

Exposure Assessment - Microcystins in Fish

Since free microcystins were not detected in fish flesh in any of the samples of eel, roach, pollan, perch or bream, and total (free + protein-bound) microcystins were not detected in any of the samples tested for these of eel, roach, pollan or perch (bream flesh was not tested for total microcystins) it is possible the toxins were not present. However, as discussed above, since some of the microcystins were detected in other parts of the fish it is also possible that they were also present in the fish flesh but at levels below the limits of detection. The limit of detection of the analytical method for total (free + bound) microcystins was 10 µg/kg wet weight.

An upper bound exposure assessment will be conducted. Upper bound exposure assessments assume that substances with analytical results below limits of detection (or other reporting limits) are present at the limit of detection (or reporting limit), in this case the limit of detection of 10 µg/kg. In contrast, lower bound exposure assessments assume that substances with analytical results below limits of detection or reporting limits are entirely absent, i.e. 0 µg/kg. Upper bound exposure assessments may overestimate exposure, whereas lower bound exposure assessments may underestimate exposure.

While edible flesh from the single sample of bream was not tested for total microcystins, free microcystins were not detected and concentrations of total microcystins measured in the viscera of the bream were similar to those for the other species tested. Therefore, it is expected that the results for total microcystins in the flesh of eel, roach, pollan and perch would also apply to the bream.

Eel

Consumption data for eels available through the National Diet and Nutrition Survey (NDNS) were considered for this assessment (Bates et al., 2014, 2016, 2020; Roberts et al., 2018). The NDNS is a programme of surveys designed to assess the diet, nutrient intake and nutritional status of the general population aged 18 months and over living in private households in the UK.

The number of consumers of eel in the NDNS is very small. However, it was considered preferable to use these consumption data rather than consumption data for another species of fish as a proxy. Nevertheless, it introduces some uncertainty in the exposure estimates. In addition, there was a lack of child consumers of eel in the NDNS survey. To address the potential exposures of children who eat eel, an estimate for the consumption of toddlers aged 1-3 years old has been made based on assuming portion sizes of eel are 1/3 those of adults aged 19-64 years (as is typical for other similar foods) and using the mean bodyweight for this age group in the NDNS of 14.6 kg. A similar approach has not been taken for ages 4-18 as their exposures are expected to be between those of toddlers and adults. The consumption data are presented in Table 1 and 2.

Table 1: Chronic consumption of eels (with recipes) in g per person per day. Data from National Diet and Nutrition Survey, years 1-11

Age group	Number of consumers	Mean (g/person/day)	97.5th Percentile (g/person/day)	Max (g/person/day)
Toddlers (1.5-3yrs)*	0*	2.6	13	16
4 - 10 yrs	0	0	0	0
11 - 18 yrs	0	0	0	0
19 - 64 yrs	3	7.9	38	47
65+ yrs	4	54	85	88

Rounded to 2 significant figures.

Consumption or exposure estimates made with a small number of consumers may not be accurate. The number of consumers is less than 60, this should be treated with caution and may not be representative for a large number of consumers.

*Calculated on the assumption toddlers would consume 1/3 of an adult portion and using the average bodyweight (bw) of 14.6 kg.

Table 2: Chronic consumption of eels (with recipes) in g per kg bodyweight (bw) per day. Data from National Diet and Nutrition Survey, years 1-11

Age group	Number of consumers	Mean (g/person/day)	97.5th Percentile (g/kg bw/day)	Max (g/kg bw/day)
Toddlers (1.5-3yrs)*	0*	0.18	0.87	1.1
4 - 10 yrs	0	0	0	0
11 - 18 yrs	0	0	0	0

Age group	Number of consumers	Mean (g/person/day)	97.5th Percentile (g/kg bw/day)	Max (g/kg bw/day)
19 - 64 yrs	3	0.13	0.67	0.82
65+ yrs	4	0.72	1	1.1

Rounded to 2 significant figures.

Consumption or exposure estimates made with a small number of consumers may not be accurate. The number of consumers is less than 60, this should be treated with caution and may not be representative for a large number of consumers.

*Calculated on the assumption toddlers would consume 1/3 of an adult portion and using the average bodyweight (bw) of 14.6 kg.

Using the 97.5th percentile consumption data for each age group in Table 2, and assuming that the total microcystins are present at 10 µg/kg (upper bound approach), the dietary intakes are as shown in Table 3. These are compared with the WHO provisional TDI for microcystins, based on toxicological data for microcystin-LR.

Table 3: Upper bound estimated intakes of total free + bound microcystins in high consumers of eels

Age group	97.5th Percentile consumption (g/kg bw/day)	Estimated intake at 97.5th percentile (µg/kg bw/day)	Percentage of provisional TDI for microcystins of 0.04 µg/kg bw (to 2 significant figures)
Toddlers (1.5 - 3 yrs)*	0.87	0.0087	22%
4 - 10 yrs	0	0	0%
11 - 18 yrs	0	0	0%
19 - 64 yrs	0.67	0.0067	17%
65+ yrs	1	0.01	25%

*Calculated on the assumption toddlers would consume 1/3 of an adult portion and using the average bodyweight (bw) of 14.6 kg.

Roach, pollan, perch and bream

There is a lack of consumption data for roach, pollan, perch and bream in the NDNS. Consumption data for trout are used here as a proxy for the consumption of these species of fish individually or in combination (Bates et al., 2014, 2016, 2020; Roberts et al., 2018). The consumption data for trout are presented in Tables 4 and 5.

