International Fishmeal & Oil Manufacturers Association

DIOXIN LEVELS IN FISH FEEDS

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DIOXIN LEVELS IN FISH FEEDS

1. Summary & recommendations

On September 14/15, the EU Standing Committee for Animal Feedstuffs will meet to discuss legislation regarding maximum levels of dioxins in animal feeds and raw materials for animal feeds. Particularly for fish feed, fish products, such as fishoil and fishmeal the norms are considered too low for the industry to meet based on the current level of knowledge and understanding of the dioxin in fish.

The norms which were proposed at an earlier stage were:

2000 pg WHO – TEQ/kg **fat** for fish, fish meal and fish oil and
1000 pg WHO – TEQ/kg **product** (fish feed).

In the annex to this document a number of technical aspects regarding this point have been further detailed and outlined. Hereafter a number of main considerations in this discussion have been outlined. The main elements are:

- Increasing quantities of fish are required by the world market because of growth in the world population and increasing per capita consumption in many countries.
- Wild fish stocks are being fully fished and supply of fish from these stocks will not increase in the foreseeable future.
- Farmed fish production is an important part of the fisheries sector and is growing to meet the increasing demand for fish. Nearly 1 million tons of fish worth 3.2 billion Euros is provided by the European fish farming sector.
- The European demand for fish and fishery products if such that 60% of the European Union's requirements are imported.
- Essential raw materials for fish feed are fishmeal and fishoil, combined constituting a substantial part of fish feed. As dioxins are omnipresent in nature, they are omnipresent in fish, fishmeal, and fishoil and therefore in fishfeed.
- Dioxin levels in the environment have declined by a factor of 2 over the past 10 years, thus indicating lower persistence of dioxin in the environment than previously anticipated.
- There are no indications available that farmed fish would contain higher levels of dioxin than wild fish. Indeed the little evidence available seems to point to the contrary. To date, dioxin levels in wild and farmed fish as part of the national food basket are not cause for concern to EU member states.
- Adequate accurate information regarding dioxin content in fish feed, fishmeal and fishoil is lacking but very much needed. Limited data (see annex) suggests that 39 out of 44 samples of fish feed would be above the proposed limit of 1,000 pg/WHO-TEQ/kg product. The same is true for information regarding control measures, retention of dioxin in farmed fish and balanced implications for human health.

In view of this, our recommendations are:

- **with respect to the risk posed to human health caused by dioxins maximum levels on total WHO – TEQ for fish and fish (by) products are required but they need to be set at realistic levels. Reduction over time should be anticipated as more knowledge becomes available**

- **a decision on the maximum level of dioxin in fishfeed, fishmeal and fishoil should be postponed at this point in time for lack of sufficient knowledge about the problem and the absence of potential remedies (technological or other)**
- **a Scientific Risk Assessment study should be started as soon as possible, within a realistic time frame which should be as short as possible**
- **careful consideration be given to policing of any limits to minimise disruption of trade**
- **investigations into technology capable of reducing dioxin content in fishmeal and fishoil should be started as soon as possible**
- **public funds are needed to accompany the R&D and investment effort required to Quality Assure low dioxin levels in fish, fish (by) products and fish feed.**

2. Main considerations concerning fish feed

Fish is an essential component of the human diet
Wild and farmed fish are an important ingredient in human consumption and increasingly so. The trend towards increasing consumption of fish is expected to continue and is likely to be reinforced by the greater availability of fish in super- and hypermarkets, as is currently the case for Salmon.

Fish consumption is known to have many beneficial effects for human health (amongst others cardiovascular diseases) due to its high level of unsaturated fatty acids and Omega-3 levels. As such, fish is a very healthy food and is perceived as such by the consumer.

Wild fish stocks are now limited and will remain so. Consequently, over the past 15 years aquaculture has grown very strongly and will continue to do so if the market demand increases as anticipated.

Currently the largest volume of farmed fish species is Atlantic Salmon provided by Norway, Scotland, the Faeroe Islands and Ireland.

Trout farming is done throughout most of Europe, providing significant quantities to the market for many years. Recently, developments in the Mediterranean area have been very strong for species like Sea bass and Sea bream.

