<原著論文 (Short communication)>

The Fatty Acid Composition of Fish Consumed in Dalian- and Hangzhou-City, China

Weiyu Zhang¹⁾, Rong Xia²⁾, Tetsuro Nagasawa³⁾, Yueji Sun⁴⁾, Kei Hamazaki³⁾*, Jun Wu⁴⁾ and Tomohito Hamazaki³⁾

¹⁾Pharmaceutics Office in Academy of Medicine, Changchun University of Traditional Medicine, Changchun-city, Jilin-province, China

²⁾Basic Medical College of Zhejiang Chinese Medical University, Binjiang Hangzhou 310053, Zhejiang Province, China,

³⁾Division of Clinical Application, Department of Clinical Sciences, Institute of Natural Medicine, University of Toyama, Sugitani, Toyama-City, Toyama 930-0194, Japan,

⁴⁾Department of Psychology, Dalian Medical University, Dalian-city, Liaoning- province 116044, China

*: Correspondence to: Kei Hamazaki, MD, PhD: Department of Public Health, Faculty of Medicine, University of Toyama, 2630 Sugitani, Toyama 930-0194, Japan; Phone: +81 76 434 7279; FAX: +81 76 434 5023; E-mail: keihama@med.u-toyama.ac.jp

Abstract

There was essentially no database on the fatty acid composition of fish available in China. Twenty-seven kinds of fish and 20 kinds were purchased in Dalian- and Hangzhou-city, China, respectively, and edible part was analyzed for the fatty acid composition. Three kinds of fish were purchased in both cities, but they contained markedly different amounts of n-3 polyunsaturated fatty acids (PUFA). Those kinds of fish in Hangzhou-city had more n-3 PUFA than those in Dalian-city. This was probably because fish were purchased in winter in Hangzhou-city and in summer in Dalian-city. Our data were limited in terms of the area and season of catch, and the number of species. However, our database would serve as the starting point for the fatty acid composition study of Chinese fish.

Key words: n-3 polyunsaturated fatty acids, fatty acid composition, Chinese fish, nutrition, database

Received 2009. 7. 24; Revised received, 2009. 10. 26; Accepted 2009. 11. 6

The importance of n-3 polyunsaturated fatty acids (PUFA) in lipid nutrition is well-known. However, there were only a few reports about the fatty acid composition of fish consumed in China, and the numbers of fish investigated were very small: one kind of fish in a report¹⁾ and two in another²⁾. We performed a case-control study of suicide attempt and n-3 PUFA in Dalian-city, China³⁾, and found that the relative risk of suicide attempt in the highest quartile of eicosapentaenoic acid (EPA) concentrations in the phospholipid fraction in red blood cells was only one eighth of that in the lowest. In that study we could not determine how much n-3 PUFA they ate because there were neither food questionnaires nor databases that would calculate n-3 PUFA intake from their diet. The purpose of the present study was to facilitate to compile a fatty acid database of Chinese fish.

In July and December, 2005, 27 and 20 kinds of popular fish were purchased at local fish and super markets in Dalian- and Hangzhou-city, China, respectively. Dalian-city is in the eastern Liaoning Province of Northeast China, facing Shandong to the south and the Yellow Sea to the east and the Bohai Sea to the west and south. Hangzhou-city is located in the Yangtze River Delta and 180 kilometres southwest of Shanghai. Those fish were stored at -30°C and then analyzed. Edible part (three to five different portions including the dorsal and ventral) of each fish (only one fish sample for each species) was minced and mixed thoroughly. One g of the mixture was analyzed with 17:0 as an internal standard by the saponification method of the Japan Food Research Laboratories⁴⁾ with slight modification. After transmethylation of fatty acids with HCl-methanol, the fatty acid composition was analyzed by gas chromatography (GC14A Shimadzu Corporation, Kyoto) with a capillary column DB-225 (length, 30 m; internal diameter, 0.25mm; film 0.25 µm; J&W Scientific, Folsom, CA). The intra-assay coefficient of variance of the saponification method was 5.0% for EPA and 4.6% for docosahexaenoic acid (DHA). Data are expressed as means.