Table 4: Chronic consumption of trout* (with recipes) in g per person per day. Data from National Diet and Nutrition Survey, years 1-11

Age group	Number of consumers	Mean (g/person/day)	97.5th Percentile (g/person/day)	Max (g/person/day)
Toddlers (1.5-3yrs)	7	13	20	20
4 - 10 yrs	6	27	49	50
11 - 18 yrs	3	42	65	73
19 - 64 yrs	42	44	89	110
65+ yrs	29	36	71	89

Rounded to 2 significant figures.

Consumption or exposure estimates made with a small number of consumers may not be accurate. The number of consumers is less than 60, this should be treated with caution and may not be representative for a large number of consumers.

*Trout has been used as a proxy for bream, roach, pollan and perch.

Table 5: Chronic consumption of trout* (with recipes) in g per kg bodyweight (bw) per day. Data from National Diet and Nutrition Survey, years 1-11

Age group	Number of consumers	Mean (g/person/day)	97.5th Percentile (g/kg bw/day)	Max (g/kg bw/day)
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Toddlers (1.5-3yrs)*	7	0.81	1.4	1.4
4 - 10 yrs	6	1.3	2.8	2.9
11 - 18 yrs	3	0.62	1.1	1.3
19 - 64 yrs	42	0.58	1.5	1.5
65+ yrs	29	0.49	1.1	1.4

Rounded to 2 significant figures.

Consumption or exposure estimates made with a small number of consumers may not be accurate. The number of consumers is less than 60, this should be treated with caution and may not be representative for a large number of consumers.

*Trout has been used as a proxy for bream, roach, pollan and perch.

Using the 97.5th percentile consumption data for each age group in Table 5, and assuming that the total microcystins are present at 10 µg/kg (upper bound approach), the dietary intakes are as shown in Table 6, below. These are compared with the WHO provisional TDI for microcystins, based on toxicological data for microcystin-LR.

Table 6: Upper bound estimated intakes of total free + bound microcystins in high consumers of roach, pollan, perch and/or bream

Age group	97.5th Percentile consumption (g/kg bw/day)	Estimated intake at 97.5th percentile (µg/kg bw/day)	Percentage of provisional TDI for microcystins of 0.04 µg/kg bw (to 2 significant figures)
Toddlers (1.5-3yrs)	1.4	0.014	35%
4 - 10 yrs	2.8	0.028	70%
11 - 18 yrs	1.1	0.011	28%
19 - 64 yrs	1.5	0.015	38%
65+ yrs	1.1	0.011	28%

Consideration of potential dietary exposures if fish were incompletely eviscerated

Since fish may be caught and prepared for consumption not only by food business operators but by recreational anglers, concern has been raised that evisceration may be incomplete or that the edible flesh may become contaminated in the process.

A total of 13 parts of viscera from 9 samples of fish were analysed for total (free + bound) microcystins, with concentrations ranging from 39 µg/kg in a sample of perch gills to 643 µg/kg in a sample of roach intestine. Microcystins were not detected in the flesh. As an exposure scenario, the highest concentration measured, 643 µg/kg in roach intestine will be used and it will be assumed that 10% of the relative proportion of the intestines may be consumed inadvertently with the flesh.

Thus, 100% would mean that edible flesh and intestine would be consumed based on the natural proportions in the fish, while 10% of the relative proportion of intestine to edible flesh is assumed here to represent inadvertent consumption of small amounts of intestine. This is expected to be conservative for long term exposure, in particular when using the highest concentration in any viscera component of all fish samples.

If it is assumed that 12% of the body weight of roach is viscera (general information for fished species in general), and that approximately half of the viscera is intestine, then about 6% of the body weight of the fish would be intestine. In general, the average proportion of a whole fish that is edible flesh is about 58% (MSC, 2021). Thus, the weight of intestines is about 9.4% of the total weight of intestines plus flesh. If it is assumed that 10% of the relative proportion of intestine to flesh may be consumed with the flesh, then fish meat as consumed would be 0.94% intestine with the remaining 99.06% being flesh.

Assuming that the edible flesh contains total microcystins at the limit of detection of 10 µg/kg (upper bound approach), then the total concentration of microcystins in the fish as consumed would be $(0.94\% \times 643 \mu\text{g/kg}) + (99.06\% \times 10 \mu\text{g/kg}) = 16.0 \mu\text{g/kg}$.

Table 7 presents an exposure assessment for roach containing 16.0 µg/kg, using the consumption data for trout from Table 5 as a proxy for roach consumption.

Age group	97.5th Percentile consumption (g/kg bw/day)	Estimated intake at 97.5th percentile (µg/kg bw/day)	Percentage of provisional TDI for microcystins of 0.04 µg/kg bw (to 2 significant figures)
Toddlers (1.5 - 3 yrs)*	1.4	0.022	55%
4 - 10 yrs	2.8	0.045	110%
11 - 18 yrs	1.1	0.018	45%

Agegroup	97.5th Percentile consumption (g/kg bw/day)	Estimated intake at 97.5th percentile ($\mu\text{g/kg}$ bw/day)	Percentage of provisional TDI for microcystins of 0.04 $\mu\text{g/kg}$ bw (to 2 significant figures)
19 - 64 yrs	1.5	0.024	60%
65+ yrs	1.1	0.018	45%