Currently we see very promising start-up developments in new species like Turbot, Tuna, Dentex, Amberjack, Striped Bass, Black and Red Sea Bream and Sole (see Table 1).

Such growth has been supported strongly by EU Member States and the Commission.

Fishoil and fishmeal are essential ingredients for fish feed
Fishoil and fishmeal are essential ingredients of fish feed. Combined these two ingredients may constitute a substantial part of fishfeed (eg.as much as 80% of fish feed).

Some partial substitution possibilities exist, using vegetable proteins and vegetable oils. However, not all fish oil and fish meal can at this point in time be replaced as these raw materials products contain fatty acids which are essential for fish and can

not be obtained from other sources. Further R&D will be required to be able to reach higher levels of substitution of both fish meal and fish oil.

In addition, the ethical questions raised in concern of animal welfare as a result of the introduction of dietary changes need to be answered. The after-effects of the BSE crisis serve to underline this question.

For the near future at least both fishmeal and fishoil remain necessary for fishfeed

Dioxins are omnipresent in nature and therefore in fish
Dioxins occur everywhere in nature at varying levels depending on the closeness of a particular area to sources (past or present) of contamination. As a consequence dioxins are present in wild fish, again in varying degrees between species and areas.

Available data for dioxin in wild fish, although limited, show a range of 1000-49000 WHO-TEQ pg/kg fat (see annex). Particularly for fishoil, one could expect the same variation in dioxin content as indicated above for fish.

Whatever the precise situation, there is clearly a reason for concern, however it should be kept in mind that the few available studies show two aspects of dioxin intake in Europe:

- human dioxin intake through the food basket has strongly diminished in the past 10-15 years, showing the impact of anti-pollution measures (the last 7 years dioxins through food reduced by a factor 2; in the same period dioxins in mother'smilk diminished by 65%)
- human dioxin intake through the food basket on average remains below the WHO safety level of 4 pg/kg BW/day

Dioxin in fish feed
Because there are dioxins in fish, there are also dioxins in fish feed, both fishoil and fishmeal being major and essential raw materials. With the present knowledge and given the high inclusion rate of fishmeal and fishoil, it is difficult to achieve low levels of dioxin in fishfeed.

Dioxins in farmed fish
Available data is once again too limited to draw firm conclusions, however it seems that the farmed species do not contain higher levels of dioxins than wild fish, possibly even lower (reference: UK MAFF Food Surveillace Information Sheet No.184, August 1999)

Other considerations
There are a number of important issues that need to be considered in deciding on dioxin tolerances in fish feed and its raw material components as well as implementing and controlling those norms.

Dietary aspects
Fish is a very healthy food in many aspects. The relatively high levels of dioxins found in some of the fish as well as relatively high levels in some of the fish products, may tarnish its reputation as a healthy food with negative consequences for fish consumption and as a consequence, possible adverse effects on other aspects of

human health. The overall health effect of a reduction in fish consumption as offset against possible dioxin effects is unknown.

There is a risk of creating unwarranted concern amongst consumers in case too much emphasis is given to the issue of relatively high levels of dioxin in fish.

The damage that may be done to the fisheries and aquaculture sectors through undue haste and overly restrictive actions must not be underestimated.

The same may happen in cases where higher norms for fishfeed than for compound feed are imposed. A Scientific Risk Assessment study is urgently needed here to be able to clarify for consumers what the real risks are.

Dioxin Measurement

Measuring dioxins is another issue that requires careful consideration. Analytical methods to measure dioxin are available but still highly inaccurate. Reported variations are in the order of magnitude of 25% (+/-), but variations of up to 70% (+/-) have been observed in split samples tested in two laboratories.

The degree of uncertainty increases strongly at low levels of dioxin content. The quick screening method (Calux) provides semi-quantitative results within 4 days, however is not yet validated. There may be legal implications in respect of:

- the use of inaccurate analytical methods,
- the enforcement of norms for dioxin content in raw materials if analytical methods are neither accurate nor validated.

In addition, the current costs are in the area of Euro 1100 for each measurement, a level which precludes batch analysis.

The European capacity for dioxin analysis is inadequate. At present, a dioxin analysis takes 3-6 weeks, without considering what would happen if dioxin norms were to be written into legislation and that routine checks on all raw materials and end products were required.

