Balanced Intake of Polyunsaturated Fatty Acids for Health Benefits

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Edited by Y. Miura, Teikyo Univ., and accepted January 20, 2001 (received for review December 6, 2000)

Abstract : The fat intake pattern of Japanese that was estimated from the annual report of national nutrition survey was introduced as a comprehensive model for a healthy way of eating polyunsaturated fatty acids (PUFA). The n-6/n-3 ratio of 4 and the polyunsaturated/saturated (P/S) ratio of 1 in the recommended dietary allowance (RDA) of fat for Japanese that was announced in 2000 essentially reflects a relatively high value of these ratios in our dietary habit. This review stresses the advantage of Japanese way of eating, in which moderate eating is indispensable, for health benefits.

J. Oleo Sci. **50**, 305-311 (2001).

Key words : polyunsaturated fatty acids, n-6/n-3 ratio, P/S ratio, Japanese eating habit, moderation

Introduction

Healthy eating is a matter of primary concern for all mankind. Dietary fat is best of all the most influential macro-nutrient to our health. There are at least two crucial points to have a proper understanding regarding healthy selection of dietary fat, i.e., quantitative and qualitative points of views. Of course, both issues are not independent factors and should be considered compatibly.

Probably, Japan is a good model to comprehend the relationship between fat consumption and health, since the consumption of fat increased markedly, from less than 10 energy % to more than 25 energy %, from the end of World War II to the present. Accompanying with the increase in fat intake, the longevity extended markedly. In Japan, intake of polyunsaturated fatty acids (PUFA) is relatively high despite a low fat diet in relation to other affluent countries. In addition, diverse statistical data related to health issues are published yearly in Japan (1-4). The recommended dietary allowance (RDA) for Japanese is revised every 5 years (5). Standard food table also is revised occasionally (6). Thus, we are able to obtain the newest data to understand the relationship between dietary fat and health. This review focuses on the characteristics of fat intake in Japan, and

introduces surpassing points of Japanese way of eating. The related reviews are currently available (7,8).

The Quantitative Standpoint of Dietary Fat

The quantity of dietary fat is a primary and crucial determinant to our health (5,7,8). The essentiality of dietary fat is limited only to PUFA as a source of essential fatty acids. The amount of PUFA required for this purpose is as low as 1~2 energy % (9). Thus, from the theoretical background, no more than 3 energy % of PUFA is required for health maintenance even we consider large individual variations. It is, however, practically impossible to live healthy under such an extremely low amount of dietary fats. In fact, people in affluent countries are consuming more than 15 times of the minimum requirement, i.e., 30 to 40 energy % for enjoyable eating habit. At present, dietary fat intake of Japanese is around 26 energy %, the level regarded as a low fat diet. Available information repeatedly noticed that the increase in the consumption of carbohydrate at the expense of dietary fat results in an elevation of serum triglyceride and a decrease in HDL-cholesterol. At the same time, the intake of Ca decreases while that of Na increases, the situations that stimulate the incidence of osteoporosis

and hypertension, respectively (10).

The problem recently encountered in affluent countries is overeat of fat. The consumption of dietary fat more than 30 energy % possibly causes various life-style related diseases (adult diseases) as can be estimated from high frequency of health hazards in the United States in relation to Japan. Thus, the reduction of dietary fat to at least 30 energy % is essential to avoid such prevalent diseases (11). It is easy to say that it is essential to avoid excessive intake of fats, but it is indeed difficult to practice. Also, "what is an appropriate level?" is a question hard to answer, although knowledge on lipid nutrition has developed greatly. Japan is a peculiar country among developed countries where fat consumption is kept below 30 energy % on average for more than these two decades (Fig. 1). This dietary fat level is regarded by Western people as a typical slim diet. It is generally recognized that this relatively low fat intake by Japanese is attributed to their eating habit. Rice is contributing as a "core food", and there is belief that rice is not intimate with fats.

Based on these considerations, the RDA of Japanese (Table 1) has been revised recently. The dietary fat level is recommended to be 20 to 25 energy %. The 25 energy % is considered to be an upper limit.

The Qualitative Standpoint of Dietary Fat

The quality of dietary fat also is an important factor.

Table 1 Recommended dietary allowance of fat for Japanese.

Quantity	
20~25 energy %	
Quality	
S : M : P=30 : 40 : 30	
n-6/n-3 ratio=4	
Addendum	
Cholesterol :	less than 300 mg/day to those who are prone to respond dietary cholesterol
Antioxidants :	pay attention to the intake of antioxidants such as α -tocopherol, carotene and vitamin C to prevent lipid oxidation

Ref. (5).

