











## Nutrient analysis of fish and fish products

It is difficult to make robust comparisons between current data and existing data held for fish and fish products derived from analytical surveys undertaken in the 1980s due to confounding factors (such as developments in analytical methods). Where it is possible to compare data results are broadly similar to existing data. Where there are differences in levels of some nutrients compared with previous data, this may be due to confounding factors and are unlikely to be nutritionally significant in a varied diet.

# Background

The Department of Health undertakes a rolling programme of nutrient analysis surveys to ensure that reliable, up-to-date information on the nutritional value of foods is available for use in conjunction with food consumption data collected in dietary surveys to monitor the nutritional content of the nation's diet. Therefore, these nutrient surveys need to provide a single, robust set of nutrient values that is indicative of the potentially broad choice available to the consumer when selecting any particular type of food. As a result, composite samples made up of a number of different brands of fish and fish products have been analysed for this survey rather than samples made up of single brands, and a generic name is given to each composite.

The aim of this particular survey was to provide up-to-date nutrient composition data for a range of fish and fish products to reflect the increasing range of commonly consumed fish and fish products and new species which are growing in popularity, as well as changes in production methods since fish and fish products were last analysed.

# Methodology

A list of composite samples to be analysed was determined following consultation with Seafish UK and expert users of UK food composition data (including representatives of the food industry, academia, catering suppliers, nutritionists and dietitians) using consumption and market share data, and taking account of the growing market for certain types of fish (eg pangasius). Availability of existing analytical data and data from recent surveys in the Nordic countries was also considered to avoid duplication. Market share information provided by Seafish UK was used where available, and industry consulted to determine the sub-samples included within each composite. To extend the scope of the survey the Shellfish Association of Great Britain funded the analysis of langoustine.

Over 480 food samples were purchased from retail outlets in the Norwich area (including supermarkets, independent retailers and catering suppliers) and prepared for analysis between November 2010 and February 2011. The food samples consisted of various species of oily and white fish, shellfish, canned fish, and fish products (including fish fingers, scampi and fish pie).

These food samples were combined into 56 composite samples for analysis. Each composite was made up of between 4 and 15 sub-samples of equivalent weight. This process allows a single, robust set of nutrient values to be derived for each composite, covering an appropriate cross-section of products available. The results of these analyses are published here. An

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additional 6 composites (made up of between 3 and 6 sub-samples) were investigated for weight loss on cooking only and these results are published in the associated sampling report. Sub-samples requiring preparation/cooking were prepared in accordance with manufacturers' instructions where available and normal domestic practices. They were then combined into composite samples for analysis. A full list of the composite food samples analysed is given in Annex A. The full sampling report is available at [www.dh.gov.uk/publications](http://www.dh.gov.uk/publications).

Composites were analysed for proximates and individual fatty acids between March and June 2011 and analysed for inorganics and vitamins between March and July 2011. Each composite was analysed for a range of nutrients depending on the importance of the particular food as a dietary source for each nutrient, and existing compositional data available. A full list of nutrients is given in Annex B. The methods used to conduct the analyses are included at Annex D.

Values provided by analytical laboratories were compiled in Excel spreadsheets for data evaluation. Where possible, analytical values were compared to other sources of comparable data, such as UK Food Composition tables, other food composition tables and information from manufacturers and retailers. Where applicable, ingredients lists were also evaluated to check that the values reported corresponded to the ingredients included in the samples. Where analytical values appeared incorrect or questionable, data was checked against original laboratory reports and re-analysed if necessary.

# Results

Each of the composite samples was analysed for an extensive range of nutrients, and therefore this project generated a large number of individual results. A summary of results for energy, protein, carbohydrate, fat and fatty acids, fibre, cholesterol, vitamins and minerals is provided in Annex C. The full set of results are provided in the analytical report associated with this project which is available at [www.dh.gov.uk/publications](http://www.dh.gov.uk/publications).

# Interpretation

This survey has determined the nutrient composition of fish and fish products.

The results from this survey provide us with robust, up-to-date data, which will be incorporated into the Department of Health's nutrient databanks which support our National Diet and Nutrition Survey and other national dietary surveys enabling the Government to monitor the nation's diet. The results of this survey will also be incorporated into future publications in the *McCance and Widdowson's The Composition of Foods* series.

It is difficult to make robust comparisons between current data and existing data held for fish and fish products derived from analytical surveys undertaken in the 1980s due to confounding factors (such as developments in analytical methods). Where it is possible to compare data results are broadly similar to existing data. Where there are differences in levels of some nutrients compared with previous data, this may be due to confounding factors and are unlikely to be nutritionally significant in a varied diet.

# Further Information

The report of this survey (entitled Nutrient analysis of fish and fish products) is available at [www.dh.gov.uk/publications](http://www.dh.gov.uk/publications).

