Mini Review

Preventive Effect of Polyunsaturated Fatty Acid and Vitamin E in Rice Bran Oil on Lifestyle-Related Diseases

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Summary The dietary fat intake of Japanese is thought to be more appropriate than in Western countries; however there is a range of differences of individuals in the amounts of fat intake and n-6/n-3 ratio. Therefore, it is important what kind of vegetable oils are used for cooking in order to consider the total balance of fat intake. Rice bran oil (RBO) is expected to reduce plasma cholesterol and be useful for prevention of cardiovascular disease because it contains several effective ingredients. RBO is rich in linoleic and oleic acid. RBO contains γ-oryzanol, which is well known to reduce plasma cholesterol levels. Furthermore, it contains tocotrienols, which are analogs of vitamin E, reported to have unique bioactivity different from that of α-tocopherol. The biological function of these components and their potential to prevent Japanese lifestyle-related diseases are discussed.

Key Words rice bran oil, polyunsaturated fatty acid, tocotrienol, lifestyle-related diseases

The fatty acid composition of vegetable oils in the Japanese market has changed from high linoleic acid to high oleic acid in the past 20 y, because n-6 fatty acids, such as linoleic and arachidonic acid were too likely to induce inflammation. Moreover, the Japanese consumer has tended to prefer “natural oils”, such as olive oil and flaxseed oil, rather than functional oils, medium chain triglycerides and diacyl glycerol, for health promotion recently. Rice bran oil (RBO) is also of increasing interest as a healthy “natural oil”.

RBO is rich in linoleic and oleic acid. It also contains γ-oryzanol, reported to lower the plasma cholesterol levels (1). RBO also contains vitamin E, especially tocotrienols which have not only strong anti-oxidative activity but also useful biological functions, such as anti-inflammation and anti-cancer (2). Vitamin E is a strong radical scavenger and suggested to protect against cardiovascular disease (CVD) because vitamin E inhibits oxidation of low-density lipoprotein (LDL), a cause of atherosclerosis (3), while tocotrienol is reported to suppress the differentiation of adipocytes (4) and suggested to improve the glucose tolerance induced by obesity (5). Vitamin E is recommended for clinical use to prevent progression of non-alcoholic steatohepatitis (NASH) (6). Tocotrienol is also suggested to be effective for treatment of NASH (7). So, the current status and problem of fat intake in Japan and the health benefit of components in RBO will be discussed here.

Characteristics of Japanese Lifestyle-Related Diseases

The trends in mortality rates for leading causes of death in Japan showed that the highest mortality rate was cancer; however, cardiovascular and cerebrovascular diseases have been gradually increasing in the past 10 y (8). The prevalence and severity of obesity with hypertension are high, while the degree of obesity with dyslipidemia is relatively mild compared to that in Western countries. Lowering blood pressure was effective in reducing Japanese mortality; however, obesity has been increasingly recently in middle-aged men. With the increasing prevalence of hypertension, the tendency toward a decreased mortality rate due to cerebrovascular disease has slowed. Insulin resistance and the onset of diabetes are also increasing. These situations are related to lifestyle and dietary habits.

Characteristic of the Fat Intake of Japanese

In dietary habits, the relationship between fat intakes and cardiovascular diseases has been studied for over 30 y all over the world. In Japan, the dietary reference intake for fat is determined as an adequate intake with reference to the median of actual intake of the Japanese population and shown alongside the dietary goal for prevention of lifestyle-related diseases because there are not many studies using a Japanese population, indicating that the scientific evidence is insufficient yet (9).

Therefore, the present state of fat intake of the average Japanese is not so bad compared with that of Western people. However, there are very individual differences in fat intake. The latest National Survey of Nutrition and Health in Japan indicates that over 30% of Japanese ingest more and approximately 20% of them ingest less than the appropriate range of total fat intake (10). The ratio of n-6/n-3 of polyunsaturated fatty acids is approximately 4, while those of Western countries are around 20. However, the n-6/n-3 ratio in the young Japanese population is reaching to 5 because of their preference of meat rather than fish (10) these days.

Figure 1 shows how much fat Japanese are taking from each food. Total fat intake per day is approxi-
mately 57 g, which is about 70% of the United States’ fat intake. Half of that is from vegetable and the half is from animal fat. Animal sources are meats, eggs, dairy food, and fish, and it is the so-called invisible fat which we do not clearly recognize that we are taking. On the other hand, invisible vegetable sources are cereals, beans, confections and others, while under a quarter of total fat intake is visible oil, meaning that we can recognize the amounts of fat intake, such as vegetable oil, mayonnaise and margarine. So, the amount of all the visible oil is estimated to be approximately one tablespoon per day.

Considering healthy fat intake, it is necessary to balance n-6 and n-3 fatty acids, including these visible and invisible oils. Therefore, it is important to choose the appropriate oil as a visible oil in order to consider not only quantity but also quality of fat intake and to maintain the balance of n-6/n-3.