When the quality is not appropriate, the health benefit of dietary fat will be spoiled even though the quantity is adequate. However, "what kinds of fatty acids should we be ingested for health?" is a puzzling question. In RDA for dietary fat, a number of countries recommend to consume dietary fats with the polyunsaturated/saturated fat (P/S) ratio of 1 and the n-6/n-3 ratio of 4 to 10 (Table 2). There is an international agreement to the favorable ratio of P/S, around 1. Although this value is thought to be beneficial to the prevention of hypercholesterolemia, information is available that it is recommended for the prevention of other diseases and/or more directly the maintenance of health. In this context, however, "P" is entirely but not exclusively linoleic acid. Since other

Fig. 1 Trends of Nutrient Intakes in Japan (Ref. 1).

Table 2 Recommended dietary allowance of fat in the world.

Country or organization	Total fat	Total PUFA	n-6 (18:2)	n-3 (18:3)	n-6/n-3 ratio
	(Energy %)				
NATO ¹ (1989)	20-28	6-7	4.8	1.0	4
Nordic (1989)	20-30	—	3-10	0.5	—
United States (1989)	<30	7	1-2	—	4-10
		(max 10)			
United States (2000)	<30	<10	—	—	—
Canada (1990)	30	3.5	3	0.5	4-10
	(Sat<10)	(min)	(min)	(min)	
COMA ² (1991)	33	6	1	0.2	—
		(min)	(min)		
FAO (1994)	15-35	—	4-10	—	5-10
	(Sat<10)				
Japan (1995)	20-25	7-8	—	—	4
Japan (2000)	20-25	7-8	—	—	4
United States (2000)	<30	—	—	—	—
	(Sat<10)				

¹North Atlantic Treaty Organization, ²Committee on Medical Aspects of Food Policy, England. Ref. (5, 12-14).

PUFA, in particular n-3 PUFA, may have beneficial health effects, incorporation of PUFA other than linoleic acid in the P/S ratio deserves future study. In spite of an absolutely high incidence of cardiovascular disease in Western countries, the average value for the P/S ratio is around 0.5. The corresponding value in Japan is 1.0 to 1.2.

Situation of the ratio of n-6/n-3 is more complicated. The recommendation of the n-6/n-3 ratio of 4 to 10 has been recognized worldwide (5,12,13). However, this range may be practically a hard obstacle for most of developed countries except Japan. In North America

and Europe, the ratio is actually more than 10, for example the ratio is said to be 16 in the United States. Japan is again the peculiar country where the P/S and n-6/n-3 ratio is maintained at around 1 and 4 for a long period, respectively (**Fig. 2**). To this relatively high level of n-3 PUFA intake, not only fishes and shellfishes, but edible vegetable oils, exclusive of rapeseed oil and soybean oil, are significant contributors (containing approximately 8% of α -linolenic acid). These two oils occupies approximately 70% of edible oils consumed in Japan (**Fig. 3**). Although a variety of edible oils are commercially available and some are thought to be a "healthy oil", they are all minority. The fats and oils are contributing 25% of total fat intake, followed by meats (**Fig. 4**). These two fat sources occupy just below 50% of fats consumed. Thus, dietary habit in Japan has made possible a higher n-3 PUFA intake under a low fat regimen.

There is however no theoretical background to present the best or even appropriate the n-6/n-3 ratio, and even in Japan several opportunistic opinions are prevailing. These extraordinary emphasize the functions of n-3 PUFA with ostracism to n-6 PUFA, in particular linoleic acid. Many consumers who are not familiar with nutritional issue are largely influenced by those claims, and abnormal adherence produces admiration of foods containing n-3 PUFA, while depreciation of linoleic acid. Strangely enough, foods containing n-3 PUFA are often called like as "Einstein Foods". The reason to cause such a chaos is mainly due to an inappropriate discrimination of fats needed for health from those used for the treatment of metabolic diseases. In addition, several researchers

Fig. 2 Trends of Polyunsaturated Fatty Acid Intakes in Japan (Ref. 1).

Fig. 3 Age-related Bias of Fish Eating Habit (Ref. 1).

Fig. 4 Consumption of Fats and Oils in Japan (Ref. 4).

persist nutritional issues of lipids directly from the results of animal studies. Therefore, the revised RDA is solely dependent on the information obtained in human studies. From the nutritional standpoint, it is very important to understand what the nutritional recommendation means. In Japan the recommendation of the n-6/n-3 ratio of 4 is based on the current consumption pattern of PUFA. The value is kept at

around 4 for at least for 2 decades, and during these periods, there were no specific health hazards that were attributable to the current pattern of fat intake. The life-span steadily, though to a somewhat slowly, increased during these decades.

