBs.....	10
Metals: Mercury (Hg), Cadmium (Cd), Lead (Pb) and Arsenic (As).....	10
PAHs	11
Pesticides.....	12
References:.....	14

Summary

Samples of farmed Atlantic salmon (*Salmo salar*) from Iceland were analysed for organic and inorganic contaminants. The results were compared to maximum limits accepted by EU and to measurements of contaminants in farmed salmon from countries like Ireland, Chile, Norway and England. From this study it can be concluded that the farmed salmon and trout from Iceland contains equal or lower concentrations of the contaminants analyzed than the samples of farmed salmon found in the literature. All measurements are far below the maximum limits set by European Union, in most cases at least ten times lower. Even an every day consumption of the farmed salmon from Iceland should therefore not in any way be a threat to the health of the consumer.

Sampling and analysis

At the request of the owners of the aquaculture station in Mjóifjörður, E-Iceland, four samples of farmed salmon were taken at the slaughtering house in Neskaupstaður on 04/03/2004 under the auspices of the staff of Chief Veterinary Office and Icelandic Fisheries Laboratories.

Each sample consisted of ten individual fishes, three batches of samples were filleted in the laboratory where the whole muscle excluding the belly of all the fishes in each sample was homogenised in one composite sample. Care was taken to remove the fatty tissue from the inside of the skin. The fourth sample was filleted by a filleting machine, deskinning and trimmed in Grindavík where the same procedure was used as when producing deskinning fillets for the market. Detailed description of the samples is given in Table 1.

Table 1: Description of the samples analysed

Lab code	SN-DL-04-01	SN-DL-04-02	SN-DL-04-03	SN-DL-04-04
Filleting	Lab	Lab	Lab	Machine
Length, cm	81,2	79,5	72,8	-
Weight, gutted, kg	5,70	5,45	3,67	5,47
Weight of fillet, %	45,7	44,1	47,7	58,6
Fat content (*), %	16,7	16,4	12,3	16,1
Fat content (**), %	16,1	16,3	12,7	15,6

* Fat determined according to Smedes, F., and Askland, T.K. 1999. Mar.Poll.Bull., 38: 193-201.

**Fat determined by diethylether extraction at IFL.

The fatty tissue left on the skin of the machine deskinning fish was taken separately, weighed and its fat content determined. The total weight of the fillet together with the fatty tissue was 64,9% of the gutted fish weight, *i.e.* the fatty tissue left on the skin was 6,2% of the gutted fish weight and its fat content found to be 40,5% by the diethylether extraction. Thus, the total fat content of the whole fillet was 18,0%. The belly-part left out from the three laboratory filleted samples was thus about 20% of the gutted fish weight and the fat content of the belly-part estimated to be about 22,5% for samples SN-DL-04-01 and SN-DL-04-02 if their whole fillets are assumed to contain 18,0% fat. This fat distribution of the fillets (between the belly-part (hypaxial anterior muscle) and the whole fillet) is in line with that found by O.Einen *et al.* (O.Einen *et al.* 1998).

The samples were analysed for polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs), dioxinlike PCBs, marker PCBs (ICES7 or Dutch seven: CB 28, 52, 102, 118, 138, 153 and 181), pesticides (HCHs, DDTs, PeCB, HCB, Chlordanes, toxaphenes (Parlars 26, 50, and 62), aldrin, endrin, dieldrin, and endosulfanes), PAHs, and the

trace elements cadmium, lead, mercury and total arsenic. The organic constituents were analysed by Ergo Forschungsgesellschaft mbH, Hamburg, Germany, as were the trace elements but total arsenic and mercury were analysed at IFL.

Results

PCDD/Fs and dioxin-like PCBs (DL-PCBs)

The following table shows the results for PCDD/Fs and dioxinlike PCBs (DL-PCBs) where upper-bound concentrations are given, *i.e.* when the analytical result of a congener is less than the detection limits, the value is set equal to the detection limit.