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## Nutrient analysis of fish and fish products

Composite sample number	Sample description	Water g/100g	Protein g/100g	Total fat g/100g	Ash g/100g	Carbohydrate g/100g	Energy (kcal)/100g	Energy (kJ)/100g	Englyst fibre g/100g	AOAC fibre g/100g	Starch g/100g	Total sugars g/100g	Glucose g/100g	Fructose g/100g	Sucrose g/100g	Maltose g/100g	Lactose g/100g	Galactose g/100g	Saturated fatty acids g/100g	Cis-monounsaturated fatty acids g/100g	Cis-n3 fatty acids g/100g	Cis-n6 fatty acids g/100g	Cis-polyunsaturated fatty acids g/100g	Trans fatty acids g/100g	Cholesterol milligrams/100g
23	Mackerel, grilled, flesh only	53.8	20.3	22.4	1.3	N/A	283	1174	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5.10	8.30	4.83	0.53	5.36	0.02	N/A
24	Trout, rainbow, raw, flesh only	76.1	19.9	5.3	1.2	N/A	127	534	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.21	1.44	1.41	0.40	1.80	0.01	60
25	Trout, rainbow, baked, flesh only	70.1	23.8	6.1	1.3	N/A	150	630	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.44	1.55	1.72	0.44	2.16	0.01	N/A
26	Kippers (analysed without butter), grilled, flesh only	58.6	21.7	17.6	3.3	N/A	245	1020	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.74	7.38	3.35	0.32	3.66	0.01	65
27	Kippers, boil in the bag, with butter, cooked	63.6	18.6	13.2	2.9	N/A	193	805	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.96	5.79	2.19	0.23	2.42	0.02	71
28	Tuna, raw, flesh only	74.9	25.2	0.7	1.4	N/A	107	454	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.21	0.19	0.09	0.04	0.13	<0.01	35
29	Tuna, baked, flesh only	68.2	32.3	0.8	1.2	N/A	136	579	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.29	0.24	0.11	0.05	0.16	<0.01	N/A
30	Sardines, raw, flesh only	74.4	19.8	6.1	1.4	N/A	134	562	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.83	1.80	1.32	0.24	1.56	0.01	51
31	Haddock, smoked, poached	76.0	21.8	0.5	1.9	N/A	92	389	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.09	0.07	0.19	0.02	0.21	<0.01	65
32	Plaice, coated in breadcrumbs, baked	52.8	14.4	11.6	1.2	21.5	243	1018	0.5	1.5	20.2	1.3	0.2	<0.1	<0.1	1.1	<0.1	<0.1	1.23	5.62	0.76	3.19	3.95	0.02	39
33	Calamari, coated in batter, baked	42.1	8.5	17.5	3.4	25.9	288	1206	0.4	1.9	25.9	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2.07	4.66	0.25	9.51	9.76	0.02	85
34	Fish fingers, cod, grilled/baked	54.5	14.3	9.2	1.4	22.0	223	936	N/A	N/A	20.6	1.5	<0.1	<0.1	0.2	1.3	<0.1	<0.1	1.19	4.40	0.42	2.61	3.04	0.02	36
35	Fish fingers, cod, fried	54.5	N/A	12.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
36	Fish fingers, salmon, grilled/baked	50.8	17.2	11.2	1.4	20.7	247	1038	N/A	N/A	19.6	1.1	0.1	0.1	<0.1	0.9	<0.1	<0.1	1.07	5.76	0.93	2.66	3.60	0.02	29
37	Cod, coated in batter, fried	49.2	N/A	17.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