Recently ISSFAL (International Society for Study of Fatty Acids and Lipids) announced adequate intake of fats for adult (14). It recommended, as % energy

level, linoleic acid, 2.0 (upper limit 3.0) ; α -linolenic acid, 1.0 ; DHA+EPA, 0.3 (both 0.1 to be at least) ; *trans* fatty acid, 1.0 (upper limit) ; and saturated fatty acids, <8.0 (upper limit). The working groups of the society recommended that the majority of fatty acids is obtained from monounsaturates. However, the recommendation of linoleic acid is questionable and it is impossible to keep the linoleic acid level as low as 3 energy % in all affluent countries. There is also no definite scientific evidence that 2 or 3 energy % of linoleic acid is enough to satisfy the essential fatty acid requirement in ordinary life.

Changing Good Eating Habit in Japan

Currently, the good eating habit of Japan is gradually depriving off, and there is a trend of an

estrangement from fish eating habit in particular in young generations, while fish consumption increases with age as shown in Fig. 5 (1). In contrast, meats are consumed more in young generations. Additionally, there is a dipolar reaction toward fish consumption, some are extraordinary expecting the functions of fish because of a wide array of physiological functions of n-3 PUFA, while the others are hesitating to eat probably because of troublesome of fish cuisine. Analyses of dietary fat consumed by students in dietician colleges and universities showed that even those who are studying nutritional sciences as a major subject are not necessarily eating reasonable quantity and quality of fats as shown in Table 3 (15-19). Analyses of health parameters including death cause support the superiority of fish eating pattern of Japanese (Table 4) (20). The eating pattern harmo-

Fig. 5 Consumption of Fish and Meat in Japan (Ref. 1).

Table 3 Fat Intake of Students in Women's Dietician Colleges and Universities in Japan.

Fat intake	Yokohama (1998)	Hiroshima (1990)	Nagoya (1994)	Tokyo (1994)	Fukuoka (1998)
Energy intake (kcal/day)	2,237	—	2,153	1,734	—
Fat intake (g/day)					
Total fat	72	30.0*	58.0	49.2	58.0
Fatty acids					
Saturated	17	10.7	17.3	15.9	15.1
Monounsaturated	27	12.1	23.6	18.8	21.0
Polyunsaturated	30	7.8	15.7	12.5	17.8
P/S ratio	1.7	0.8	0.8	1.2	1.2
n-6/n-3 ratio	6.0	6.1	6.1	3.5	4.8

* As fatty acids. Ref. (15-19).

Table 4 Relationship between Frequency of Fish Intake and Gender- and Age-Standardized Death Rate of Japanese (relative risk).

Death cause	Frequency of fish intake				P
	Every day	Occasional	Rarely	None	
All cases	1.00	1.07	1.12	1.32	<0.001
Cerebrovascular	1.00	1.08	1.10	1.10	<0.001
Heart	1.00	1.09	1.13	1.24	<0.001
Hypertensive	1.00	1.55	1.89	1.79	<0.001
Liver cirrhosis	1.00	1.21	1.30	1.74	<0.001
Stomach cancer	1.00	1.04	1.04	1.44	<0.05
Liver cancer	1.00	1.03	1.16	2.62	<0.05
Uterine cancer	1.00	1.28	1.71	2.37	<0.0001

Ref. (20).

nized with the western regimens plays an important role in our health. In addition, at present it can not be disregarded a considerable variation of food intake in all age groups, and only limited peoples, around 35%, are satisfying with RDA for dietary fat, approximately 40% of excessive and 25% of shortage (1).

The Future

The problem of how to eat fat for health may be an eternal puzzle, since the amount of fat usually consumed is far more than that of its essentiality. In future, more fats will be consumed popularly as reflecting the improvement of living condition. Until we have an instinctive desire to eat delicious foods, fat consumption should increase. Foods rich in fat are in general very tasty and we yield to temptation. Which do we select taste or health is the turning point for maintenance of health. At present a sole recommendation that may be possible is that eat well-balanced fats moderately. There is no single fat that provides complete health, and in our meals it is impossible to consume only one source of fat. Therefore, the combined effect of different dietary fats should be well understood.

Dietary fat is one of the most crucial nutrients to determine our health. In this sense, "eat moderately" is the simplest recommendation that everyone can practice. The balanced intake will be satisfied with the understanding of the real meaning of moderate eating. Be sure to eat moderately for your health. Never be tempted by delicious fatty meals.

More recently, the Ministry of Health and Welfare published the guidelines for dietary standard, which was prepared to materialize RDA (21). This recom-

mendation is in essence similar to that published in the United States (11). Thus, the path is now opened.

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