Table 2: Dioxins and dioxin like PCBs in the samples in WHO-TEQ pg/g wet weight

Lab code	SN-DL-04-01	SN-DL-04-02	SN-DL-04-03	SN-DL-04-04
Levels on basis of wet weight				
PCDDs, pg WHO-TEQ/g	0,10	0,10	0,10	0,12
PCDFs, pg WHO-TEQ/g	0,30	0,29	0,29	0,29
Sum of PCDD/Fs, pg WHO-TEQ/g	0,40	0,39	0,39	0,41
DL-PCBs, non-ortho, pg WHO-TEQ/g	0,60	0,61	0,56	0,59
DL-PCBs, mono-ortho, pg WHO-TEQ/g	0,23	0,21	0,21	0,21
Sum of DL-PCBs, pg WHO-TEQ/g	0,83	0,83	0,77	0,80
Sum of PCDD/Fs & DL-PCB, pg WHO-TEQ/g	1,23	1,21	1,16	1,21

These result compare very well with results for both salmon and trout, arctic char (*Salvelinus alpinus*) taken from fish farms in SW-Iceland in October 2003, ten fish in each sample and filleted in the laboratory as above and analysed by the same laboratory. These results were the following.

Table 3: Dioxins and dioxin like PCBs in samples taken in SW Iceland in WHO-TEQ pg/g

Lab code	SN-D-03-09	SN-D-03-10
Species	Salmon	Trout
Size, kg (whole and ungutted)	2,68	0,742
Fat, %	13,5	14,8
Levels on basis of wet weight		
PCDDs, pg WHO-TEQ/g	0,07	0,07
PCDFs, pg WHO-TEQ/g	0,21	0,22
Sum of PCDD/Fs, pg WHO-TEQ/g wet weight	0,28	0,29
DL-PCBs, non-ortho, pg WHO-TEQ/g	0,54	0,60
DL-PCBs, mono-ortho, pg WHO-TEQ/g	0,25	0,29
Sum of DL-PCBs, pg WHO-TEQ/g	0,79	0,89
Sum of PCDD/Fs & DL-PCB, pg WHO-TEQ/g wet weight	1,08	1,18

These results show that the levels of both PCDD/Fs and DL-PCBs are the same in all the six samples on wet weight basis.

Secondly, these results show that DL-PCBs contribute to 67% of the total dioxin-activity in Mjóifjörður which is lower than in the samples from SW-Iceland. Typically 75% of the total activity is due to DL-PCBs see for example the article by Hites *et al.* (Hites et.al. 2004). This slight difference is due to a larger contribution of PCDFs in the Mjóifjörður samples than in SW-Iceland, resulting in 0,3 pg WHO-TEQ/g PCDFs in the Mjóifjörður samples but only 0,2 pg WHO-TEQ/g in the samples from SW-Iceland.

These results further show the following:

a) **The levels of PCDD/Fs are well below the recently stipulated maximum residue levels in EU**, which for fish are 4 pg WHO-TEQ/g wet weight (COUNCIL REGULATION (EC) No 2375/2001), *i.e.* ten times lower in the case of the salmon from Mjóifjörður. The new limits for the sum of dioxin and dioxinlike PCBs in fish are 8 pg WHO-TEQ/g wet weight so the dioxin and dioxinlike PCB content of the salmon investigated is also well below these limits.

b) Risk assessment has been performed for the total dioxinlike activity, both within EU (PTWI= 14pg WHO-TEQ/kg bw) and WHO (PTMI=70pg WHO-TEQ/kg bw). These PTWIs, calculated as daily tolerable provisional intakes, become 2,0 and 2,3pg WHO-TEQ/kg, respectively. From the results above, the total dioxinlike activity is 1,08-1,23pg WHO-TEQ/g of the farmed fish, and thus **the intake rate of a person weighing 70kg may be up to 130g of salmon every day without any harm to health due to these compounds** assuming other sources of dioxins to be negligible. For a standard meal in US, 8oz or 227g, 70kg person may consume salmon every second day. It must be stressed here that these provisional tolerable intakes are based on the most sensitive endpoints, *i.e.* the fertile woman since the foetus is the most vulnerable to the possible effects of dioxins.

c) The results may be compared with results for wild and farmed salmon found in the literature:

i) Results appearing in Hites *et al.*, indicate that **the results above for Icelandic salmon and trout (both PCDD/Fs and PCDD/Fs & DL-PCBs) are in line with results for farmed Chilean salmon, the salmon showing the lowest contamination of the farmed salmon samples in that study.** Furthermore, according to Hites *et al.* 2004, there is one sample of Icelandic salmon in their study but statistically pooled with two samples of Chilean farmed salmon (bought in Washington DC). The standard deviation in the results for total dioxin-activity in this pooled sample is very small and therefore the results for these three samples must be similar which further confirms the similarity of Icelandic and Chilean salmon in this respect. Farmed salmon from Scotland, Faroe Islands and Norway are all higher than the samples from Iceland in the study of Hites *et al.* 2004. (Hites *et al.* 2004).

