

Scientific Advisory Committee on Nutrition
&
COMMITTEE ON TOXICITY OF CHEMICALS IN FOOD
CONSUMER PRODUCTS AND THE ENVIRONMENT

Paper for discussion: Advice on fish consumption

This paper comprises a main paper and three annexes: fish consumption in the UK; nutritional considerations; and contaminants in fish and their toxicological considerations. The main paper summarizes the issues and the details are given in the annexes.

Possible questions to be addressed by the joint committee:

1. Do the SACN and COT opinions need to be revised in light of more recent evidence?
2. Are there other toxic contaminants in fish that should be evaluated by the COT?
3. Is the dietary advice to consume two portions of fish, one of which should be oily, per week consistent with receiving health benefits without incurring risks of adverse effects?
4. Are there any appropriate methods of risk-benefit analysis, which could be used in assessing benefits and risks associated with fish consumption?
5. Are there additional benefits to consumers eating more portions per week that outweigh the risks?
6. Is current scientific evidence consistent with existing advice to consumers, and, if not, in what respect should advice be revised?
7. In particular, does existing advice reflect the nutritional benefits of fish consumption and the extent that these would be offset by potential risks?
8. Is there a case for providing additional advice to high level consumers and/or susceptible population groups, and what should that advice be?

Scientific Advisory Committee on Nutrition & COMMITTEE ON TOXICITY OF CHEMICALS IN FOOD CONSUMER PRODUCTS AND THE ENVIRONMENT

Advice on fish consumption

Aim

- To bring together the nutritional considerations from Scientific Advisory Committee on Nutrition (SACN) on fish consumption and the toxicological considerations from Committee on Toxicity (COT) on the contaminants in fish.
- To weigh the nutritional benefits against possible risks and to develop sensible dietary advice for the public on consumption of fish, with particular reference to oily fish.

Background

1. The Committee on Medical Aspects of Food (COMA) recommendation of 1994 (Department of Health, 1994) based on the evidence of health benefits of fish consumption (especially oily fish and fish oils) was that 'people eat at least two portions of fish, of which one should be oily, weekly'.
2. Recently SACN advised COT on the benefits of oily fish and fish oil consumption (SACN, 2002). Following a brief review of the data, SACN concluded that the evidence to support nutritional benefits of fish consumption had strengthened since 1994 and if it were to consider the issue in full it would probably recommend a higher level of fish consumption.
3. The COT has recently considered the toxicological effects of a number of contaminants present in fish, which has indicated that some subgroups of the population should limit their consumption of certain types of fish.
4. Interested parties have commented that mixed messages are being given to consumers and so this review aims to bring these views together in order to allow the Food Standards Agency to provide clear and helpful advice to consumers.

Fish consumption in the UK – see annex 1 for details

5. White fish have flesh that is very low in fat as these fish accumulate fat in their livers, e.g. cod. Oily, or fatty, fish have fat in their flesh – the amount is related to their breeding cycle, and after breeding the fat content falls considerably. Oily fish are 5-20% fat compared with 1-2% fat for white fish. Oily fish include, sardines, salmon, pilchards, mackerel, herring and trout, whether fresh, frozen or canned. Fresh tuna is also included; however unlike other canned oily fish, canned tuna is not regarded as oily, as processing of tuna during canning reduces the fat content of the fish to a low level. White fish include cod, haddock, turbot, bream, bass etc. Please see Annex 1 which lists in Table 1 oily and white fish and in Table 2 details of the commonly consumed fish in the UK taken

from the 2000/2001 National Diet and Nutrition Survey (NDNS) (Henderson *et al.*, 2002).

6. The UK population average total fish and fish products consumption was 143 grams/person/week in 2000 (National Food Survey). Of this total 36 grams was fresh, frozen or processed white fish and 20 grams was fresh and processed (other than canned) oily fish. Consumption of canned salmon was 6 grams/ per person/week and other canned or bottled fish (including tuna) 26 grams. The remainder of the total is accounted for by cooked fish and fish products and shellfish.
7. The latest NDNS (Henderson *et al.*, 2002) of adults aged 19-64 years shows that mean consumption of white fish (including products and dishes) by adults was 103g/week and for oily fish (excluding canned tuna) 50g/week. Correspondingly, mean consumption of white fish and oily fish by consumers was 221g/week and 194g/week respectively. Details are given in Annex 1 Tables 3-6. Most people in the UK consume very little fish. For example, during the period of the NDNS survey 74% of the participants did not consume oily fish (excluding canned tuna), 65% did not consume coated and/or fried white fish and 82% did not consume other white fish and dishes (Henderson *et al.*, 2002).
8. Comparison of the National Food Survey data from 1979 and 1999 shows that consumption of total fish and fish products increased by 13% between 1979 and 1999. Within the total, consumption of fresh oily fish more than doubled since 1979 while processed canned and shellfish increased by over 60% and fish products by over 40%.
9. The mean consumption of oily fish by adults (Henderson *et al.*, 2002) has increased from 34g to 53g/week (from about $\frac{1}{4}$ to $\frac{1}{3}$ of a portion) since the last survey of this age group in 1986/87. The mean consumption of oily fish (excluding tinned tuna) by consumers has increased correspondingly from 134g/week to 194g/week. This is mainly due to an increase in consumption by women, particularly older women. Increased salmon consumption largely accounts for the increase.
10. The average portion size for adults is 140g. Details of other age groups given in Annex 1 Table 7.
11. In this paper, n-3 polyunsaturated fatty acids (PUFA) refers to eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) – these have been shown to be responsible for the beneficial effects of fish consumption on coronary heart disease (CHD) risk. The estimates used for n-3 PUFA and oil content of oily fish are 2g/100g and 6g/100g respectively; however, there is much seasonal and interspecies variation.