Tables 1 and 2 show the fatty acid composition of fish purchased in Dalian- and Hangzhou-city, respectively. Three kinds of fish, ribbonfish (*Trichiurus haumela*), tench (*Ophiocephalus argus*) and small yellow croaker (*Pseudosciaena polyactis*), were purchased in both Dalian- and Hangzhou-city. The total n-3 PUFA content found in those three fish in Dalian-city were 280, 224 and 366 mg/100g of edible part, respectively. Those values were smaller than those found in Hangzhou-city (821,

617 and 543, respectively).

The differences in n-3 PUFA content in three kinds of fish between two cities may be explained by the difference in the seasons of catch. The fish in Dalian-city were purchased in July, when Dalian was hot, and the fish in Hangzhou-city were purchased in December. It has long been known that fish contain more fat in winter. In fact sardines caught in Japan showed a wide range of fat content according to the season of catch. For instance, DHA content in the non-polar lipid fraction of sardine flesh varied from 2.4 weight % in August to 8.0% in December⁵⁾. There are a few Chinese epidemiological studies showing the healthy aspects of n-3 PUFA or fish eating. Men in Shanghai who consumed ≥ 200 g of fish/shellfish per week had a relative risk of 0.41 for fatal acute myocardial infarction (AMI) compared with men consuming < 50 g per week⁶⁾. However, the algorithm used in their study for the assessment of n-3 PUFA intakes was rather simple. They assigned the following constants to three categories of fish: 0.57g n-3 PUFA per 100g fresh fish, 0.44g per 100g salted fish, and 0.36g per 100g shellfish⁶⁾. n-3 PUFA intakes were not calculated in many of the other epidemiological studies with Chinese subjects^{3,7,8)}. Databases of the fatty acid composition of Chinese fish are necessary to better estimate the fatty acid composition of diet. Our data were limited in terms of the area and season of catch, and the number of species. However, our database would serve as the starting point for the fatty acid composition study of Chinese fish. Further studies are, therefore, necessary.

We are grateful to Ms Hiroko Hamatani and Ms Shizuko Takebe for their technical assistance. This work was partly supported by Polyene Project Corporation.

Table 1. The fatty acid content of various fish available in Dalian-city

Scientific Name	Oreochromis lele Walbaum	Silurus asotus Linnaeus	Salmo salar Linnaeus	Monopterus albus Zievel	Pagrus major Temnick et Schlegel	Stromateoides argenteus Euphrasen	Scorpaenopsis nipponica Cuvier et Valenciennes	Aulopus japonicus Bleeker	Eupagrus japonicus Temnick et Schlegel	Chirocentron purpuratus Temnick et Schlegel	Myxoprogodon paciatus Richardson	Acipenser sinensis Gray	Pseudosciaena polynesiensis Bleeker
Common Name	Pacific salmon	Amur catfish	Atlantic salmon	Swamp eel	Stripper sea bream	silver pomfret	Japanese Spanish mackerel	Jellynose fish	Japanese anchovy	Dotted gizzard stad	Black carp	Chinese sturgeon	Small yellow croaker
Chinese Name	Danhaiyu	Nian	Daxianggan	Huangshan	Zhendao	Yinchang	Lardianjiangao	Rhebianyu	Ti	Banji	Qingyu	Zhonghuayun	Xiaohuangyu
Saltwater or freshwater fish	saltwater	freshwater	freshwater	freshwater	saltwater	freshwater	freshwater	freshwater	saltwater	saltwater	saltwater	freshwater	saltwater
Local Chinese Name	Sanweiyu	Nanyu	Gayu	Shanyu	Jiayu	Changyu	Fayu	Banyu	Pinkou	Lingyu	Qingyu	Xunyu	Huangyu
Fatty Acid (mg/100g)													
Saturated													
14:0	544	302	237	252	130	187	133	70	91	374	194	76	45
16:0	1705	1756	1419	1665	976	1312	564	592	491	965	389	446	410
18:0	462	358	335	247	348	353	150	115	91	129	32	65	86
20:0	25	14	15	16	16	24	15	8	3	7	2	4	5
Monounsaturated													
16:1 n-7	695	1186	410	566	317	226	203	344	267	366	229	96	186
18:1 n-9	2338	1635	1278	2788	1054	1568	565	539	325	1058	338	538	386
18:1 n-7	394	367	223	292	162	138	125	145	136	121	93	79	59
20:1 n-9	11	70	43	159	84	85	40	25	32	79	36	18	13
22:1 n-9	28	10	4	ND	16	40	5	ND	4	5	62	3	ND
24:1 n-9	36	6	4	23	30	33	15	6	ND	2	15	1	6
n-6 polyunsaturated													
18:2 n-6	862	345	561	77	94	31	33	34	32	27	10	373	17
20:4 n-6(AA)	87	135	153	44	81	133	41	89	68	54	8	20	27
22:4 n-6	20	40	41	13	19	59	4	14	21	4	ND	1	3
22:5 n-6	40	32	96	16	35	50	15	21	15	17	ND	8	16
n-3 polyunsaturated													
18:3 n-3	288	93	507	44	50	18	30	16	18	10	4	49	12
20:5 n-3(EPA)	1000	706	148	243	65	189	229	218	257	377	214	104	80
22:5 n-3	509	129	103	124	108	123	57	57	62	71	9	20	19
22:6 n-3(DHA)	1497	462	306	621	669	573	463	461	352	177	315	243	255
Total fatty acid	10721	7808	5994	7240	4402	5186	2719	2780	2295	3878	1962	2174	1633
Total PUFA	4458	2076	2006	1215	1250	1202	892	929	853	762	568	847	435
Total n-3 PUFA	3294	1391	1064	1032	992	904	779	752	689	636	542	416	366
Total n-6 PUFA	1164	685	942	183	259	298	113	177	164	126	27	431	69
n-6/n-3	0.35	0.49	0.88	0.18	0.26	0.33	0.14	0.24	0.24	0.20	0.05	1.02	0.19