No indication has been given yet as to how control measures will be implemented, nor to the responsibilities of control and penalties. If, based on previous experience, such costs are appropriated to the industrial sector this would clearly be against the principle of 'the polluter pays', the overriding philosophy of environmental measures.

The introduction of legislation at a European level concerning dioxin levels (hence analysis and costs) should not create the circumstances for trade imbalance (as seen previously with the requirements for conditioning and processing fish) where the control measures on European produce would not be matched by those on imports.

Since 60% of the European demand is already provided by imports, equal treatment must be guaranteed.

Reducing dioxin levels

Little information is available about reducing dioxin content in raw materials. Clearly it would be highly interesting if such were possible, as one would eliminate, to a large

extent, the cause of the problem. Apart from the cost effects, there might however be negative effects on farmed fish because the characteristics of fish oils might change. Not enough knowledge is yet available about this.

For fish or fishmeal, no industrial "cleaning methods" are available at present. This means that, at a structural level, the supply line to the aquaculture sector, is neither capable nor ready to be able to supply 'refined' fishmeal or fish oil. This option does require rapid and substantial investigation however.

The problem of dioxin contamination has been caused by environmental pollution in the past 20-30 years. It is clearly the wider responsibility of society, not that of the industrial segments involved in human or animal food production. It is to be noted that European legislation follows the principle that it is the 'polluter who pays'.

In view of this and in order to accelerate the process, the Member States and/or the EU should assume the responsibilities in terms of assisting and financing the R&D and the investment effort required for resolving the identified problems for fish and fish feeds.

The consequences of introducing limitations on dioxin level in raw materials for feed for farmed fish do not seem to be fully evaluated. A lack of a holistic approach might reduce the consumption of fish in general, as these regulations might disturb the perception of fish as a healthy product for human consumption.

TABLE 1

PRODUCTION (tons)		**YEAR**				
GROUP	**COUNTRY**	***1994***	***1995***	***1996***	***1997***	***1998***
Carps	AUSTRIA	1,250	1,200	800	800	800
	BELG.-LUXBG.	500	400	400	300	300
	CZECH REPUBLIK	17,138	17,053	17,034	16,343	16,039
	FRANCE	5,000	5,000	5,005	5,500	6,000
	GERMANY	11,607	11,978	10,878	11,514	10,647
	GREECE	142	154	150	50	60
	ITALY	500	100	100	100	100
	NETHERLANDS	100	80	80	80	80
	POLAND	19,800	20,300	23,200	24,000	20,900
	SPAIN	50	50	50	50	
	TURKEY	288	424	780	800	850
	UTD. KINGDOM		13	13		
Carps Total		56,375	56,752	58,490	59,537	55,776
Catfish	BELG.-LUXBG.	150	200	150	150	150
	CZECH REPUBLIK		45	28	45	43
	FRANCE	300	300	300	300	
	ITALY	2,000	400	500	600	600
	NETHERLANDS	1,000	1,000	1,000	1,000	1,650
Catfish Total		3,450	1,945	1,978	2,095	2,443