## Nutrient analysis of fish and fish products

Composite sample number	Sample description	Water g/100g	Protein g/100g	Total fat g/100g	Ash g/100g	Carbohydrate g/100g	Energy (kcal)/100g	Energy (kJ)/100g	Englyst fibre g/100g	AOAC fibre g/100g	Starch g/100g	Total sugars g/100g	Glucose g/100g	Fructose g/100g	Sucrose g/100g	Maltose g/100g	Lactose g/100g	Galactose g/100g	Saturated fatty acids g/100g	Cis-monounsaturated fatty acids g/100g	Cis-n3 fatty acids g/100g	Cis-n6 fatty acids g/100g	Cis-polyunsaturated fatty acids g/100g	Trans fatty acids g/100g	Cholesterol milligrams/100g
38	Fishcakes, white fish, coated in breadcrumbs, baked	56.9	9.3	9.4	1.5	22.6	206	867	0.4	1.7	20.8	1.8	0.2	0.2	0.1	1.3	<0.1	<0.1	1.00	5.52	0.55	1.72	2.27	0.02	30
39	Fishcakes, salmon, coated in breadcrumbs, baked	54.7	11.4	13.7	1.6	20.4	245	1027	N/A	N/A	18.8	1.6	0.1	0.2	<0.1	1.3	<0.1	<0.1	2.00	7.00	1.74	1.91	3.65	0.04	25
40	Scampi coated in breadcrumbs, baked	50.7	11.6	10.5	2.3	24.3	232	975	0.3	1.5	23.5	0.8	<0.1	<0.1	<0.1	0.8	<0.1	<0.1	0.85	6.24	0.74	1.97	2.72	0.01	64
41	Scampi coated in breadcrumbs, fried	51.6	N/A	13.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
42	Fish pie, white fish, retail, baked	73.8	6.6	4.8	1.5	14.4	124	521	0.6	2.1	12.7	1.8	0.2	<0.1	0.3	<0.1	1.2	<0.1	2.55	1.39	0.12	0.22	0.33	0.12	29
43	Mussels in white wine sauce, cooked	82.0	9.7	3.2	2.3	3.7	81	342	<0.1	<0.5	2.9	0.8	<0.1	<0.1	<0.1	<0.1	0.8	<0.1	1.26	0.71	0.26	0.62	0.89	0.04	25
44	Salmon, smoked (cold-smoked)	64.5	22.8	10.1	4.1	0.5	184	769	N/A	N/A	N/A	0.5	<0.1	<0.1	<0.1	0.5	<0.1	<0.1	2.15	3.10	2.18	0.66	2.84	0.01	45
45	Salmon, smoked (hot-smoked)	60.1	25.4	8.8	3.3	1.3	186	778	N/A	N/A	N/A	1.3	<0.1	<0.1	0.8	0.4	<0.1	<0.1	1.94	2.63	2.28	0.64	2.92	0.01	N/A
46	Mackerel, smoked	50.9	21.1	24.1	2.9	N/A	301	1250	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5.04	9.33	5.57	0.58	6.14	0.02	63
47	Seafood sticks	73.3	7.3	1.9	2.1	14.9	102	433	N/A	N/A	10.1	4.8	<0.1	<0.1	4.8	<0.1	<0.1	<0.1	0.29	0.72	0.19	0.52	0.17	<0.01	16
48	Tuna, canned in brine	74.3	24.9	1.0	1.5	N/A	109	460	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.30	0.17	0.32	0.08	0.40	<0.01	47
49	Tuna, canned in sunflower oil	67.1	25.4	6.4	1.8	N/A	159	669	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.78	1.64	0.18	3.43	3.62	<0.01	N/A
50	Salmon, red, canned	66.5	23.5	7.3	2.1	N/A	160	670	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.43	3.01	1.65	0.15	1.80	0.01	62
51	Salmon, red, canned, skinless and boneless	68.5	23.2	6.7	1.9	N/A	153	642	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.28	2.75	1.50	0.15	1.65	0.01	61

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Composite sample number	Sample description	Water g/100g	Protein g/100g	Total fat g/100g	Ash g/100g	Carbohydrate g/100g	Energy (kcal)/100g	Energy (kJ)/100g	Englyst fibre g/100g	AOAC fibre g/100g	Starch g/100g	Total sugars g/100g	Glucose g/100g	Fructose g/100g	Sucrose g/100g	Maltose g/100g	Lactose g/100g	Galactose g/100g	Saturated fatty acids g/100g	Cis-monounsaturated fatty acids g/100g	Cis-n3 fatty acids g/100g	Cis-n6 fatty acids g/100g	Cis-polyunsaturated fatty acids g/100g	Trans fatty acids g/100g	Cholesterol milligrams/100g
52	Salmon, pink, canned	71.4	23.6	4.8	2.1	N/A	138	579	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.92	1.71	1.34	0.11	1.45	0.01	61
53	Mackerel, canned in brine	65.0	19.2	14.1	1.4	N/A	204	848	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.17	4.81	3.53	0.33	3.86	0.01	52
54	Sardines, canned in tomato sauce, whole contents	67.3	18.5	10.8	2.8	0.9	175	729	N/A	N/A	<0.5	0.9	0.3	0.6	<0.1	<0.1	<0.1	<0.1	2.89	2.70	2.98	0.51	3.49	0.01	71
55	Sardines, canned in brine	66.1	22.1	9.1	3.1	N/A	170	712	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.61	2.29	2.50	0.23	2.73	0.01	66
56	Langoustine, boiled	80.7	19.7	0.8	1.5	N/A	86	369	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.15	0.15	0.17	0.04	0.21	<0.01	133