Nutritional considerations – see annex 2 for details

12. The COMA statement (Department of Health, 1994) that ‘people eat at least two portions of fish, of which one should be oily, weekly’ (Department of Health, 1994) was based on a review of scientific evidence that related fish consumption (especially oily fish and fish oils) inversely to coronary heart disease (CHD). As most people in the UK consume considerably less fish than one portion per week, the Committee concluded that CHD reductions would be gained by increasing levels of consumption.
13. The evidence on the health benefits of fish consumption is mainly drawn from secondary prevention trials that consistently show increased fish consumption or fish oil supplementation decreases the incidence of CHD in an at risk group. Extrapolating to a

'healthy' population is difficult; however, the UK population is a 'high risk' population with regard to CHD: almost 30% of the English population have been diagnosed with some form of cardiovascular condition.

14. The evidence from secondary prevention trial data demonstrates that a beneficial effect of fish consumption, and fish oil supplementation, on CHD risk is mediated by long chain n-3 PUFA at a dose of 1g/d. There are benefits, however, at lower levels and the COMA recommendation was for n-3 PUFA intake to increase from 0.1g/d to 0.2g/d. SACN, however, indicated in their previous correspondence to COT that if they revisited this recommendation, the strength of the current evidence would probably lead to a recommendation for a figure greater than 0.2g/d for the UK population.
15. An uncertainty is the exact nature of the dose-response effect, as only one dose was investigated in the secondary prevention trials; however, examination of prospective studies in populations with a higher prevalence of CHD shows that there appears to be a dose-dependent benefit of increasing fish consumption of up to 40-60g/d mixed type (corresponding to about 0.9g/d n-3 PUFA). It should also be noted that at least 1.5g/d n-3 PUFA is required in trials to demonstrate an effect on cardiovascular risk factors, e.g. lowering plasma triacylglycerol concentrations.
16. The evidence for any non-cardiac benefits of fish consumption (e.g. on cognitive function, gestation length, cancer risk) is, at this time, insufficient to draw any firm conclusions.

Nutritional benefits associated with fish consumption apart from n-3 PUFA provision

17. Fish, both oily and white, is also a rich source of selenium and the UK population has a low selenium intake (average TDS intake is 39µg/d; whereas, the RNI is set at 60µg/d and 75µg/d for women and men, respectively). The significance to health of this low status is currently unknown.

Contaminants in fish and their toxicological considerations – see annex 3 for details

18. Environmental contaminants, such as dioxins and heavy metals are present in sediment and water from both natural sources and as a result of human activities. These contaminants are taken up by marine organisms and many have the potential to accumulate, higher up the food chain, in certain types or species of fish.
19. Dioxins tend to accumulate in fatty tissues so high levels can occur in oily fish. Brominated flame-retardants also accumulate in fatty tissues but there is currently insufficient evidence to conclude that high levels would occur in oily fish. Some heavy metals, such as mercury, tend to accumulate in larger, older fish, for example predatory fish regardless of whether they are oily or not. Other metals, for example arsenic, are present in fish but do not appear to bio-accumulate up the food chain or in any particular species/type of fish.
20. In annex 3 a summary of the general toxicological principles and a summary of the relevant information on each contaminant is provided covering the following areas:

- a) Reasons why certain contaminants are present in the marine environment and the factors which affect their accumulation in fish? The factors discussed include species, geographical location, weight, age and proportion of fatty tissue.
- b) A summary of the toxicology of each contaminant, including any relevant safety guidelines (e.g. tolerable daily intakes, reference doses etc.) and evaluations by any other countries where available.
- c) Information on surveys carried out to monitor the levels in fish, which includes estimations of dietary intakes for consumers and assessments carried out by the COT where available.