Eels	BELG.-LUXBG.	150	150	150	150	150
	DENMARK	1,000	1,200	1,200	1,700	2,468
	FRANCE	810	180	160		
	GERMANY	900	600	140	150	150
	GREECE	341	234	350	312	500
	ITALY	2,800	3,000	3,000	3,100	3,100
	NETHERLANDS	1,500	1,650	1,800	1,800	3,250
	NORWAY	300	200	200	200	200
	PORTUGAL	200	200	200	200	200
	SPAIN	180	174	210	266	270
	SWEDEN	200	158	184	215	250
	TURKEY				200	200
Eels Total		8,381	7,746	7,594	8,293	10,738
Flatfish	FRANCE	550	800	852	950	853
	ICELAND					20
	NORWAY	133	234	276	251	
	SPAIN	1,752	2,010	1,890	2,055	1,851
Flatfish Total		2,435	3,044	3,018	3,256	2,724
Other Freshwater fish	CZECH REPUBLIK	407	457	418	522	474
	FRANCE	2,500	2,500			
	GERMANY	70	70			
	SPAIN	450	450			
Other Freshwater fish Total		3,427	3,477	418	522	474
Other Marine fish	FRANCE	250	250			
	GREECE		93			60
	ITALY	2,150	2,150			
	SPAIN	110	110			
Other Marine fish Total		2,510	2,603			60
Salmon	FAROE ISLANDS	13,290	10,000	5,950	15,000	25,000
	FINLAND	4				
	FRANCE	400	400	400	0	
	GREECE	59	12	12	2	
	ICELAND	3,000	2,880	2,850	3,500	3,360
	IRELAND	13,900	14,500	13,872	14,500	15,200
	NORWAY	207,000	249,200	296,000	316,000	343,000
	SPAIN	800	1,250	1,100	1,100	
	SWEDEN	7	25	100	100	3
	UTD. KINGDOM	64,064	70,060	83,000	100,000	115,000
Salmon Total		302,524	348,327	403,284	450,202	501,563
Sea Basses	CYPRUS		101	151	59	205
	FRANCE	1,440	1,360	1,511	1,661	2,516
	GREECE	6,800	8,048	9,042	12,040	17,070
	ICELAND					5
	ITALY	3,500	4,428	3,928	4,328	5,260
	MALTA	400	330	396	500	1,150
	PORTUGAL	300	490	556	906	1,004
	SPAIN	610	654	904	835	1,415
	TURKEY	2,229	2,000	3,000	5,020	5,770
Sea Basses Total		15,279	17,410	19,487	25,349	34,396

Sea Breams	CYPRUS		257	635	804	866
	FRANCE	360	907	1,013	1,016	1,262
	GREECE	6,700	9,048	12,053	14,060	19,084
	ITALY	2,500	2,628	3,028	3,528	5,240
	MALTA	1,100	970	1,156	2,000	550
	PORTUGAL	450	785	1,150	1,704	1,905
	SPAIN	2,720	3,300	4,732	5,571	6,366
	TURKEY	6,070	8,000	9,000	6,025	6,775
Sea Breams Total		19,900	25,894	32,766	34,707	42,047
Sturgeon	BELG.-LUXBG.	4	4	4	4	4
	FRANCE	300	300	280	140	121
	ITALY	666	1,000	1,000	1,000	800
Sturgeon Total		970	1,304	1,284	1,144	925
Tilapias	BELG.-LUXBG.	300	300	250	300	300
Tilapias Total		300	300	250	300	300
Trout	AUSTRIA	3,500	3,500	3,400	3,400	3,400
	BELG.-LUXBG.	800	800	800	820	800
	CYPRUS		98	110	105	90
	CZECH REPUBLIK	650	645	647	499	554
	DENMARK	39,650	41,250	37,250	36,550	39,500
	FAROE ISLANDS	452	452	63	100	0
	FINLAND	16,600	17,300	18,000	16,500	16,500
	FRANCE	43,660	51,660	57,660	51,660	51,660
	GERMANY	25,000	25,000	25,000	25,000	25,000
	GREECE	1,943	2,455	2,500	2,322	2,300
	ICELAND	718	851	1,344	1,350	1,100
	IRELAND	1,370	1,300	1,300	1,300	1,300
	ITALY	42,000	50,300	49,000	51,000	48,000
	NETHERLANDS	200	200	200	200	200
	NORWAY	15,741	13,289	40,200	34,344	47,200
	POLAND	4,500	4,679	5,800	6,500	9,000
	PORTUGAL	2,328	3,000	1,500	1,500	1,500
	SPAIN	22,750	18,750	25,000	25,850	26,700
	SWEDEN	6,250	5,952	6,250	5,258	6,900
	TURKEY	6,977	6,977	8,000	20,075	22,625
	UTD. KINGDOM	15,648	13,649	14,850	15,100	15,825
Trout Total		250,737	262,107	298,874	299,433	320,154

DIOXIN, FURANS AND PCB IN AQUACULTURE.

A. Background information on dioxin and PCB.

Introduction

Polychlorinated dioxin (PCDD) and dibenzofurans (PCDF) comprises of two series of tri-cyclical aromatic compounds with similar chemical properties. There are 75 different congeners ("variants") of PCDD and 135 of PCDF, which differs in location and numbers of chlorine atoms. The most toxic congener is 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Polychlorinated biphenyls (PCB) stands for a group of 209 different congeners that differ in the number and position of chlorine atoms. The chemical properties and toxic effect of these substances will depend on the number and position of the chlorine atoms.