# Micronutrients

Composite sample number	Sample description	Vitamin A micrograms/100g*	Vitamin D micrograms/100g	Thiamin milligrams/100g	Riboflavin milligrams/100g	Niacin milligrams/100g	Tryptophan/60 milligrams/100g	Vitamin C milligrams/100g	Vitamin E milligrams/100g	Vitamin B <sub>6</sub> milligrams/100g	Vitamin B <sub>12</sub> micrograms/100g	Folate micrograms/100g	Pantothenic acid milligrams/100g	Biotin micrograms/100g	Sodium milligrams/100g	Potassium milligrams/100g	Calcium milligrams/100g	Magnesium milligrams/100g	Phosphorus milligrams/100g	Iron milligrams/100g	Copper milligrams/100g	Zinc milligrams/100g	Chloride milligrams/100g	Iodine micrograms/100g	Manganese milligrams/100g	Selenium micrograms/100g
1	Cod, raw, flesh only	2	<0.1	0.06	0.08	2.3	2.6	N/A	0.66	0.14	1.45	7	0.25	1.3	91	322	12	25	169	0.10	0.02	0.34	165	196	0.01	23
2	Cod, baked, flesh only	2	<0.1	0.10	0.09	2.0	4.0	N/A	0.95	0.12	1.91	8	0.30	0.9	91	367	18	30	189	0.15	0.02	0.57	130	161	0.01	44
3	Cod, microwaved, flesh only	N/A	N/A	0.08	0.10	1.8	3.7	N/A	0.86	0.13	2.19	8	0.28	0.7	108	427	16	32	216	0.16	0.02	0.53	168	N/A	0.01	44
4	Haddock, raw, flesh only	1	N/A	0.13	0.15	4.9	3.1	N/A	0.49	0.29	1.90	10	0.27	2.0	68	315	11	25	163	0.12	0.02	0.31	110	320	0.01	34
5	Haddock, grilled, flesh only	N/A	N/A	0.09	0.14	4.0	4.3	N/A	0.52	0.29	2.37	6	0.28	1.7	92	433	20	33	232	0.17	0.02	0.50	130	N/A	0.01	48
6	Haddock, steamed, flesh only	N/A	N/A	0.07	0.11	3.9	4.1	N/A	0.57	0.24	2.14	9	0.29	1.6	84	376	14	28	199	0.16	0.03	0.42	120	N/A	0.01	51
7	Alaskan pollock, raw, flesh only	N/A	N/A	0.03	0.09	2.6	2.6	N/A	0.60	0.04	2.32	5	0.22	1.3	68	216	12	30	120	0.18	0.03	0.39	100	56	0.01	27
8	Sole, raw, flesh only	N/A	N/A	0.15	0.08	4.3	2.5	N/A	0.73	0.15	1.01	13	0.30	4.3	115	177	17	26	124	0.12	<0.01	0.31	178	23	0.01	50
9	Sole, grilled, flesh only	N/A	N/A	0.12	0.10	3.7	3.9	N/A	0.85	0.13	1.14	10	0.29	4.5	151	260	28	26	163	0.50	0.01	0.45	160	N/A	0.01	83
10	Plaice, raw, flesh only	N/A	N/A	0.33	0.14	2.5	3.0	N/A	0.57	0.23	1.30	12	0.77	35.5	147	226	17	21	157	0.10	0.01	0.45	180	31	<0.01	35
11	Pangasius, raw, flesh only	<0.1	1.35	0.02	0.06	6.3	3.5	N/A	0.23	0.12	1.05	10	0.66	37.9	204	293	10	29	166	0.09	0.02	0.32	190	3	0.01	18
12	Coley, raw, flesh only	N/A	N/A	0.23	0.17	2.6	3.7	N/A	0.57	0.27	3.48	5	0.33	3.7	68	303	7	32	171	0.27	0.04	0.43	130	111	0.01	33
13	Sea bass, raw, flesh only	34	<0.1	0.39	0.20	3.0	4.4	N/A	0.48	0.37	3.01	5	0.73	2.5	72	370	14	30	202	0.27	0.04	0.62	90	8	0.02	29

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14	Sea bass, baked, flesh only	N/A	N/A	0.19	0.18	2.6	4.9	N/A	N/A	0.14	2.91	4	0.63	2.5	80	390	31	35	231	0.27	0.04	0.75	100	N/A	0.03	24
15	Prawns, cold-water (Pandalus borealis), purchased cooked	<0.1	<0.1	<0.01	0.05	<0.1	3.6	N/A	3.63	0.03	2.35	10	0.14	4.0	588	74	65	36	127	1.00	0.28	1.02	770	13	0.02	30
16	Prawns, king, warm-water (Penaeus vannamei), raw	<0.1	<0.1	<0.01	0.05	0.1	3.6	N/A	1.80	0.11	1.26	11	0.16	3.9	215	126	44	28	155	0.70	0.21	1.16	260	5	0.04	34
17	Prawns, king, warm-water (Penaeus vannamei), grilled from raw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	305	181	59	37	209	0.43	0.35	1.58	310	N/A	0.05	41
18	Prawns, king, warm-water (Penaeus vannamei), purchased cooked	<0.1	<0.1	<0.01	0.05	0.1	3.4	N/A	1.64	0.05	1.40	10	0.20	4.3	643	65	49	21	125	0.27	0.23	1.04	740	12	0.03	30
19	Mussels, purchased cooked	117	N/A	0.02	0.26	1.0	4.6	N/A	1.72	0.03	10.56	25	0.32	11.0	401	116	40	50	258	3.25	0.17	3.39	700	247	0.18	66
20	Crab, brown meat, purchased cooked	6	<0.1	0.06	1.50	1.0	6.4	<0.1	7.33	0.22	22.40	19	1.22	6.0	351	167	366	49	488	2.46	2.49	5.90	550	333	0.33	225
21	Crab, white meat, purchased cooked	<0.1	<0.1	0.03	0.25	0.5	4.5	<0.1	2.12	0.10	3.40	6	1.99	11.4	322	240	86	34	147	0.53	0.95	7.23	480	103	0.04	87
22	Mackerel, raw, flesh only	54	8.00	0.17	0.30	11.3	4.4	N/A	0.43	0.40	8.81	1	0.63	5.8	153	335	20	37	220	0.98	0.08	0.51	250	29	0.01	42