**Polyunsaturated Fatty Acids in Rice Bran Oil (RBO)**

Table 1 shows the fatty acid composition of vegetable oils commonly used in Japan (11). Canola, safflower, sunflower and olive oil are rich in oleic acid. Safflower and sunflower oils were rich in linoleic acid before; however, it has mostly been replaced with oleic acid regarded to be safe, in order to avoid the risk of linoleic acid. So now, vegetable oils containing mainly linoleic acid are grape seed, corn, soy bean, rice bran and sesame seed oil. In these oils, RBO and sesame seed oil are unique in also containing relatively higher levels of oleic acid.

Flax seed oil is high in α-linolenic acid. α-Linolenic acid is also contained in canola and soy bean oils. They are well balanced between n-6 and n-3 fatty acids in the Japanese food style. Therefore, understanding the characteristics of these oils, we can recommend better choices for visible oils. Currently, “premium natural oils”, such as extra virgin olive oil, flaxseed oil and RBO are getting popular in the Japanese market.

**Unique Components of RBO and Their Biological Function**

Vegetable oils are important as sources of not only essential fatty acid but also the lipid soluble trace elements, such as vitamin E and phytosterols like γ-oryzanol. γ-Oryzanol and linoleic acid, which are abundant in RBO, are well known to decrease plasma cholesterol (1).

A recent systematic review and meta-analysis showed
that consumption of RBO decreased LDL cholesterol and total cholesterol significantly, which may lead to prevention and control of CVD. In this study, eleven RCT trials were analyzed and the data on RBO intake from 18 to 50 g/d and intervention duration between 21 and 90 d were used. Although the sample size is small and further studies are needed, results of the meta-analysis showed that consumption of RBO decreased LDL cholesterol and total cholesterol significantly and might lead to prevention and control of CVD.

**Preventive Effect of Vitamin E on Lifestyle-Related Diseases**

As shown in Table 2, RBO contains vitamin E, and is especially rich in γ-tocotrienol (13).

Although several studies suggest vitamin E was effective for type 2 diabetes (5, 14), the effect of vitamin E on diabetes is still controversial. In recent years, personalized medicine utilizing personal genome information and individualized nutritional guidance has been attempted in various diseases. Regarding the vitamin E therapeutic effect on patients with type 2 diabetes, an analysis based on haptoglobin (Hp) gene polymorphism was promising. Levy et al. conducted a double-blinded cross-over study with vitamin E versus a placebo in individuals with type 2 diabetes and the Hp2-2 genotype, and they showed that vitamin E might provide benefit in reducing CVD in Hp2-2 individuals with diabetes (15).

With the increase in the prevalence of obesity and metabolic syndrome, non-alcoholic fatty liver disease (NAFLD) and NASH have become one of the most important health issues. There are not many effective treatments for NAFLD/NASH other than improvement of lifestyle, so far. One of the large well-controlled RCT trials, Pioglitazone versus Vitamin E versus Placebo for the Treatment of Nondiabetic Patients with Nonalcoholic Steatohepatitis (PIVENS trial), showed that serum ALT concentration, liver fat accumulation, and leaf inflammation were significantly decreased by administration of vitamin E as compared with the placebo group (16). A treatment of NAFLD in a child study (TONIC study) also examined the effect of vitamin E in child NASH patients (17). Sato et al. conducted the meta-analysis including these studies and reported that vitamin E was effective against NAFLD (6). Therefore, only vitamin E is recommended as pharmacologic treatment.

The effect of tocotrienol on NASH model mice was reported by Yachi et al. (7), and we are now evaluating the effect of tocotrienol on the prevention of NASH using the other NASH animal models. Further study will be needed to clarify its advantage over α-tocopherol.

While obtaining numerous basic research results that are useful in the therapeutic effect of vitamin E and its homologues on type 2 diabetes, definite evidence for clinically recommended levels has not been established. One of the problems is that the fundamental onset factors of type 2 diabetes mellitus are diverse, its pathology is diverse and individual differences are large. This is likely to be a clue about individualization analysis considering genetic polymorphism, such as Hp. The second problem is that clinical application requires evidence from a large-scale epidemiological study, but because vitamin E is inexpensive and has no patentability, there seems to be a current situation in which it is difficult to invest a large amount of research funding there.

Therefore, RBO might be worth a try as a well-balanced good natural oil, not a medicine.

**Disclosure of State of COI**

The author declares no conflicts of interest associated with this manuscript.

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**Table 2. Concentrations of tocotrienols in vegetable oils.**

|            | α-Tocotrienol | γ-Tocotrienol | δ-Tocotrienol | Total tocotrienols |
|------------|--------------|---------------|---------------|-------------------|
| Palm       | 205          | 439           | 94            | 738               |
| Rice bran  | 236          | 349           | 585           | 785               |
| Wheat germ | 26           | —             | —             | 26                |

Data was referenced from Liu DH et al. (13).
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