Dioxin, furans and PCB are fat soluble substances which are resistant towards degradation. For these reasons, the substances are stored in lipid tissue and accumulate in the food chain, however, at a lower rate than previously anticipated.

There are toxicological effects of dioxin and dioxin like PCB as shown by animal experiments. By chronic exposure, the most important health implications are: cancer development, reproduction disturbances, reduced immune response neurotoxical effects, endocrine disturbances and impact on the hormonal balance. 2,3,7,8-TCDD acts as an antiestrogen and some PCB's as an anti-estrogen or anti-androgen.

The toxicity of the different congeners is related to the most toxic congener 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) and the toxicity of the other congeners is expressed as a function of the toxicity of TCDD, named toxic equivalents (TEF). By multiplication of the individual congener with its TEF and thereafter add up the different products, the total TCDD- equivalency (TEQ) is obtained. In this way it is possible to calculate intakes and assess health risks.

Health risk judgment in connection to exposure of dioxins and PCB is based on animal experiments. A Nordic working group gave a common Nordic risk judgment in 1988 by judgment of TCDD . They established a Tolerable Daily Intake (TDI) of 0 to 5 picogram per kg body weight or a Tolerable Weekly Intake (TWI) of 0 to 35 picogram per kg body weight. The same levels were agreed upon after a reconsideration in 1994. For calculation of TWI an uncertainty factor of 200 in relation to the lowest doses that have caused harmful effects on animals has been used . In 1997, The Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT), UK, recommended a TDI of 10 pico gram TEQ/kg body weight/day for mixtures of dioxins and PCB's . Recently, the WHO work group proposed a TDI value range of 1 - 4 pico gram TEQ/kg body weight/day for dioxins and PCBs.

Dioxin and PCB production and pollution and trends over time

PCDD and PCDF have never been produced commercially. They are formed as unwanted by- products in small amounts by the production of certain chloro-compounds as chlorphenols, chlorinated diphenylethers and biphenyls. The use of pentachlorphenol is regarded as a considerable source for PCDD and PCDF in industrial countries. They are also formed by combustion processes like waste combustion and by production of iron and steel. Chlorine bleaching of paper has earlier been a considerable source as well as chlor-alkali fabrics with graphite electrodes. Other sources are exhaust gases from cars where chlorinated solvents have been used in leaded fuel. A formation has also been shown in waste and garden waste . Dioxin and PCB are produced by low temperature burning of wood and coal and are formed through forest fires. Volcanic eruption is also causing formation of these unwanted compounds.

PCB has been used since 1930 for several industrial purposes as in electrical transformators and condensers, grouting mass for insulating glass in windows and light fittings. The total production of PCB in the world is approximately 1.8 million tons. It is assumed that 20 - 30 % of this is distributed to the environment.

New use of PCB was prohibited in Norway in 1980 and all use of PCB containing transformators and power condensers was terminated in 1995. Similar measures have been taken in other countries. With respect to the dioxins, reductions have been made due to efforts for waste reductions in metal -industries and waste combustion plants, process changes in the cellulose industry and reduced use of leaded fuel added chlorine containing compounds. A total reduction in discharges of dioxins to air and water from known sources has been reduced by over 90 % from 1985 to 1992. Correspondingly, has measurements of PCDD and PCDF which started in Sweden around 1985 shown that discharges have been reduced from 300 gram TEQ down to probably less than 50. The content in fish from the Baltic Sea and the contents in breast milk has also been reduced. Long term monitoring of PCB in herring from the Baltic Sea since 1978 has shown that concentration of PCBs have fallen by 6.3 to 13 per cent per year. Reports showing similar developments are available also from other parts of the world.

