

Original Article

Comparison of Usage of Fat and Oil (Lipids) for Cooking in Mass Feeding Facilities and Home

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The differences in intake amount of fats and oils and in the intake ratios of the constituent fatty acids are closely related to prevention and contraction of the life-style related diseases. In the present paper we investigated and analyzed the usage status of fats and oils for cooking in mass feeding facilities and in the home.

This study shows that fats and oils were used properly in 86% of cooking in mass feeding facilities and in 72% in private homes. Twelve types of fats and oils were used in mass feeding facilities compared with 15 in private homes. Survey results indicate that soybean oil was used most frequently in 88% of the mass feeding facilities, sesame oil in 76%, butter in 64%, margarine in 52% and rapeseed oil in 32%. Both olive oil and sesame oil were used most frequently in 48% of home cooking sites, margarine and butter in 41% and 40%, respectively, and both rapeseed oil and corn oil in 38%. Reasons for selecting cooking fats and oils in the mass feeding facilities were "good for health" and "adhere to the brand of manufacturer", whereas the home cooking sites specified "good for health" and "in use from a long time ago" as the major reasons. In the selection of fats and oils their reasonable prices were common considerations. Both the mass feeding facilities and home cooking sites were careful about reasonable prices of fats and oils for their selection, and also careful about preventing oxidation and deterioration of the oils.

A lot of fats and oils for food are manufactured and sold these days in Japan. A suitable selection of fats and oils for each dish is required in consideration of harmony with food, cookery and so on. In addition, a proper selection of fats and oils is necessary in mass feeding facilities from the viewpoint of business management, working surroundings and nutritional administration for each subject.

Key Words: Fat and oil, Mass feeding facility, Home cooking

Introduction

Fats and oils, which are major components of lipids, are esters of fatty acids and glycerol. Fatty acids that occur in foods are classified into saturated (S), monounsaturated (M) and polyunsaturated fatty acids (P). Components of these fatty acids differ depending on dietary sources such as animals, poultry, fish and plants. Even

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in the same species, fatty acid components show variation depending on the environment and conditions in which they grow. The differences in fatty acid components determine the physiological function of fats and oils.

With the recent increase of fatty acid intake by Japanese, the importance of the quality of fatty acids has been pointed out. According to the recommended dietary allowance, 6th revised [1], for Japanese, the favorable S:M:P intake ratio is 3:4:3. The intake ratio of polyunsaturated fatty acids of n-6 series (n-6 PUFA) and of n-3 series (n-3 PUFA) (n-6/n-3 ratio for healthy person) is recommended to be around 4.0. Calculations based on the result of the national nutrition survey for the 20 year period from 1971 to 1990 show that the average intake ratio of n-6/n-3 was 4.2 [2]. The survey also showed that the n-6/n-3 intake ratio tended to decline a little after 1990 (from 1991 to 1998), although there was no noticeable difference in the intake amount of fats and oils [3].

It has been suggested that the westernization of dietary habits and increases of fast food consumption and of eating-out brought about an increased intake of n-6 PUFA. A simultaneous reduction of the intake of fish and shellfish [4] and vegetables resulted in decrease of n-3 PUFA. The survey, which used juveniles and students as subjects, shows that the n-6/n-3 ratios of the subjects were variable from 3.3 to 17.8, indicating considerable difference in individuals and generally high values [5].

For prevention and treatment of life-style related diseases, study on components of intake fatty acids, especially the n-6/n-3 ratio, is thought to be important. In this paper we surveyed and analyzed the use of fats and oils, which mainly contribute to the n-6/n-3 ratio [2, 6, 7], and also investigated the cooking fats and oils.

Subjects and methods

1. Subjects of our investigation

Nutritionists of mass feeding facilities specified for the extra training of the students majoring in nutrition and families of the students were set as subjects. The use of cooking fats and oils was investigated through a questionnaire.