Dioxins and dioxin-like PCBs

21. In 2001 the COT concluded that dioxins and dioxin-like polychlorinated biphenyls (PCBs) have the potential to cause a wide range of adverse health effects. Those most likely to be associated with low levels of exposures relate to the developing embryo/fetus.
22. A tolerable daily intake (TDI) of 2 pg WHO-TEQ/kg bw per day was established, based upon effects on the developing male reproductive system mediated via the maternal body burden. This TDI was considered to be adequate to protect against other possible effects, such as cancer and cardiovascular effects (COT 2001).
23. The COT also noted that the most recent intake estimates for the UK population were 1.8 pg/kg bw/day for the average consumer and 3.1 pg/kg bw/day for the 97.5 percentile consumer and that dietary intakes are decreasing.
24. The COT considered that there are no short-term measures that can be used to decrease the body burden of dioxins and dioxin-like PCBs in humans because of their long half-lives and widespread presence at low levels in food. Similarly, because of the long half-life, the Committee considered that short-term exceedance of the TDI would not be expected to result in adverse effects, but that it was not possible to identify a duration and degree of exceedance at which adverse effects might occur.
25. Since the COT consideration in 2001, data on dioxin levels in food from the 2001 total diet study (TDS) have become available. Average and high level dietary intakes calculated using these data and the most recent food consumption data from the 2000/2001 adults survey (average: 0.9 and high level: 1.7 pg WHO-TEQ/kg bodyweight/day) are approximately half those calculated using the 1997 TDS data and the 2000/2001 adult survey (average: 1.8 and high level: 3.3 pg WHO-TEQ/kg bodyweight/day). Therefore, it is apparent that dioxin intakes since 1997 have fallen considerably.
26. The COT considered a survey of dioxins and dioxin like PCBs in fish oil supplements. The Committee noted that some of the fish oil samples surveyed would provide a higher intake of dioxins than from dietary sources, which was estimated from the 1997 TDS to be on average 1.8 pg TEQ/kg bw/day, with some samples exceeding twice the TDI. In light of the COT advice the Agency asked manufacturers to withdraw the batches of products for which intakes from the oils would exceed twice the TDI.

Brominated Flame Retardants

27. The COT recently considered the available toxicological information on brominated flame retardants (BFRs) in conjunction with the results of a survey of the levels of BFRs in fish caught in the Skerne-Tees River system and samples from the 2001 Total Diet Study.
28. The Committee conclusions have not yet been finalised. However during the discussion members noted that:
- a) The available toxicological databases for these chemicals had a number of limitations which prevent the setting of tolerable daily intakes.
 - b) Although BFRs show some weak interaction with the aromatic hydrocarbon (Ah) receptor, this does not represent the principal mechanism by which the most sensitive end-point for toxicity occurs.
 - c) Analysis of composite samples from food groups in the TDS was undertaken on a limited set of isomers representative of the principal components of commercial BFR products. Any comparison of the commercial BFR products or environmental samples with the material tested in toxicity studies is limited by the sparse data on the composition of the chemicals tested.
 - d) Consumption of fish from the Skerne-Tees is likely to be infrequent since there are no commercial fisheries in the area. However given the variability in BFR levels observed in this limited survey, it is not possible to exclude higher intakes in a small number of anglers or those they give their fish to.
 - e) Comparison of the available toxicological data with the estimated intakes from consumption of a single portion of fish from the Skerne-Tees indicates that this would be unlikely to represent an immediate risk to health.

Mercury

29. In 2002 the COT (COT, 2002) concluded that because of the risk to the developing fetus or neonate, pregnant women, women who may become pregnant within the next year and breast feeding mothers should be considered as high risk groups when considering methylmercury toxicity.
30. The COT concluded that the Joint FAO/WHO Expert Committee on Food Additives and Contaminants (JECFA) provisional tolerable weekly intake (PTWI) of 3.3 µg/kg bw/week for methylmercury was sufficiently protective for the general population. However US Environmental Protection Agency (EPA) reference dose of 0.1 µg/kg bw/day would be more applicable for the high risk groups since it is based on the effects on the developing fetus.
31. The COT was reassured by the blood mercury data taken from the 2000/1 NDNS adults since the adults surveyed had blood mercury levels indicating that the JECFA PTWI for methylmercury was not being exceeded. Estimates of average and high level mercury exposure resulting from fish for which consumption data were available were within the JECFA PTWI for methylmercury for all age groups. Adult women who are high level consumers of these commonly eaten fish may marginally exceed the EPA reference dose

but the COT considered that this dietary exposure is not likely to be associated with adverse effects to the developing fetus.