Human exposure to dioxins and PCB

The humans are mainly exposed to dioxins and PCB via food, swallowing of contaminated earth particles, inhalation of contaminated air etc. The contribution from the different categories has been estimated as follows:

Food	:	90. %
Air	:	2 - 3 %
Earth	:	< 1 %
Others	:	7 - 8 %

In general, it seems that about 90 % of the dioxin intake in humans is related to the food. Since dioxin and PCB are fat soluble and accumulates in the food chain, food rich in fat will be the main sources for intake. The intake of these foods varies between countries, which in turn will affect the dioxin intake.

Transmission of dioxins to the aquatic environment

Both PCB and dioxins show highest concentration close to their origin, but are extensively spread with air and water. The compounds are spread throughout the whole world and is detectable in low concentrations in nearly all environmental samples. In the air, the compounds can be spread over wide distances. Due to this, dioxins and PCB can be found in organisms far from human activity, for instance in fish and seal from Arctic areas.

In water and earth, the substances are mainly located to small particles that is easily washed out, transported further or are deposited in water sediments.

PCDD and PCDF are lipophilic substances, they retain in lipid tissues and are resistant to degradation. For this reason, they are accumulated in the food chain and humans are exposed to these mainly through the food. Fat fish from polluted areas have shown high concentrations. Figure 1 shows a schematic drawing of transmission of dioxins and PCB to the aquatic environment and to humans.

In general, concentrations of dioxins and PCBs in fish depend on their fat contents, the extent to which fish migrate, the number of times they spawn, their ages, size and feeding habits. For example may fish living on the bottom be more exposed to dioxin and PCBs bound to the sediments.

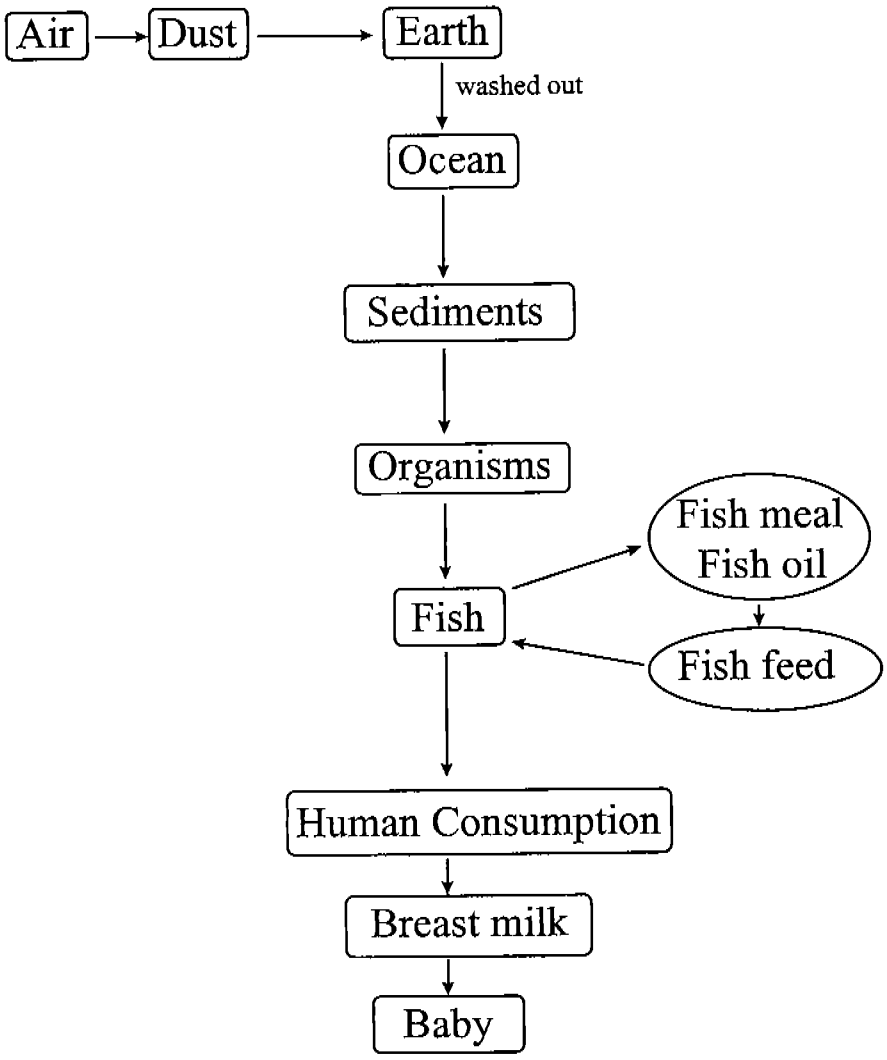

Figure 1. Schematic drawing of the transmission of dioxin and PCB to the aquatic environment and to humans