ii) **Fish on the European market** was surveyed intensively for PCDD/Fs, DL-PCBs and marker PCBs during 2003. The following table gives median values with 90th and 95th percentiles within parentheses, for PCDD/Fs, DL-PCBs and total dioxin-activity in fish in EU sampled during 2003 (excluding fish from the Baltic) (Gallani, B., and Boix, A. 2004. Dioxins and PCBs in Food and Feed: Data available to DG SANCO Joint Report DG-SANCO/DG-JRC-IRMM). The fatty fish in the SANCO-report includes wild and

farmed salmon, herring (*Clupea harengus*) and mackerel (*Scomber scombrus*), 85 samples of which 74 is wild and farmed salmon or 87%.

Table 4: Dioxins and dioxin like PCBs in fish on the European market in 2003 in WHO-TEQ pg/g fresh weight

All values are expressed as pg WHO-TEQ/g fresh weight	<u>All fish (lean and oily)</u> in Europe 2003 n=157	<u>Oily fish</u> in Europe 2003 n=85 (74 wild and farmed salmon)	<u>Farmed salmon and trout in Iceland</u> n=6
	median (90th and 95th)	median (90th and 95th)	median (max)
PCDD/Fs	0,30 (0,97 and 1,22)	0,62 (1,00 and 1,17)	0,39 (0,42)
DL-PCBs	0,79 (2,23 and 3,66)	1,05 (3,31 and 3,71)	0,80 (0,84)
Total: PCDD/Fs + DL-PCBs	1,10 (4,10 and 4,63)	1,86 (4,22 and 4,60)	1,21 (1,23)

The table illustrates fairly well that the farmed salmon and trout from Iceland is significantly lower than oily fish in Europe (mostly wild and farmed salmon) and resembles more fish in general in Europe (lean and oily) and thus relatively low. Only lean fish in Europe 2003, n=72, has of course lower levels than fish in general or median values for PCDD/Fs, DL-PCBs and total dioxin-activity approximately half the median values of all fish but the 90th and 95th percentiles are the same for the lean fish as for all fish in EU. Finally it may be noted that the average levels for PCDD/Fs, DL-PCBs and total dioxin-activity in the European data are much higher than the median values due to a log-normal distribution of the data.

iii) 15 samples of wild salmon, 15 samples of farmed salmon and 15 samples of farmed trout were collected and analysed in Ireland 2001 (<http://www.fsai.ie>). The following table gives a summary of these results and comparison with the results from Iceland in this report.

PCDD/Fs, DL-PCBs and total dioxin-activity in wild and farmed salmon from Ireland as well as Irish farmed trout. All values are upperbound levels in pg WHO-TEQ/g fresh weight.

Table 5: Dioxins and dioxin like PCBs in salmon and trout from Ireland in 2001 compared to the values measured in Icelandic trout and salmon in 2003 in WHO-TEQ pg/g wet weight.

	<u>Wild Irish</u> <u>salmon</u> n=15 median (min-max)	<u>Farmed Irish</u> <u>salmon</u> n=15 median (min-max)	<u>Farmed Irish</u> <u>trout</u> n=15 median (min-max)	<u>Farmed salmon and</u> <u>trout in Iceland</u> n=6 median (min-max)
PCDD/Fs	0,30 (0,14-0,61)	0,85 (0,59-1,5)	0,29 (0,17-0,55)	0,39 (0,29-0,42)
DL-PCBs	0,64 (0,52-1,19)	3,34 (1,71-4,8)	1,03 (0,60-1,45)	0,80 (0,77-0,84)
Total (PCDD/Fs and DL-PCBs)	1,00 (0,68-1,80)	4,10 (2,3-6,3)	1,30 (0,77-2,00)	1,21 (1,08-1,23)

This table clearly indicates that farmed salmon from Ireland contains more than twice the levels found in farmed fish in Iceland which in turn resembles farmed trout and wild salmon in Ireland. Unfortunately, we don't yet have results for wild Icelandic salmon. It may be mentioned that the same laboratory analysed these samples from Ireland as the one that analysed the samples from Iceland.

iv) results for farmed **salmon from Norway** may be found at <http://www.nifes.no> for 25 samples of salmon fillets collected during 2003. The results obtained are reported in Table 6. PCDD/Fs, DL-PCBs and total dioxin-activity in farmed salmon from Norway. All values are upperbound levels in pg WHO-TEQ/g wet weight.