Data were means of 3-4 measurements. Species are arranged according to the total n-3 fatty acid content (decreasing order). ND-not detected.

The five most eaten fish are written in boldface. The fish in Dalian-city were purchased in July.

Table 1 (Continued)

Scientific Name	Lampetra japonica Matsurs	Candiru chrysomus Cuvier	Bunkidjops obsoletus Temmink et Schlegel	Trichanema haemula Forsskal	Iseogrammus ocella Jordan et Sclater	Stenodochela graham legan	Culter erythropterus Baesovsky	Pseudophoxinus japonicus Human	Opliocephalus angus Cantor	Pseudophoxinus yokohamae Cantor	Cyprinus pellegrini Ichang	Abudefdu indanus Baesovsky	Late hemimachilis Temmink et Schlegel
Common Name	River lamprey	Goldenfinned conallish	Bastard halibut	No English common name. A kind of Carp	Hairtail	Gianting	Golden-fine burl	Piedlary carp	Chub mackerel	Snakehead fish	Barbless carp	Chinese false gudgeon	Soy-ry maki
Chinese Name	River lamprey	Shuoyou salwater	Yupin salwater	Danzhongyangu salwater	Dayu salwater	Dahongyangu salwater	Danzhongyangu salwater	Hongsha salwater	Wuli salwater	Huangguilie salwater	Daxia salwater	Bingyayou salwater	Suo salwater
Local Chinese Name	Qingyu	Xijieyu	Yupianyu	Bangyu	Dayu	Hangu	Hongyuan	Pingyou	Tianyu	Heiyu	Dingyu	Bahayu	Soyu
Fatty Acid (mg/100g)													
Saturated													
14:0	21	17	17	11	28	11	26	15	7	12	5	6	6
16:0	194	198	167	172	233	163	255	181	93	132	97	98	103
18:0	43	44	41	38	85	40	110	88	39	34	27	33	35
20:0	2	1	1	1	2	1	5	3	1	1	1	1	1
Monounsaturated													
16:1 n-7	74	81	32	13	31	46	47	35	10	37	29	24	16
18:1 n-7	151	163	73	43	188	99	129	55	28	93	82	55	86
18:1 n-7	54	67	23	14	22	36	34	19	12	27	16	15	15
20:1 n-9	11	7	2	4	4	5	7	1	2	9	2	4	2
22:1 n-9	2	ND	2	ND	ND	ND	ND	ND	ND	1	ND	ND	ND
24:1 n-9	ND	1	3	ND	3	ND	ND	ND	ND	1	ND	2	ND
n-6 polyunsaturated													
18:2 n-6	10	7	13	23	8	11	9	15	7	22	4	5	104
20:4 n-6(AA)	30	37	10	15	25	32	39	39	22	16	18	22	36
22:4 n-6	5	18	ND	ND	4	7	16	4	1	2	2	3	2
22:5 n-6	4	3	4	10	17	6	14	23	12	4	4	8	16
n-3 polyunsaturated													
18:3 n-3	5	2	5	6	3	9	3	11	4	5	2	2	16
20:5 n-3(EPA)	103	128	74	40	29	104	75	35	43	65	56	27	32
22:5 n-3	39	51	16	26	17	16	29	12	7	8	10	11	9
22:6 n-3(DHA)	177	141	216	214	231	145	135	180	174	147	84	108	63
Total fatty acid	932	973	704	634	935	742	940	722	463	634	443	427	549
Total PUFA	378	391	341	336	337	341	327	324	272	275	183	188	283
Total n-3 PUFA	324	311	311	286	289	274	284	238	227	234	152	146	130
Total n-6 PUFA	54	69	30	51	57	66	87	86	45	51	31	40	163
n-6/n-3	0.17	0.22	0.1	0.18	0.2	0.24	0.36	0.36	0.20	0.23	0.21	0.27	1.53