2. Investigation items

(1) Choice of fats and oils depending on cooking menu

We had subjects select either "Yes" or "No" to determine whether they chose a particular fat or oil for the cooking menu. To the subjects who selected "Yes", we

further asked them to determine the menu with the examples such as "preference for a fat or an oil either for deep-fried food or for salad dressing", "the choice of a fat or an oil either for the western cooking menu (steak, meuniere, etc.) or for another cooking menu", "the choice of the fat or the oil either fried vegetables or stir-fried meats for Chinese dishes or for the other dishes".

(2) Name of fat or oil used (raw material name)

We had subjects select the name of the fat or the oil (raw material name) from the following 15 items such as corn oil (*Zea mays* L. seed oil), rapeseed oil (*Brassica rapa* var. *nippo-oleifera* seed oil), soybean oil (*Glycine max* seed oil), safflower oil (*Carthamus tinctorius* L. seed oil), olive oil (*Olea europaea* L. ripe fruit oil), sesame oil (*Sesamum indicum* L. seed oil); perilla oil (*Perilla frutescens* Britton var. *japonica* Hara seed oil), lard (*Sus scrofa* v. *domesticus*, fat, separated by boiling water), beef tallow (*Bos taurus* v. *domesticus*, beef dripping fat, separated by boiling water), butter (*Bos taurus* v. *domesticus*, milk fat, centrifugally separated), margarine (hardened or hydrogenated oil, made of fish oil or vegetable oil of low melting temperature), prepared corn and rapeseed oil, prepared corn and soybean oil, prepared rapeseed and soybean oil, and the other oils (free description). In cases where the subjects used fat or oil of their choice for each cooking menu, all the fats or the oils for each menu could be counted as multiple answers.

(3) Reasons for choosing fats or oils for daily use

We had the subjects choose the reason for picking each fat or oil currently used from the following eight reasons: "low price", "good for health", "in use for a long time", "like its taste", "favor to brand or manufacturer name", "in favor of its component", "without clear reason", and "other reason" (free description). Subjects were advised to select multiple answers whenever appropriate.

(4) Attention to daily fat or oil selection, or use of fat or oil

Subjects were asked to describe freely the attention they paid when choosing the fat or oil and when the fat or oil was used.

3. Study on cooking fats and oils

The perilla oil which contains a lot of alpha (α)-linolenic acid (n-3 PUFA) was studied for its cooking quality and preferred taste. We cooked a meal using perilla oil. Then 14-second year students of the Chugoku Junior College evaluated the meal.

(1) Dishes prepared without heating

We put perilla oil as A and a general plant oil mixture (the mixed oil of rapeseed and soybean) as B (a control). We prepared 3 types of dressings that were composed of 1 part vinegar and 2~3 parts A or B oil (vinegar-oil bases) in addition to some seasonings. Japanese style dressings were completed by the mixing of suitable soy sauce and salt with the above vinegar-oil bases. The western style dressings used A and B oils and an appropriate amount of salt and pepper. The Chinese style dressings used soy sauce, salt, sugar and sesame together with the above bases. In addition, we prepared two series of mayonnaises mixing the A or B oil with egg yolk, vinegar, salt, pepper, sugar and mustard. All dressings and mayonnaises were served with four fresh vegetables (as salads) to the students for the oil evaluation.

(2) Dishes cooked with heating

a) Fried food

We cooked 4 vegetables and pork meats with a salt-pepper mixture, the perilla oil (oil A) and the regular mixed vegetable oil (oil B).

b) Deep-fried food (*tempura*)

We used olive oil only as oil C, and a mixture of olive oil and perilla oil as oil D (balanced oil) which is commercially available and contains 30% or more α -linolenic acid. A mixture of 2 parts of olive oil and one part of perilla oil was prepared at our laboratory of the Chugokugakuen (the olive-perilla mixed oil; oil E). Using oils C, D or E, and an electro-magnetic cooking device, we fried sectioned sweet potato (30 g per section) for 2 minutes and 50 second at a temperature of 170 °C.

(3) Evaluation items

To evaluate salads, fried vegetables and pork, subjects selected from the following items, "like A" "I like A oil-used ones", abbreviated as "like A", hereafter, "like B", "like both A and B", "dislike both A and B", "cannot decide". Subjects also had to write about their opinion and reflect freely.