Table 6: Dioxin and dioxin like PCBs in farmed salmon from Norway compared to salmon and trout from Iceland in 2003-2004 in WHO-TEQ pg/g wet weight.

	Farmed Norwegian salmon	Farmed Icelandic salmon and trout
	2003 n=25 average (min-max)	2003-2004 n=6 average (min-max)
PCDDs	0,22 (0,12-0,43)	0,10 (0,07-0,12)
PCDFs	0,32 (0,17-0,68)	0,28 (0,21-0,31)
Sum of PCDDs and PCDFs	0,54 (0,29-0,97)	0,38 (0,29-0,42)
DL-PCBs, non-ortho	0,94 (0,57-1,74)	0,58 (0,54-0,61)
DL-PCBs, mono-ortho	0,37 (0,19-0,73)	0,22 (0,21-0,25)
Total (PCDD/Fs and DL-PCBs)	1,85 (1,10-3,44)	1,18 (1,08-1,23)

This table makes clear that the farmed salmon from Norway has the same level of PCDFs as the Icelandic fish but otherwise it contains up to 100% higher levels than the Icelandic salmon and trout with the total dioxin-activity being 50-60% higher. These results for farmed Norwegian salmon are in line with the results of Hites *et al.* or somewhat lower but similar to 6 samples of farmed Norwegian salmon samples from 1997 and analysed for only PCDD/Fs, *i.e.* with average PCDD/Fs of 0,504 (0,262-0,737) pg WHO-TEQ/g wet weight (Karl *et al.* 2002) to be compared with the values in the table above of 0,54 (0,29-0,97). In this study of Karl *et al.* two samples of Danish rainbow trout (*Oncorhynchus mykiss*) from 1998 were analysed for PCDD/Fs giving an average of 0,351 (0,309 and 0,351) pg WHO-TEQ/g fresh weight or the same as the Icelandic samples with 0,38 (0,29-0,42) pg WHO-TEQ/g fresh weight. (Hites *et al.* 2004, Karl *et al.* 2002).

v) **Scottish salmon** has been studied and reported in the literature (Jacobs, M., *and et al.* 2002).. Nine samples (plus one from Norway not significantly different from the Scottish salmon) gave a medium bound-levels of PCDDs and PCDFs of 0,22 and 0,48 pg WHO-TEQ/g fresh weight, respectively, or **approximately two times the levels found in Icelandic salmon and trout** with medium levels for PCDDs and PCDFs of 0,09 and 0,27 pg WHO-TEQ/g fresh weight, respectively.

vi) In a **surveillance by MAFF** and reported in 1999, twelve samples of salmon (mostly farmed but at least one wild) were obtained from retailers and analysed for PCDD/Fs and DL-PCBs (Food Surveillance Information Sheet, Number 184, August 1999: MAFF UK - DIOXINS AND PCBs IN UK AND IMPORTED MARINE FISH). The average upperbound levels found were for PCDD/Fs, DL-PCBs and total dioxin-activity of 6.3, 18.2 and 24.5 pg WHO-TEQ/g fat weight to be compared with 2.4, 5.5, and 7.9 pg WHO-TEQ/g fat weight for the six Icelandic samples of this report. **These samples of salmon from retailers in the MAFF-report are on average 3 times the levels found in the Icelandic samples.**

vii) In an another **surveillance by MAFF** and reported in 1998, forty samples of farmed trout had been sampled in England and Wales in 1995 and analysed for PCDD/Fs and DL-PCBs (Food Surveillance Information Sheet, Number 145, March 1998: MAFF UK - DIOXINS AND PCBs IN FARMED TROUT IN ENGLAND AND WALES). The median values for PCDD/Fs, DL-PCBs and total dioxin-activity were 4.85, 16.5, and 21.8 pg WHO-TEQ/g fat weight to be compared with 2.4, 5.3, and 7.4 pg WHO-TEQ/g fat weight for the six Icelandic samples of this report. **These samples of trout from trout farms in England and Wales in 1995 are on average also 3 times the levels found in the Icelandic samples.**

viii) **Pacific salmon**, both farmed and wild, were sampled from retailers in the Vancouver area and wholesalers in the Sidney area and analysed for DL-PCBs by M.D.L.Easton *et al.* (Easton M.D.L. 2002). The results were the following (lowerbound levels for gutted fish, i.e. not only fillets):

