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DIFFERENCE IN THE ACCUMULATION AND OXIDATION OF LIPIDS IN RAT BODY AFTER TAKING VARIOUS KINDS OF LIPIDS

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Background and objectives

Since the intake of animal fats usually increases the incidence of hyperlipidemia and hypercholesteremia, animal fats have been considered to be a less-desirable lipids than vegetable oils to health of human beings and animals(Oliver, 1990). It has been recognized that the intake of n-6 fatty acids such as linoleic acid is metabolized to arachidonic acid, this fatty acid is further metabolized to hormone-like substances such as prostaglandins. These substances are involved in the increase of thrombosis responsible for the increase of the incidence of colonary heart disease, cerebral hemorrhage and also of cancer. On the other hand, n-3 fatty acids such as α-linolenic acid are metabolized to EPA and DHA. These metabolites play very important role in improving the circulation of the blood and immunizing acitivity. Therefore, it is now generally considered that n-3/n-6 fatty acid ratio is a good parameter to health. In addition, saturated and monounsaturated fatty acids are not metabolized to the hormone-like substances, so that these fatty acids may be safer than n-6 fatty acids, although n-6 fatty acids have an acitivity to reduce the concentration of serum lipids and cholesterol(Okuyama, 1990). Animal lipids are also useful constituents of plasma memmbrane responsible for increasing the stability of the membrane. We have shown that lipid accumulation in the liver of rats fed with a diet containing beef tallow rich in saturated fatty acids is less than that of rats fed with a diet containing soybean oil rich in linoleic acid and olive oil rich in oleic acid. It is generally considered that vegetable oils products containing less amount of antioxidants than natural oils are more sensitive to oxidation than animal fats. Therefore, our recent results indicate that beef tallow rich in saturated fatty acids is less hazardous to health of the liver than vegetable oils rich in polyunsaturated fatty acids(Tajima et al., 1995; Kawahara et al., 1997).

The objectives of the present study were (1) to investigate fatty acid composition of accumulated lipids in rat body after feeding the animals with diets containing various kinds of dietary lipids and (2) to investigate the development of lipid hydroperoxide(LPO) in the accumulated lipids in the liver and abdominal cavity of the animals in order to elucidate the safety of the animal fat to health.

Materials and Methods

Animals and diets. Thirty of SPF-Sprague-Dawley(SD) rats(male, 7 weeks old) were purchased from an animal breeder (Seac Ltd., Fukuoka, Japan). The rats were fed with a commercial diet(Charles River CRF-1) in separate stainless wire cages under the conditions of 20 ℃ in temperature, 60% in humidity and 12hr in lightening for one week to accustom to the conditions of Kyushu University Biotron. After weighing body weight of each rat, the rats were divided into five groups in which total weight of the rats in each group was adjusted to almost the same weight as possible as we could. The five groups of rats were fed with different kinds of diets as follows: (1) 6 rats of group 1 were fed with the commercial diet throuought the period of animal, (2) 6 rats of group 2 were with a diet containing beef tallow, (3) 6 rats of group 3 were with a diet containing olive oil, (4) 6 rats of group 4 were with a diet containing canola oil, and (5) 6 rats of group 5 were with a diet containing safflower oil. Feces were collected from each rat during 7 days of the last week of the animal experiment. After feeding the rats for 4 weeks, each rat was killed according to the guideline for Animal Experiment in the Faculty of Agriculture and the Graduate Course of Kyushu University and the Law[No.105] and Notification[No.1] of the goverment. Blood, liver and pre-lenal fat and hind leg muscles were collected. Serum was obtained from the blood by centrifugation. The other tissues were weighed and then freezed in liquid nitrogen and were stored at - 80 C until use. The composition of the four kinds of experimental diets were almost the same as written in a previous paper(Kawahara et al., 1997).

Fatty acid analysis. Lipid was extracted from serum(0.5 ml), liver(0.6g), pre-lenal fat(1.0g) and feces(1.0g) with chloroform-methanol mixture(2 : 1) according to the method of Folch(1957). After lipid extraction, the extracting solvent was eliminated by evapolation and dried lipids were weighed.