## Nutrient analysis of fish and fish products

Composite sample number	Sample description	Vitamin A micrograms/100g*	Vitamin D micrograms/100g	Thiamin milligrams/100g	Riboflavin milligrams/100g	Niacin milligrams/100g	Tryptophan/60 milligrams/100g	Vitamin C milligrams/100g	Vitamin E milligrams/100g	Vitamin B <sub>6</sub> milligrams/100g	Vitamin B <sub>12</sub> micrograms/100g	Folate micrograms/100g	Pantothenic acid milligrams/100g	Biotin micrograms/100g	Sodium milligrams/100g	Potassium milligrams/100g	Calcium milligrams/100g	Magnesium milligrams/100g	Phosphorus milligrams/100g	Iron milligrams/100g	Copper milligrams/100g	Zinc milligrams/100g	Chloride milligrams/100g	Iodine micrograms/100g	Manganese milligrams/100g	Selenium micrograms/100g
23	Mackerel, grilled, flesh only	61	8.50	0.14	0.37	11.1	4.4	N/A	0.46	0.27	9.08	1	0.57	5.2	163	349	17	38	236	1.28	0.10	0.79	290	N/A	0.01	60
24	Trout, rainbow, raw, flesh only	25	7.89	0.16	0.12	7.3	4.2	N/A	0.44	0.31	2.84	9	1.23	3.2	110	383	21	26	228	0.28	0.04	0.47	150	5	0.01	19
25	Trout, rainbow, baked, flesh only	44	8.19	0.13	0.13	6.4	5.3	N/A	0.89	0.19	3.11	11	1.11	3.8	93	434	19	29	254	0.40	0.05	0.56	160	N/A	0.01	23
26	Kippers (analysed without butter), grilled, flesh only	26	10.09	<0.01	0.27	5.1	4.5	N/A	0.47	0.29	11.12	3	0.81	6.1	947	384	39	47	270	1.51	0.11	1.07	1360	24	0.02	57
27	Kippers, boil in the bag, with butter, cooked	30	11.15	0.01	0.24	4.2	4.3	N/A	0.23	0.22	9.48	3	0.57	5.5	860	254	47	38	208	1.11	0.12	1.47	1220	13	0.03	40
28	Tuna, raw, flesh only	76	3.20	0.13	0.07	21.9	6.1	N/A	0.04	0.43	2.21	4	0.23	2.8	66	444	4	39	266	0.72	0.03	0.39	120	18	0.01	93
29	Tuna, baked, flesh only	78	3.10	0.12	0.07	17.4	7.5	N/A	0.13	0.23	2.15	5	0.21	2.9	63	450	11	41	290	0.93	0.03	0.52	130	N/A	0.01	92
30	Sardines, raw, flesh only	10	3.95	<0.01	0.34	10.1	5.3	N/A	0.31	0.31	8.31	7	0.69	9.7	136	387	50	32	257	1.55	0.13	0.71	200	79	0.03	51
31	Haddock, smoked, poached	2	2.00	0.11	0.14	6.3	5.1	N/A	0.77	0.22	2.37	8	0.28	1.5	464	265	24	25	164	0.17	0.02	0.45	640	217	0.01	42
32	Plaice, coated in breadcrumbs, baked	N/A	N/A	0.32	0.14	2.3	2.7	N/A	3.32	0.09	1.64	9	0.43	35.0	275	178	61	22	126	0.77	0.05	0.63	390	16	0.19	30
33	Calamari, coated in batter, baked	64	N/A	0.05	0.40	1.2	2.2	N/A	0.75	0.03	1.72	3	0.68	2.5	1182	88	41	33	259	0.52	0.12	0.81	1280	3	0.19	17
34	Fish fingers, cod, grilled/baked	N/A	N/A	0.17	0.08	1.2	3.4	N/A	2.75	0.09	1.50	9	0.24	1.2	317	254	32	25	142	0.57	0.05	0.50	460	117	0.20	18