	DL-PCBs pg WHO-TEQ/g wet weight
Farmed salmon (Atlantic salmon, fillet with skin, n=1)	3,81
Farmed salmon (Chinook, fillet with skin, n=1)	7,19
Farmed salmon (Chinook, gutted, n=2)	5,66 and 10,54
Wild salmon (Chinook, gutted, n=1)	0,60
Wild salmon (Chum, gutted, n=1)	0,26
Wild salmon (Sockeye, gutted, n=2)	1,11 and 0,57

The wild salmon is markedly lower in DL-PCBs than the farmed samples. The levels in the filleted farmed salmon are much higher than the median value for the farmed Icelandic fish of 0,80 pg WHO-TEQ/g wet weight, and, actually not much different from gutted wild Pacific salmon. Results from Hites *et al.* (Hites *et al.* 2004), show, however, that wild salmon from the Pacific is less contaminated with respect to total dioxin-activity than farmed salmon from *e.g.* Chile.

Summary of the discussions on PCDD/Fs and DL-PCBs

In summary, with respect to PCDD/Fs and DL-PCBs, the farmed salmon and trout from Iceland contains equal or lower amount of these substances than all samples of farmed salmon found in the literature. Further the results are very similar to measurements of wild salmon from Ireland and similar to median values for all fish (lean and oily, mostly wild) on the European market in 2003 (with Baltic fish species excluded due to their high levels of PCDD/Fs and DL-PCBs). Only wild salmon from the Pacific seem to be lower in these contaminants than the Icelandic samples.

Metals: Mercury (Hg), Cadmium (Cd), Lead (Pb) and Arsenic (As)

The concentration of the four metals Hg, Cd, Pb and As in the four salmon samples is shown in Table 7. here below. For the metals lead and cadmium the levels in the samples were always below the detection limits, hence the upper-bound concentrations are given in Table 7 for these metals.

Table 7: Concentration of Hg, Cd, Pb and As in the salmon samples*

Lab code:	SN-DL-04-01	SN-DL-04-02	SN-DL-04-03	SN-DL-04-04
	mg/kg wet weight	mg/kg wet weight	mg/kg wet weight	mg/kg wet weight
Arsenic (As)	0,99	1,04	0,98	1,07
Mercury (Hg)	0,023	0,022	0,024	0,022
Lead (Pb)	0,02*	0,02*	0,02*	0,02*
Cadmium (Cd)	0,01*	0,01*	0,01*	0,01*

* For Lead (Pb) and Cadmium (Cd) the upper-bound concentrations are given

The results obtained in this study are compared (Table 8) to the concentrations of the same metals measured year 2004 in farmed salmon from Norway (<http://www.nifes.no>) and from Faroe Islands (<http://www.hfs.fo>). A slight difference is observed in the concentration for arsenic, while similar values are obtained for mercury in farmed salmon from Iceland and Norway. Other results are not comparable since they are below the detection limits of the analytical method used. As can be seen from Table 8, all results are well below the maximum limits of the European Union. (EU).

Table 8: Heavy metal content of farmed salmon from three countries compared to maximum levels in EU.

Country:	Norway	Faroe Islands	Iceland	EU maximum level
	mg/kg wet weight	mg/kg wet weight	mg/kg wet weight	mg/kg wet weight
Arsenic (As)	2,4 (1,1-3,1)	*	1,02	-
Mercury (Hg)	0,029 (0,024-0,036)	< 0,053	0,023	0,500
Led (Pb)	0,002 (0,002-0,003)	< 0,02	< 0,02	0,200
Cadmium (Cd)	< 0,001	< 0,002	< 0,01	0,050

In addition, Easton *et. al.* 2002 reported mercury values in four samples of wild salmon and two samples of farmed salmon from Canada (British Columbia) and USA (Alaska), in the range from 0,025 – 0,072 mg/Kg and 0,017 – 0,042 mg/Kg respectively. It can be concluded from this data that the heavy metal content of the Icelandic farmed salmon is not higher than in the salmon from the above mentioned countries.