For the evaluation of the fried sweet potatoes, subjects selected from the following items, "like A", "like B", "like C", "like both A and B", "like both A and C", "like both B and C", "dislike all A, B and C", "others" (free description) and "cannot decide". Subjects also were able to write the point they hit upon and reflect freely. With regard to deep-fried sweet potatoes (*tempura* of sweet potato), the chosen frequencies were individually totaled for each selection in the following matters, "like C", "like D", "like E", "like both C and D", "like both

C and E", "like both D and E", "dislike all C, D and E", "others" (free description) and "cannot decide".

Results

1. Number of answers

Responses were compiled from 27 mass feeding facilities, including 7 hospitals, 13 elementary schools, 3 enterprises and 4 facilities for welfare of the aged, and from 64 home cooking sites.

2. Choices of fats and oils depending on dishes

Fig. 1 shows frequency of proper use of cooking fats and oils depending on menus. 86% of the mass feeding facilities and 72% of home cooking sites answered that they chose cooking fats and oils depending on menus. As shown in Fig. 2, 50% of the mass feeding facilities answered that they most frequently make choices based on whether the dishes were composed of fried food or composed of dressing oils. 28% of them made choices

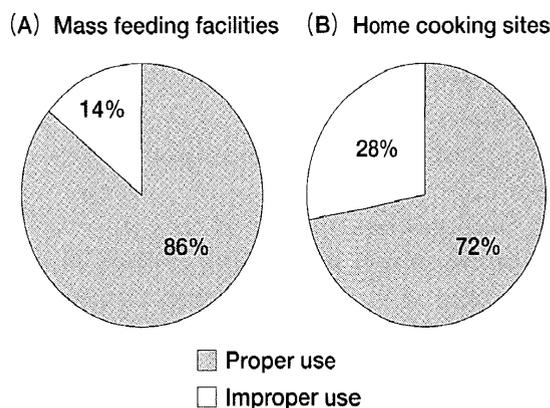


Fig. 1 Frequency of cooking fats and oils depending on menus.

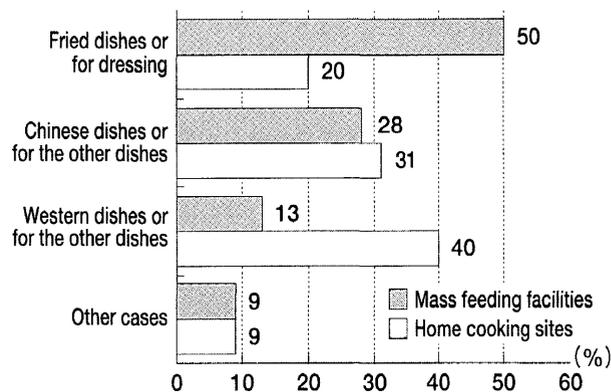


Fig. 2 Choices of fats and oils depending on dishes.

depending on whether the dishes are the Chinese ones or the other ones. And 13% of them made choices concerning whether the dishes were western ones or other ones. On the other hand, 40% of home cooking sites admitted that they made choices of cooking fats and oils depending upon whether the dishes are western ones or other ones. A level of 31% of homes admitted that they made choices whether the dishes were the Chinese ones or the other ones. 20% of the surveyed homes admitted that they made choices concerning whether the dishes were fried ones or salads.

3. Utilization frequency of cooking fats and oils in raw material names

Fig. 3 shows utilization frequency of various cooking fats and oils. In the mass feeding facilities, soybean oil was used most frequently, in 88% of the facilities; sesame oil in 76%, butter in 64%, margarine in 52%, rapeseed oil in 32%, and corn and olive oils both in 28% of the facilities.

At the home cooking sites, however, olive oil and sesame oil were used both in 48% of the sites, margarine and butter in 41% and 40%, respectively, and rapeseed oil and corn oil both in 38%.