32. Consuming one weekly portion of either shark, swordfish or marlin would result in a dietary exposure close to, or exceeding, the PTWI and therefore exceeding the EPA reference dose for methylmercury in all age groups. This consumption would not be expected to result in adverse effects in the general adult population, but could be harmful to the fetus and to the breast-fed infant. The exceedance of the PTWI is relatively greater for children under 14 years, because their food intake is greater, on a bodyweight basis, than that of adults. However, taking into account the evidence for the beneficial effects of eating fish, consumption of one portion per week of these fish is not expected to result in adverse health effects.
33. The mercury content of tuna was lower than that of shark, swordfish or marlin, but higher than that of other commonly consumed fish. The COT considered that consumption of one portion of fresh tuna (140g), or two portions of canned tuna (280g), per week, by pregnant or breast-feeding women would not be expected to result in adverse effects on the developing fetus or infant.
34. The Committee recommended that these conclusions should be reviewed following the JECFA evaluation of methylmercury in 2003.
35. Following the advice of the COT, the Agency reviewed its earlier precautionary advice regarding mercury exposure via fish consumption. The new advice recommended that:
 - a) Pregnant and breast-feeding women, and women who intend to become pregnant, should limit their consumption of tuna to no more than two medium size cans or one fresh tuna steak per week.
 - b) These women are also advised to avoid eating shark, swordfish and marlin.
 - c) Children under 16 are also advised to avoid eating shark, swordfish and marlin
 - d) Other consumers should eat no more than one portion of shark, swordfish or marlin per week, but do not need to limit consumption of tuna.
36. Following the recent consideration of metals in infant foods, the COT concluded that exposure of infants to mercury through consumption of commercially available infant foods was unlikely to result in any adverse health effects. However due to the apparent rise in the concentrations of mercury in the infant foods, possibly due to the number of meals containing fish included in the survey, the Committee recommended that the mercury content of infant foods should continue to be closely monitored.

Arsenic

37. Following the consideration of a Total Diet Study of total and inorganic arsenic, (COT, 2003/01) the COT concluded that there are no relevant tolerable intakes or reference doses by which to assess safety of either inorganic or organic arsenic in the diet. Inorganic arsenic is genotoxic and a known human carcinogen, and therefore exposure should be as low as reasonably practicable (ALARP).

38. The method used to measure inorganic arsenic had a low sensitivity. However the Committee considered that the large number of food samples with inorganic arsenic concentration below the limit of detection was consistent with dietary exposure being ALARP.
39. The COT noted that fish was a major contributor to dietary exposure to arsenic with the predominant form of arsenic in fish being organic. The general assumption that organic arsenic is less toxic than inorganic arsenic is based on an extremely limited database. However the COT considered that there is no evidence that exposure to organic arsenic through high levels of fish consumption would result in harmful effects, and therefore concluded that the dietary exposure to organic arsenic identified in the survey was unlikely to constitute a hazard to health.
40. The COT was also reassured that the average population dietary exposure to total arsenic was lower than that estimated for previous years, indicating that dietary exposure to total arsenic through food is not increasing.
41. Following the consideration of a survey of metals in infant foods, members concluded that levels of arsenic in infant foods had not increased since previous surveys and were unlikely to result in adverse health effects. They reiterated that the levels in foods should be ALARP.

Other Metals

42. Other metals such as lead and cadmium are also found in some fish. Fish is not a major contributor to total dietary exposure and therefore these metals are not considered in detail in this paper.

Advice on fish consumption given in other countries

43. A number of countries (Canada, Sweden, USA, Australia, Japan) as well as the World Health Organization and North Atlantic Treaty Organization have made formal population-based dietary recommendations for n-3 PUFA. Typical recommendations are 0.3 to 0.5 g/d of EPA+DHA: equivalent to between one and two portions of oily fish/week.
44. The American Heart Association population-based dietary guidelines recommend consumption of a variety of (preferably oily) fish at least twice a week (Kris-Etherton et al, 2002 and 2003).
45. In 2001 the U.S. Food and Drug Administration (FDA) advised children and women of child-bearing age, pregnant or breastfeeding, not to eat shark, swordfish, king mackerel and tile-fish because of the high levels of methyl mercury found in these fish.
46. The benefits and risks of fish consumption vary depending on a person's stage of life. Specific guidance by the US Environmental Protection Agency and the FDA:
 - a) Children and pregnant and nursing women usually have very low CHD risk, but may be at higher risk of exposure to excessive mercury from fish. Avoiding potentially contaminated fish is a higher priority for these groups

- b) For middle-aged and older men and postmenopausal women, the benefits of eating fish far outweigh the risks when consumed according to the guidelines of the US FDA
- c) Eating a variety of fish will help to minimize any potentially adverse effects due to environmental pollutants

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