Data were means of 3-4 measurements. Species are arranged according to the total n-3 fatty acid content (decreasing order). ND: not detected.

The fish most eaten fish are written in boldface. The fish in Dalian city were purchased in July.

Table 2. The fatty acid content of various fish available in Hangzhou-city

Scientific Name	Micthylus milu	Lateolabrax japonicus	Tilichthys lunulata	Ophichthys argente Cantor	Pseudosciaen polyactis	Anguilla japonica	Pomus argentatus	Aspichthys laticeps	Johnius carutta	Mandarin fish Aukia
Common Name	Chinese drums	Japanese sea bass	Ribwortfish	Tench	Small yellow croaker	Conger pike	Silvery pomfret	Big head schizothracin	Kant wak	Cucian
Chinese Name	Mangyu	Lu	Daiyu	Wudi	Xiaohuangyu	Manli	Changyu	Huanwenyu	Can	Jueyu
Saltwater or freshwater fish	saltwater	freshwater	saltwater	saltwater	saltwater	freshwater	freshwater	freshwater	saltwater	freshwater
Local Chinese Name	Mayu	Luyu	Daiyu	Heiyu	Xiaohuangyu	Mayu	Changhuanyu	Xiguyu	Biliyuyu	Jihayu
Fatty Acid (mg/100g)										
Saturated										
14:0	320	101	225	49	104	255	75	48	32	50
16:0	2809	599	1295	456	745	1063	492	560	262	331
18:0	629	109	342	80	135	195	127	85	61	81
20:0	50	4	19	3	7	4	9	4	4	4
Monounsaturated										
16:1 n-7	1327	281	295	173	372	374	81	232	102	106
18:1 n-9	715	552	1348	574	708	1703	400	751	524	367
18:1 n-7	273	109	149	95	103	156	54	78	51	54
20:1 n-9	50	17	21	57	18	115	38	19	15	12
22:1 n-9	7	ND	ND	ND	ND	ND	16	ND	1	ND
24:1 n-9	11	3	8	4	3	4	6	ND	ND	ND
n-6 polyunsaturated										
18:2 n-6	71	32	33	39	28	206	13	289	188	240
20:4 n-6(AA)	220	60	54	26	45	26	52	38	13	64
22:4 n-6	40	16	13	4	4	5	20	1	ND	10
22:5 n-6	52	43	22	12	18	10	24	7	2	30
n-3 polyunsaturated										
18:3 n-3	35	21	22	31	17	34	15	163	123	131
20:5 n-3(EPA)	604	123	215	119	173	64	50	60	51	47
22:5 n-3	146	126	103	86	33	74	52	24	14	27
22:6 n-3(DHA)	426	565	480	382	320	369	247	134	112	89
Total fatty acid	7919	2789	4688	2219	2855	4720	1820	2534	1570	1675
Total PUFA	1653	1006	964	714	649	822	518	517	300	294
Total n-3 PUFA	1211	835	821	617	543	541	400	380	217	371
Total n-6 PUFA	441	171	144	97	106	281	119	374	0.72	1.26
n-6:n-3	0.36	0.21	0.17	0.16	0.19	0.52	0.3	0.98		

Data were means of 4-5 measurements. Species are arranged according to the total n-3 fatty acid content (decreasing order). ND=not detected.

The five most eaten fish are written in boldface. The fish in Hangzhou-city were purchased in December.