4. The reason for selecting cooking fats and oils in use

The results of multiple answers about the reason for selecting cooking fats and oils are shown in Fig. 4. The most often cited reason for oil selection was cost. This was the case in both mass feeding facilities (24%) and home cooking sites (26.2%). The mass feeding facilities specified the reason for the selection as “good for health” 22% and “adhere to the brand of manufacturer” 17%. On the other hand, the home cooking sites specified “good for health” and “in use from long time ago” as reasons 17% alike. Only 2% of the homes chose “adhered to the brand name” as a reason.

5. The points on which the subjects were careful in selecting and using cooking fats and oils

Both the mass feeding facilities and home cooking sites were careful in preventing oxidation and deterioration of cooking fats and oils. Subjects were careful about such points as “cautious on production date and available term” and “be quick in use of cooking fats and oils after the package is opened”. Some of the mass feeding facilities answered “considering the choice of cooking fats and oils depending on the condition of a patient”. On the other hand, some of the home cooking sites frequently answer-

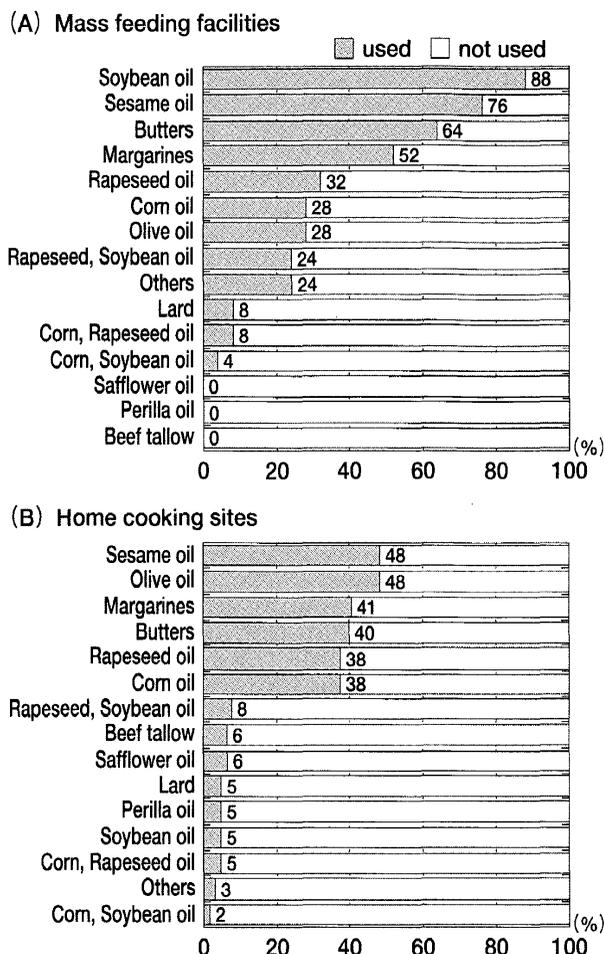


Fig. 3 Utilization frequency of fats and oils in raw material names.

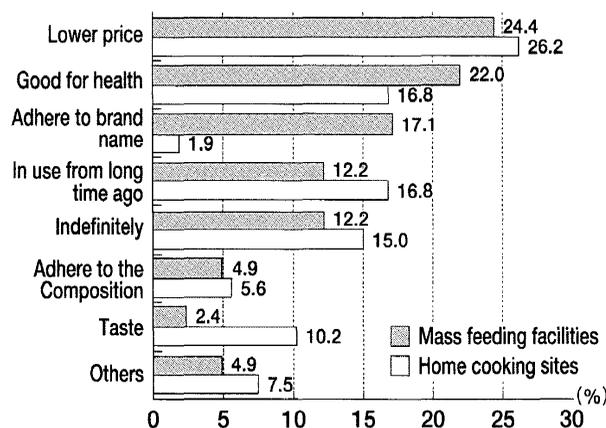


Fig. 4 The reason for selecting cooking fats and oils.

ed "using olive oil for menu because a newspaper recommended".