## Nutrient analysis of fish and fish products

Composite sample number	Sample description	Vitamin A micrograms/100g*	Vitamin D micrograms/100g	Thiamin milligrams/100g	Riboflavin milligrams/100g	Niacin milligrams/100g	Tryptophan/60 milligrams/100g	Vitamin C milligrams/100g	Vitamin E milligrams/100g	Vitamin B <sub>6</sub> milligrams/100g	Vitamin B <sub>12</sub> micrograms/100g	Folate micrograms/100g	Pantothenic acid milligrams/100g	Biotin micrograms/100g	Sodium milligrams/100g	Potassium milligrams/100g	Calcium milligrams/100g	Magnesium milligrams/100g	Phosphorus milligrams/100g	Iron milligrams/100g	Copper milligrams/100g	Zinc milligrams/100g	Chloride milligrams/100g	Iodine micrograms/100g	Manganese milligrams/100g	Selenium micrograms/100g
35	Fish fingers, cod, fried	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
36	Fish fingers, salmon, grilled/baked	7	4.50	0.41	0.11	5.3	4.1	N/A	2.82	0.22	2.27	15	0.58	2.5	288	300	14	30	194	0.75	0.07	0.58	420	7	0.32	24
37	Cod, coated in batter, fried	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
38	Fishcakes, white fish, coated in breadcrumbs, baked	N/A	N/A	0.25	0.07	1.7	1.9	N/A	1.98	0.09	1.44	6	0.31	2.2	356	233	51	19	102	0.76	0.06	0.42	520	58	0.17	13
39	Fishcakes, salmon, coated in breadcrumbs, baked	2	5.71	0.38	0.10	4.7	2.8	N/A	2.79	0.22	1.57	14	0.74	2.3	322	269	42	21	150	0.77	0.05	0.40	470	6	0.15	13
40	Scampi coated in breadcrumbs, baked	N/A	N/A	0.16	0.06	2.1	2.4	N/A	3.18	0.06	1.52	14	0.29	2.1	561	234	105	34	260	1.91	0.18	0.81	620	101	0.27	26
41	Scampi coated in breadcrumbs, fried	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
42	Fish pie, white fish, retail, baked	84	2.82	0.11	0.13	0.8	1.6	N/A	0.51	0.02	1.29	9	0.40	3.1	254	300	86	21	119	0.35	0.04	0.54	380	33	0.08	7
43	Mussels in white wine sauce, cooked	11	<0.1	0.05	0.18	0.8	1.8	N/A	0.84	0.03	9.44	26	0.39	4.8	608	173	68	76	122	1.46	0.08	1.54	970	282	0.07	32
44	Salmon, smoked (cold-smoked)	28	8.90	0.43	0.12	8.3	5.4	N/A	2.03	0.73	3.15	15	1.22	5.2	1184	442	8	31	266	0.23	0.02	0.36	1480	9	0.01	19
45	Salmon, smoked (hot-smoked)	N/A	11.00	0.41	0.16	9.5	6.5	N/A	2.29	0.51	4.19	14	1.35	4.0	848	460	8	32	293	0.34	0.05	0.49	1200	N/A	0.01	24

## Nutrient analysis of fish and fish products

Composite sample number	Sample description	Vitamin A micrograms/100g*	Vitamin D micrograms/100g	Thiamin milligrams/100g	Riboflavin milligrams/100g	Niacin milligrams/100g	Tryptophan/60 milligrams/100g	Vitamin C milligrams/100g	Vitamin E milligrams/100g	Vitamin B <sub>6</sub> milligrams/100g	Vitamin B <sub>12</sub> micrograms/100g	Folate micrograms/100g	Pantothenic acid milligrams/100g	Biotin micrograms/100g	Sodium milligrams/100g	Potassium milligrams/100g	Calcium milligrams/100g	Magnesium milligrams/100g	Phosphorus milligrams/100g	Iron milligrams/100g	Copper milligrams/100g	Zinc milligrams/100g	Chloride milligrams/100g	Iodine micrograms/100g	Manganese milligrams/100g	Selenium micrograms/100g
46	Mackerel, smoked	36	8.20	0.15	0.37	6.9	4.6	N/A	0.46	0.28	10.18	4	0.61	4.0	746	319	33	38	237	1.13	0.07	0.92	1010	28	0.02	59
47	Seafood sticks	N/A	N/A	0.01	0.06	1.2	2.0	N/A	0.47	0.03	0.94	12	0.30	3.3	714	21	50	8	61	0.19	0.01	0.28	940	21	0.02	19
48	Tuna, canned in brine	26	1.10	<0.01	0.11	10.3	6.2	N/A	0.42	0.31	3.42	3	0.19	2.7	293	230	10	27	171	1.51	0.07	0.89	490	12	0.01	69
49	Tuna, canned in sunflower oil	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.84	N/A	N/A	N/A	N/A	N/A	368	267	11	35	204	1.19	0.05	0.80	610	N/A	0.01	87
50	Salmon, red, canned	7	10.90	0.03	0.21	7.6	6.1	N/A	1.65	0.20	4.88	14	0.88	4.1	430	305	164	29	291	0.68	0.06	0.82	670	22	0.02	37
51	Salmon, red, canned, skinless and boneless	10	11.82	0.04	0.22	6.9	6.1	N/A	1.47	0.23	4.50	12	0.82	4.9	379	304	6	27	214	0.60	0.07	0.52	580	24	0.01	38
52	Salmon, pink, canned	12	13.59	0.02	0.21	7.4	6.0	N/A	0.76	0.19	4.68	19	0.68	4.9	352	326	109	25	234	0.83	0.07	0.65	500	18	0.01	34
53	Mackerel, canned in brine	11	7.40	0.04	0.22	5.5	5.9	N/A	0.30	0.15	6.98	4	0.35	3.6	276	227	14	22	162	0.89	0.07	0.61	410	17	0.01	41
54	Sardines, canned in tomato sauce, whole contents	N/A	N/A	0.03	0.22	5.5	5.2	N/A	1.84	0.25	8.85	4	0.63	5.9	315	371	455	38	417	2.69	0.12	1.98	480	N/A	0.18	39
55	Sardines, canned in brine	10	3.27	0.01	0.22	5.5	4.2	N/A	0.24	0.07	10.81	4	0.64	4.7	368	287	679	42	545	2.73	0.13	2.23	560	26	0.18	41
56	Langoustine, boiled	N/A	N/A	0.08	0.06	2.7	3.7	N/A	3.55	0.10	2.45	5	0.24	3.4	216	214	125	53	197	1.68	0.32	1.37	280	139	0.12	49