Table 2 (Continued)

Scientific Name	Scomberomorus niphonius	Coilia ectenes	Therapon dahegammii	Hypophthalmichthys molitrix	Crassostrea auratus	Ctenopharyngodon idella	Megalocypalis	Erythrinus barbusa	Asiatidius nobilis	Panbaranis piddensis
Common Name	Spanish mackerel	Shorthead tapered anchovy	Cod	Silver carp	Black carp	Grass carp	Millet	Yellowhead carp	Bighead carp	White bream
Chinese Name	Bayu	Ji	Xue	Lian	Ji	Caoyu	Zhiyu	Caoyu	Yong	Bian
Saltwater or freshwater fish	saltwater	freshwater	freshwater	freshwater	freshwater	freshwater	freshwater and saltwater	freshwater	freshwater	freshwater
Local Chinese Name	Mijayou	Fengqieyu	Minguiyu	Bailiuyu	Jiyou	Haiyu	Zhiyu	Huangyu	Hailiuyu	Baiyu
Fatty Acid (mg/100g)										
Saturated										
14:0	12	75	473	24	7	34	8	16	7	10
16:0	134	287	1365	137	149	481	97	218	64	178
18:0	47	45	274	27	40	85	27	64	28	65
20:0	2	3	13	1	1	3	1	3	1	1
Monounsaturated										
16:1 n-7	18	157	631	56	19	131	20	65	17	35
18:1 n-9	52	106	2790	97	179	758	53	207	37	296
18:1 n-7	16	27	712	27	34	70	18	52	15	29
20:1 n-9	3	6	728	7	13	26	3	16	2	10
22:1 n-9	ND	ND	561	ND	ND	ND	ND	ND	ND	ND
24:1 n-9	3	3	57	ND	ND	ND	ND	ND	ND	ND
n-6 polyunsaturated										
18:2 n-6	8	6	54	17	164	307	58	45	19	162
20:4 n-6(AA)	14	17	19	30	30	70	23	67	41	48
22:4 n-6	1	1	ND	2	3	2	1	14	3	7
22:5 n-6	9	10	1	18	7	22	13	22	17	26
n-3 polyunsaturated										
18:3 n-3	5	6	19	46	17	71	16	29	13	12
20:5 n-3(EPA)	40	72	119	54	19	12	47	22	42	5
22:5 n-3	5	11	18	15	10	10	13	15	8	3
22:6 n-3(DHA)	238	155	65	65	99	52	67	73	67	37
Total fatty acid	611	997	7948	632	809	2180	468	953	384	956
Total PUFA	322	280	314	255	368	581	241	310	214	331
Total n-3 PUFA	288	244	220	179	145	144	143	138	129	58
Total n-6 PUFA	34	36	93	76	223	437	99	172	85	273
n-6/n-3	0.12	0.15	0.42	0.42	1.53	2.96	0.7	1.25	0.65	4.72

Data were means of 4-5 measurements. Species are arranged according to the total n-3 fatty acid content (decreasing order). ND=not detected.

The five most eaten fish are written in boldface. The fish in Hangzhou-city were purchased in December.

REFERENCES

1. Wang XC and Chen JQ. Guangzhou Food Sci Technol, 20: 81-82, 2004. (in Chinese)
2. Yang JG, Li GL, Jin QH, Chen DH and He SW. J Tongji Med Univ, 14: 77-80, 1994.
3. Huan M, Hamazaki K, Sun Y, Itomura M, Liu H, Kang W, Watanabe S, Terasawa K and Hamazaki T. Biol Psychiatry, 56: 490-496, 2004.
4. Japan Food Research Laboratories. Jitsumushano-kaita 5tei nihonshokuhin-hyojunseibun bunseki-manualno kaisetsu. (Japan Food Research Laboratories, Edit) pp 277-280, Tokyo. Chuohoki, Tokyo, 2001. (in Japanese)
5. Hayashi K and Takagi T. S Bull Fac Fish Hokkaido Univ, 28: 83-94, 1977.
6. Yuan J-M, Ross RK, Gao Y-T and Yu MC. Am J Epidemiol, 154: 809-816, 2001.
7. Hankin JH, Stram DO, Arakawa K, Park S, Low SH, Lee HP and Yu MC. Nutr Cancer, 39: 187-195, 2001.
8. Woo J, Leung SS, Ho SC, Sham A, Lam TH and Janus ED. Eur. J. Clin. Nutr, 53: 461-467, 1999.