6. Desirable oil taste for dishes prepared without heating

Taste tendency of salads prepared with one of three dressings (described in the section of Subjects and methods) and mayonnaise are shown in Fig. 5. There were no "dislikes" concerning each salad oil. When A (perilla oil) was compared with B (the mixed vegetable oil) in Japanese dressing, 80% answered "like both A and B", while 10% answered "like A" and only 5% preferred B oil, which was composed of rapeseed and soybean oil. The result shows that there was no significant effect due to types of salad oils. Concerning the western style dressing oils, 16% answered "like A" (perilla oil). Together with "like both A and B" the answers represented 84% of the total. Oil spices did not influence choices. In the case of the Chinese dressings, the most frequent answers (36%) were "like A (perilla oil)" compared with the other dressings and mayonnaise. This suggests that the flavor of perilla oil blends well with sesame which is an ingredient of Chinese dressings.

On the other hand, when oil is used as a mayonnaise ingredient, "like A", "like B" and "like both A and B" each accounted for roughly 30% of answers. When the amount of fatty acids was integrated from the data of the table of the food lipophilic components in Japan [8], and the n-6/n-3 ratio was calculated for each dressing, the n-6/n-3 ratios of the dressings prepared with mixed vegetable oils distributed within 1.4 and 2.0, and those of the dressing prepared with perilla oil within 0.2 and 0.5.

7. Desirable oil taste for fried dishes

Favorite taste of oil for stir-fried vegetables is shown in Fig. 6. 55% of the subjects answered "like B", the mixed vegetable oil (rapeseed and soybean oils). Only 6% answered "like A" (perilla oil), and 18% answered "like both A and B". This infers that there were differences of favorable taste in oil types. On a flavor of oil, participant comments included the impression that perilla oil smells like grass, or the mixed vegetable oil is fragrant. The n-6/n-3 ratio of the vegetables stir-fried by use of the mixed vegetable oil was 1.4. On the other hand, that fried by use of perilla oil was 0.4.

Fig. 7 shows the preferences for deep-fried sweet potato sections (sweet potato *tempura*). Many subjects (87%) cooked the deep-fried sweet potatoes using "oil E" which was prepared by mixing 2 parts of olive oil and one part of perilla oil in our laboratory. The oil D was a

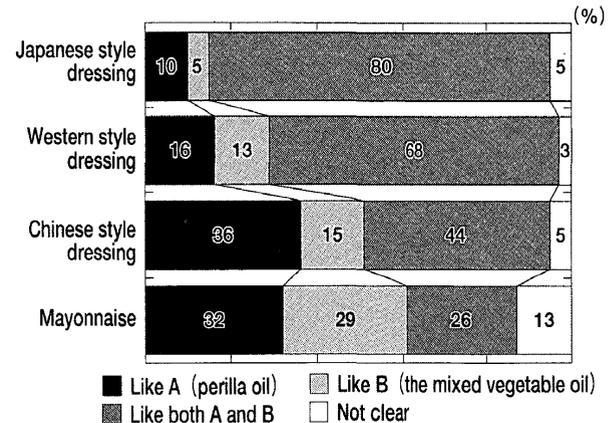


Fig. 5 Favorite oil taste for salad.

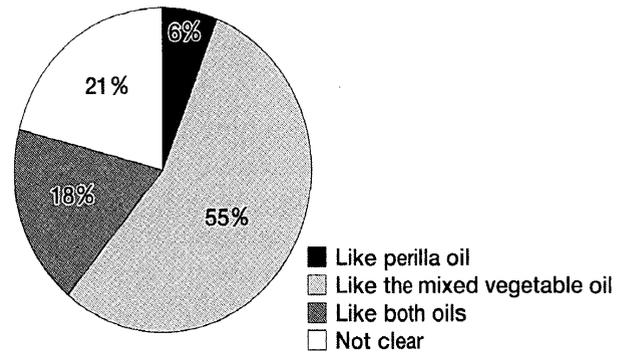


Fig. 6 Favorite oil taste for stir-fried vegetables.