PAHs

The results from the PAH measurements in the four salmon samples are shown in Table 9. As can be seen none of the seventeen PAH substances measured were above the limits of detection, it is therefore difficult to compare the results obtained with results found in the literature. Furthermore, PAH has normally only been monitored in smoked salmon where the values are much higher. No comparable results were found in the literature except in the article by Easton *et. al.* 2002, where four samples of farmed salmon from Canada (British Columbia) and USA (Oregon) were analysed for 20 PAH congeners and the results were in the range of 7,31 – 9,55 µg/kg wet weight. The

wild salmon measured in Easton’s study contained less PAH than the farmed one, or in the range of 3,32 – 4,10 µg/kg (with one exception where PAH level was very high or 39,79 µg/kg wet weight). These results are lower bound levels which mean that when the individual congener is measured below LOD, its concentration is calculated to be 0. The lower bound concentration of PAH of the Icelandic salmon is 0 µg/kg for all four samples but upperbound is 6 µg/kg weight. Therefore, it is clear that the PAH level measured in the Icelandic farmed salmon is lower than in the samples of farmed salmon from Canada and USA measured in the study by Easton *et. al.*..2002.

Table 9: PAH values in the farmed salmon from Iceland (n.d.= not detected with detection limits in within the parenthesis.

Lab code	SN-DL-04-01	SN-DL-04-02	SN-DL-04-03	SN-DL-04-04
	µg/kg wet weight	µg/kg wet weight	µg/kg wet weight	µg/kg wet weight
Phenanthrene	n.d.(3)	n.d.(3)	n.d.(3)	n.d.(3)
Anthracene	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)
Fluoranthene	n.d.(0,8)	n.d.(0,8)	n.d.(0,8)	n.d.(0,8)
Pyrene	n.d.(0,6)	n.d.(0,6)	n.d.(0,6)	n.d.(0,6)
Benzo[b]naphtho [2,1-d] thiophene	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)
Benzo[c]phenanthrene	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)
Benzo[a]anthracene	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)
Chrysene - Triphenylene	n.d.(0,2)	n.d.(0,2)	n.d.(0,2)	n.d.(0,2)
Benzo[ghi]fluoranthene	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)
Benzo[b+j+k]fluoranthene	n.d.(0,2)	n.d.(0,2)	n.d.(0,2)	n.d.(0,2)
Benzo[e]pyrene	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)
Benzo[a]pyrene	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)
Indeno[1,2,3-cd]pyrene	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)
Benzo[ghi]perylene	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)
Anthanthrene	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)
Dibenz[ah]anthracene	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)
Coronene	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)	n.d.(0,1)

Pesticides

The results of the pesticides analysis are reported in Table 10. Maximum permissible levels have been adopted by the European Community for some of the pesticides and they are shown in the same table for comparison. The pesticide content of the four samples of farmed Icelandic salmon is far from the maximum concentration accepted by EU. The concentration is lower than generally observed in wild fish of similar fat

content (12-16%) from the Icelandic waters (Asta M. Asmundsdottir *et.al.* 2006). Compared to the results reported by Hites *et. al.* 2004 the pesticide content of the farmed Icelandic salmon is similar to the majority of the results obtained for farmed salmon in his study and in some cases (e.g. HCB and Toxaphene) the results are actually more comparable to the concentration found in wild salmon. In addition, the values for Heptachlor, DDT and HCB seem to be similar to values for these pesticides measured in farmed salmon in Norway (<http://www.nifes.no>).

Table 10: Pesticides in farmed salmon from Iceland, compared to maximum limits in EU

Lab code	SN-DL-04-01 µg/kg wet weight	SN-DL-04-02 µg/kg wet weight	SN-DL-04-03 µg/kg wet weight	SN-DL-04-04 µg/kg wet weight	Maximum limits EU µg/kg wet weight
b-HCH	0,25	0,20	0,16	0,19	50
a-HCH	1,40	0,85	0,59	0,75	50
g-HCH	0,3	0,3	0,3	0,3	50
d-HCH	0,4	0,07	0,05	0,07	*
total DDT	14,33	12,05	12,72	12,93	500
Pentachlorbenzene	0,4	0,4	0,3	0,4	*
Hexachlorbenzene	4	4	4	4	50
Heptachlor	2,04	1,09	1	1,19	50
Toxaphene	13,75	13,5	12,6	12,7	*
Octachlorstyrene	0,13	0,099	0,069	0,089	*
Aldrin/Dieldrin	4,9	5,07	4,46	5,27	50
Endrin	0,74	0,93	0,81	0,84	50
Endosulphane	4,5	2,6	2,9	4,2	*
Chlordanes	6,665	5,94	5,94	6,58	*

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