B. Dioxin and furans in feed ingredients, fish feeds and fish

Introduction

The following considerations are based on the assumption that the EU Commission at present only is putting into action limitations on the use of dioxin (dioxin and furans). Therefore, all values given in the following contributing to TEQ are based on the content of dioxin +furans excluding PCBs.

When discussing dioxin levels in land animal feed products, it should be kept in mind that the use of raw materials of marine origin seldom exceed 5% of the total raw materials and the fat content is normally below 10% in compound feed. On the other hand, due to the specific requirements for essential nutrients in carnivorous and omnivorous farmed fish species, the majority of raw materials in these diets are still of marine origin. In addition, in the high nutrient diets used in intensive fish farming, the oil level is normally in the area of 30 - 35 %.

The amount of feed needed to produce one kg of meat or fish filet differs between species. In rough terms, fish need one kg of feed per kg weight gain, the figures for broilers and pigs are two and three kg, respectively.

Due to the differences between species it should be evaluated if different dioxin levels in feed for different species should be set, and as a minimum, a split should be made between feed for agriculture and aquaculture.

Dioxin in wild fish.

The best documented data so far found on background contamination of dioxin in wild fish is to be found in MAFF: Food surveillance information sheet: No 184 August 1999 - DIOXINS AND PCBs IN UK AND IMPORTED MARINE FISH. Table 1 shows the result of this investigation

Table 1. Estimated oil content and analyzed dioxin content in fillets of raw fish (WHO - TEQ: pico gram/ kg fat)

	No. of Samples	% oil in fillet	Dioxin
Landed in UK:			
Cod	17	0,3	2000-24000
Haddock	16	0,3	1000-14000
Plaice	10	1,4	3000-43000
Whiting	14	0,6	2000-20000
Herring	10	20,0	13000-38000
Mackerel	13	14,0	1000-9000
Salmon	11	10,0	4000-11000
Trout	?	7,0	2000-14000
Imported:			
Cod	13	0,3	1000-18000
Haddock	10	0,3	1000-9000
Plaice	3	1,4	16000-27000
Salmon Norway	1	10,0	3400
Red fish Norway	2	3,5	12000-16000

Table 2 gives some indication on the content of dioxin and furans in wild fish in a number of countries.

Table 2. Concentrations of PCDD/PCDF in fish from food surveys in different countries

Country	PCDD and PCDF TEQ pico gram/kg lipid
Canada	8500
Germany	8100 - 43000
Russia	800 - 46000
Sweden	2000 - 10400
The Netherlands	6800 - 49000
USA	2500 - 12500

Looking at the values in table 1 and 2, it appears that there is a considerable variation in the dioxin content of wild fish that are used for human consumption.

Dioxin in fish feed.

Limited information exists on the retention of dioxin in the different stages in the food chain from wild fish to the farmed fish. In less than two months, results from retention studies for dioxin in salmon will be made available. These results will also give information about the effect of the feed manufacturing process on the levels of dioxin left in the feed.

A limited number of analyses of dioxins and furans in salmon diets from UK, Norway and Denmark show the following values expressed on pico gram/kg diet.

LEVEL OF WHO-TEQ PCDD/PCDF	SOURCE
1,700	1
4,010	1
3,200	1
1,500	1
2,000	1
1,600	1
4,370	2
3,670	2
1,940	2
3,640	2
2,222	2
1,050	2
740	2
2,380	2
2,170	2
3,960	2
4,640	2
2,000	3
1,000	3
4,700	3
560	4
680	4
920	4
1,040	4
1,000	4
1,340	4
1,290	4
1,160	4
1,420	4
1,220	4
1,030	4
1,660	4
1,630	4
1,960	4
1,870	4
1,780	4
1,680	4
1,540	4

2,750	4
2,220	4
2,350	4
2,410	4
2,010	4
3,420	4

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