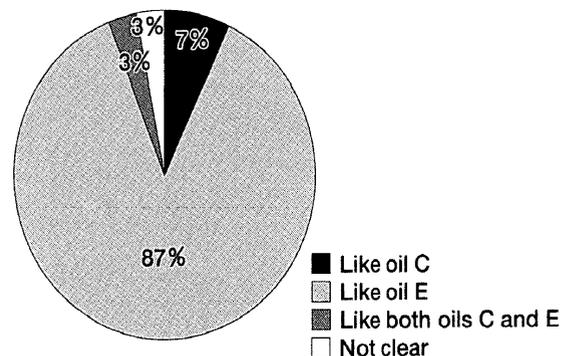


Fig. 7 Favorite oil taste for a deep-fry of sweet potato sections. Oil C, olive oil; Oil E, a mixture of 2 parts of olive oil and one part of perilla oil.

market-sold, "balanced" mix oil composed of perilla oil and olive oil containing α -linolenic acid level at 30% or more. However, no subject preferred this oil. Some of the subjects' impressions were as follows: the smell of perilla oil was rather strong, and had a strange taste. The calculated n-6/n-3 ratio of the deep-fried sweet potato was 14.1 for olive oil alone, 0.7 for our mixed oil, and 0.5 for the olive-perilla mixed oil, the market-sold balanced mix oil including 30% or more of α -linolenic acid.

Discussion

The fat and oil (lipid) have physiological functions not only as an energy source but also as suppliers of essential fatty acid and other lipophilic materials. The differences in the intake amount of lipid and the intake ratio of constitutive fatty acids are intimately related to prevention or contraction of the life-style related diseases. The questions "what kinds of fats and oils and how much of them should be eaten for good health" are not so easy to answer with present knowledge [9]. There are many opinions on the favorable intake ratio between polyunsaturated and saturated fatty acids [10, 11]. The ratio of contents between the n-6 series and n-3 series of polyunsaturated fatty acid (PUFA) differs by the type of fats and oils taken, especially in the vegetable oils (Fig. 8) [8].

It has been reported that safflower oil and corn oil, which are rich in the n-6 PUFA (linoleic acid), are recommended because of their effect in preventing arterio-

sclerosis by lowering cholesterol [12]. However, many other data indicated that excess intake of linoleic acid is related to various diseases [13, 14]. Since monounsaturated fatty acid, oleic acid, was suggested to be useful [15], many vegetable oils rich in oleic acid, such as olive oil, rapeseed oil (Canola oil), high oleic acid safflower oil, etc. have been widely marketed. In the Fifth Edition of Food Composition Table in Japan [16], safflower oil is shown as a high oleic acid-refined oil with just a note indicating a high linoleic acid content. Studies on the physiological function of n-3 series PUFA [14, 17, 18] have also made progress in elucidating the oils' functions such as prevention of circulatory diseases, anti-inflammatory and anti-allergic actions and growth-inhibitory effect on cancer cells. As a result, perilla oil and perilla oil-blended oil which mainly contained the α -linolenic acid (one of n-3 series PUFA) have been widely on the market. Moreover, fats and oils enriched with diacylglycerol, middle chain triacylglycerol (MCT) and α -linolenic acid have received attention for their effects on decreasing triglyceride and cholesterol [19]. Given the current situation of production and distribution of various types of oils, proper choice of cooking oils is required.

The present investigation to inform about the uses of cooking fats and oils showed that the subjects of mass feeding facilities appeared to use as many as 12 kinds of oils, and the subjects of home cooking sites to use 15 kinds of fats and oils. Reasons for selecting cooking fats and oils in mass feeding facilities and home cooking sites were attained by a questionnaire, and multiple answers were collected and analyzed. The most frequent reason for selecting fats and oils was "low price" in both mass feeding facilities and home cooking sites. The mass feeding facilities frequently answered "in use from long time ago" and also answered, "the city office decided the fats and oils in use". The result suggests complacency in set habits and lack of decision-making powers by the users. In contrast, the home cooking sites answered that they change from the fats and oils in use to olive oil or sometimes to perilla oil (even though both olive and perilla oils are a little bit more expensive) based on the information from mass media of "good for health".