\* Total vitamin A is calculated as retinol equivalents and is equal to retinol + (beta-carotene equivalents/6)

N/A = Not Analysed

< = Result was below the analytical limit of quantification (LOQ) or limit of detection (LOD). There is no distinction between '<' and 'not detected'

#Energy calculated assuming that mussels contain 3.5g carbohydrate as glycogen (existing data)<sup>4</sup>

## Annex D: Analytical methods used

### **Moisture:**

A homogenised portion of the sample is mixed with sand and heated to 102°C. The moisture loss is determined gravimetrically.

Accredited to BS/EN ISO/IEC 17025:2005. UKAS 0680

Ref: BS 4401 pt3:1997

LOQ 0.1 g/100g

### **Ash:**

A homogenised portion of the sample is ashed in a muffle furnace at 550°C. The ash is determined gravimetrically.

Accredited to BS/EN ISO/IEC 17025:2005. UKAS 0680

Ref: BS 4401 pt11:1998

LOQ 0.1 g/100g

### **Protein:**

The sample is analysed using Leco instrumentation following the Dumas procedure: The sample is combusted in an oxygen atmosphere, the gaseous product is cleaned and nitrogen compounds converted to nitrogen which is measured by a thermal conductivity cell. The crude protein is calculated by multiplying by the appropriate conversion factor.

Accredited to BS/EN ISO/IEC 17025:2005. UKAS 0680

LOQ 0.1 g/100g

### **Fat:**

The sample is acid hydrolysed with hydrochloric acid, cooled, filtered and dried. The fat is extract from the residue with petroleum ether and the dried fat determined gravimetrically.

Accredited to BS/EN ISO/IEC 17025:2005. UKAS 0680

Ref: BS 4401 pt4:1970 (Weibull Stoldt)

LOQ 0.1 g/100g

### **Fatty acids:**

The lipid fractions of the sample are solvent extracted. The isolated fat is transesterified with methanolic sodium methoxide to form fatty acid methyl esters (FAMES). The FAME profile is determined using capillary gas chromatography (GC). Quantification and identification of individual FAMES in the test material is achieved with reference to calibration standards.

Accredited to BS/EN ISO/IEC 17025:2005. UKAS 0680

LOQ 0.01 mg/100g

### **Sugars:**

The sugars are extracted with water, clarified and chromatographically separated on an amine column with an acetonitrile/water mobile phase. The sugars are detected using an evaporative light scattering detector and quantified with reference to calibration standards.

Accredited to BS/EN ISO/IEC 17025:2005. UKAS 0680

LOQ 0.1 g/100g

**Starch:**

The method consists of two separate determinations. The sample is treated with warm diluted hydrochloric acid, clarified and filtered; the optical rotation of the resulting solution is determined. In the second determination, the sample is extracted with 40% ethanol and filtered. The filtrate is acidified with hydrochloric acid, clarified and filtered again; the optical rotation of the resulting solution is determined at 20 ±2°C.

Accredited to BS/EN ISO/IEC 17025:2005. UKAS 0680

Ref: The Feeding Stuffs (Sampling and Analysis) Regulations 1982 Method 30a.

LOQ 2 g/100g

**Oligosaccharides:**

Malto-oligosaccharides (DP1-7) are determined individually by High Performance Anion Exchange Chromatography with Pulsed Amperometric Detection. In-house method

LOQ 0.1 g/100g

**Dietary Fibre:**

**AOAC**

The sample is weighed and de-fatted if necessary. It is then gelatinised and treated with α-amylase and further digested enzymatically with protease and amyloglucosidase to remove the starch and protein. The dietary fibre is precipitated with IMS, filtered, washed, dried and weighed. Total dietary fibre is then determined gravimetrically and corrected for protein and ash.

Accredited to BS/EN ISO/IEC 17025:2005. UKAS 0680

Ref: AOAC 985.29/45.4.07 (2007)

LOQ 0.5 g/100g

**Englyst (Non-starch polysaccharides)**

Englyst Fibrezym kit with colorimetric end point

LOQ 0.2 g/100g

**Cholesterol:**

Method Lipid in sample is saponified at high temperature with ethanolic KOH solution. Unsaponifiable fraction containing cholesterol and other sterols is extracted with toluene. Sterols are derivatized to trimethylsilyl (TMS) ethers and then quantified by GC.