Both the mass feeding facilities and home cooking sites showed a lot of interest in the quality control of fats and oils. Some mass feeding facilities selectively used cooking fats and oils depended on the condition of their patients. Regarding nutrition control in hospitals, the

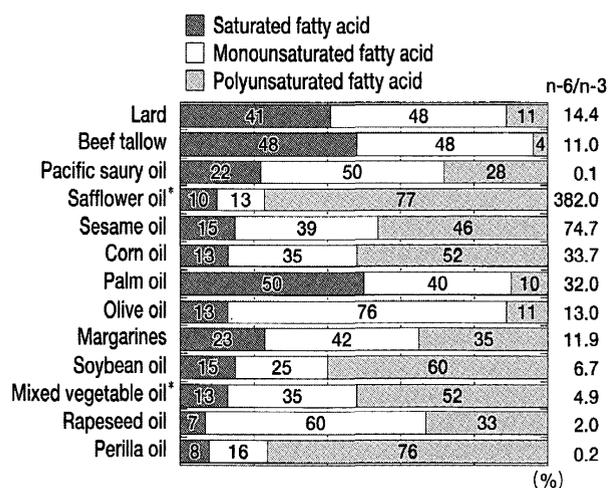


Fig. 8 Fatty acid composition and n-6/n-3 ratio of oil used.

*Safflower oil: High linoleic var., refined.

*Mixed vegetable oil: Rapeseed oil 3 parts and soybean oil 7 parts, refined.

choice of cooking fats and oils according to patient condition should be considered more seriously in the future.

Use of perilla oil as a cooking oil was suggested to be effective for dietetic treatment (diet therapy) of patients with allergic diseases, atopic dermatitis and bronchial asthma by the rectification of the n-6/n-3 ratio of intake fatty acids [20, 21]. However, there were few reports concerning the cooking characteristics and taste tendency of perilla oil. In this report, we found that it is not the difference of kinds of fats and oils but the influences of other seasonings that are reflected in taste tendency at least in the use of preparation without heating. We could confirm the taste compliance when the mixed oil was changed to perilla oil. On the other hand, there exists a problem that the perilla oil containing much n-3 PUFA is prone to oxidization. Therefore, precaution should be taken to avoid oxidization, especially when perilla oil is heated, even though perilla oil usually contains small amounts of α -tocopherol which act an antioxidant.

Our preliminary experiments show that perilla oil exhibits an unpleasant smell caused by the oxidized oil fumes, when deep-fried food was made using boiling perilla oil. This is a problem in the workers' environment in mass feeding facilities where large volumes of food are prepared over a long time. Therefore, we tried to shorten the cooking time using perilla oil only, and also tried to use olive oil and the olive-perilla mixed oil which are stable to oxidization. The commercially available olive-perilla oil for frying at high cooking temperatures was also examined.

In the case of stir-fried vegetables, however, the flavor, taste and eating preference changed depending on oils used. The special flavor of perilla oil was strengthened by cooking, although there were many answers that could not clearly differentiate between the perilla and other oils.

About 90% of the subjects supported the use of the olive-perilla mixed oil as it provided best flavor and taste when frying sweet potatoes. Therefore, in either case, it is possible to use perilla oil for cooking; however it is not a practical recommendation because perilla oil is 15 to 20 times more expensive than the general vegetable mix oil composed of rapeseed and soybean oils, in addition to the factor of heat instability.

One of the merits of using of fats and oils for cooking is that high temperature cooking becomes possible. For this reason, fried food and stir-fried food have been

increasing as a trend in the school lunch which requires production of large amounts of food within short time [22]. High temperature cooking using oil has appeared frequently even in canteen food in an industrial factory for the main or additional vegetable dishes [23].

It is recommended to choose the cooking oil for each dish with its way along with cooking materials, their usefulness in cooking that distill the taste from cooking materials, heat stability and antioxidant characteristics. From the perspective of taste, there was no one almighty cooking oil; and it is not recommended to impose one species of oil [24]. Furthermore, the staffs of the mass feeding facilities should choose their cooking oils from the stand point of management and business control of their facilities, and should consider nutritional control (diet control) for all the subjects concerned. Now, we would like to strictly focus on the future.

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