LOQ 0.7 mg/100 g

Reproducibility 20%

Reference Method ISO 6799: 1992

**Inorganics:**

**Sodium, Potassium, Calcium, Magnesium, Copper, Iron, Manganese, Zinc, Phosphorus, Selenium**

Samples are digested in acid under oxidising conditions, using sealed 'bombs' in automated microwave digestors, to prevent losses of volatile metals/inorganics, Metals (and some inorganics) are then determined by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) or by Inductively Coupled Plasma Mass Spectrometry (ICP-MS). These techniques allow the sensitive and accurate (true and precise) determination of metals in foods and allow matrix interferences to be overcome.

In house methods - UKAS accredited.

**Iodide:**

Concentrations are determined by high resolution ICP-MS after extraction with tetra methyl ammonium hydroxide.

UKAS accredited.

**Chloride:**

Concentrations are determined using a Corning Chloride Analyser after extraction with nitric acid.

In house method FFF/B1-2104 - UKAS accredited.

**Vitamins – Water Soluble:**

**Thiamin, Riboflavin & Vitamin B6**

Thiamin, riboflavin and Vitamin B6 are determined by HPLC after appropriate and controlled acid and enzymatic hydrolysis. The methods are based on published CEN Standards. The selected method enables determination of total B6 as pyridoxine and is most appropriate to samples of this type where pyridoxine or its phosphate will form the major vitamin B6 component.

UKAS accredited.

**Niacin, Total Folate, Biotin, Pantothenic acid**

Determined using microbiological assay (MBA) procedures with detection carried out using VitaFast® MBA test kits.

UKAS accredited.

**Tryptophan**

Determined by HPLC using fluorescence detection after alkaline hydrolysis. Tryptophan contributes to the available Niacin on the basis that Niacin = Tryptophan/60.

**Vitamin B12**

Vitamin B12 is extracted from food by autoclaving in acetate buffer in the presence of cyanide. Vitamin B12 is determined by microbiological assay using *L.Delbrueckii.Lactis*.

UKAS accredited.

The B-vitamin results are expressed as follows:

Thiamin:	thiamin chloride hydrochloride
Riboflavin:	free riboflavin
Niacin:	nicotinic acid
Vitamin B6:	pyridoxine hydrochloride
Pantothenate:	pantothenic acid
Biotin:	d-biotin
B12:	cyanocobalamin
Total folate:	pteroylglutamic acid

**Vitamin C**

Vitamin C is determined by HPLC using fluorescence detection.

**Oil Soluble Vitamins:**

## Nutrient analysis of fish and fish products

Vitamins A, D, E and the carotenoids are determined using an in house procedure involving saponification of the sample, solvent extraction and HPLC determination - UKAS accredited methods based on:

- Vitamin A – Retinol: BS EN 12823-1:2000. Foodstuffs-Determination of Vitamin A by High Performance Liquid Chromatography-Part 1: Measurement of Retinol
- Vitamin A –  $\beta$ -Carotene: BS EN 12823-2:2000. Foodstuffs-Determination of Vitamin A by High Performance Liquid Chromatography-Part 2: Measurement of  $\beta$ -Carotene
- Vitamin D: BS EN 12821:2000. Foodstuffs-Determination of Vitamin D by High Performance Liquid Chromatography-Measurement of Cholecalciferol (D3) and Ergocalciferol (D2)
- Vitamin E: BS EN 12822:2000. Foodstuffs-Determination of Vitamin E by High Performance Liquid Chromatography-Measurement of  $\alpha$ -,  $\beta$ -,  $\gamma$ - and  $\delta$ -tocopherols

The total vitamin E figure takes into account the relative biological activities of the different isomers. Vitamin E is given as mg/100g of  $\alpha$  - tocopherol equivalent. The activities used for these calculations are as shown below:

$\alpha$ - tocopherol	1.0
$\beta$ - tocopherol	0.4
$\gamma$ - tocopherol	0.1
$\delta$ - tocopherol	0.01

Total vitamin A is expressed as ug/100g all-trans retinol equivalent (ATRE) and is calculated as follows:

All-trans retinol + (0.75\*13-cis retinol) +(  $\beta$ -carotene/6) +(other active carotenoids/12)

UKAS accredited.

Details of the quality control measures employed are given in the analytical report associated with this project, available at [www.dh.gov.uk/publications](http://www.dh.gov.uk/publications).

# References

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<sup>1</sup> Responsibility for nutrition policy in England transferred from the Food Standards Agency to the Department of Health (DH) on 1st October 2010. Management of the rolling programme of nutrient analysis has also transferred to DH

<sup>2</sup>Food Standards Agency. *Management of the Food Standards Agency programme of nutrient analysis and associated work*

<http://collections.europarchive.org/tna/20100907111047/http://food.gov.uk/science/dietarysurveys/analyticalsurveys/n10040/> (accessed 28 December 2012)

<sup>3</sup>Food Standards Agency. *McCance & Widdowson's The Composition of Foods integrated dataset*

<http://tna.europarchive.org/20110116113217/http://www.food.gov.uk/science/dietarysurveys/dietsurveys/> (accessed 28 December 2012)

<sup>4</sup> Holland B, Brown J, and Buss. Fish and Fish products. Third supplement to fifth edition of McCance and Widdowson's *The Composition of Foods*. Royal Society of Chemistry. 1993