Gas chromatograph. Dried lipids (100ug) were hydrolyzed and methylated in HCl-methanol mixture, and then the resulting methylated fatty acids were analyzed with gas chromatograph GC-14A(Shimadzu) using capillary column[HR-SS-10(0.25mm x 30m), Ulborn]. Column temperature was programed as 150 - 220 C (4 ℃/min). Detection was made with a FID detector.

Lipid hydroperoxide(LPO) acitivity. LPO activity was assayed with a LPO assay kit (Funakoshi Ltd., Tokyo).

Results and Discussion

Growth and feed efficiency. Body weight of the rats fed with experimental diets containing various kinds of dietary lipids increased faster than that of the rats fed with the commercial diet. The difference in body weight between them after 4 weeks' feeding

was significant. This difference probably be due to the difference in calories between the commercial diet(80 kcal/day) and the experimental diets(ca. 120 kcal/day in average). However, no significant difference was observed in body weight of the rats among the four kinds of diets' groups. Feed efficiency of the diet containing olive oil was slightly higher than the other three diets, but the difference was not statistically significant.

Liver. There was no significant difference in liver weight, expressed as liver wt/100g of body wt, among the four kinds of diets. The amount of accumulated lipids in the liver(hepatic lipids) of the rats fed with the diet containing beef tallow, expressed as lipid wt/g tissue, was significantly less than that of the rats fed with olive oil, but it was much more than that of the rats with the commercial diet.

Pre-lenal fat. The accumulation of pre-lenal fat in the rats fed with the diet containing beef tallow was significantly less than that of the rats fed with the diet containing olive oil. When compared to other groups of rats fed with the diets containing canola and safflower oils, the accumulation of pre-lenal fat and hepatic lipids in the rats fed with the diet containing olive oil was appreciably higher than the other groups of rats.

Feces. Although there was no significant difference in the amounts of feces among the four diets' groups of rats, the amount of lipids in the feces of the rats fed with the diet containing beef tallow was significantly less than those of the other diets' groups. It has been reported that absorptivity of fat is dependent on chemical structure of its constituent triglycerides, eg. triglyceride species having palmitic acid at sn-1and oleic acid at sn-2 is less absorbable than the species with reverse order of the fatty acids (Aoyama et al., 1996). Therefore, the present result seems to contradict such concepts.

Gas chromatography. It was clearly shown that fatty acid composition of pre-lenal fat is quite similar to that of dietary fat. This indicates that fatty acid composition of pre-lenal fat is dependent on the composition of dietary fats. Fatty acid composition of lipids accumulated in skeletal muscle is also similar to that of dietary lipis. The similarity in the composition of hepatic lipids is less that of the accumulated lipids in skeletal muscle. However, the composition of serum lipids is almost completely different from that of dietary lipids. This must be due to selective partition of lipids by those tissues and also due to physiological function of the liver to keep the homeostasis of blood composition. It was also found that the proportion of saturated and mono-unsaturated fatty acid of the lipids in the liver of the rats fed with the diet containing beef tallow is higher than that of the rats fed with the diet containing lipids other than beef tallow. In comparing fatty acid composition of feces and that of the dietary lipids, it is evident that approximately 50% of palmitic acid of beef tallow was not absorbed into the rats' body. This indicates that the absorptivity of saturated fatty acid is lower than that of unsaturated \fatty acids. This result is consistent with that of Aoyama et al.(1996). It is also shown that the absorption of oleic acid and linoleic acid is higher than that of other kinds of fatty acids.

LPO. For all of the dietary fats examined, LPO of pre-lenal fat was lower than that of the lipids in other sources(liver and feces). This difference was statistically significant. The difference in LPO of hepatic lipids between the rats fed with beef tallow and the rats with the commercial diet was significant. In the case of feces, there was no significant difference in LPO activity between the rats with beef tallow and rats with olive oil. Therefore, the present results indicate that the accumulated lipids in rat body after intaking beef tallow have lower LPO acitivity. The lower LPO suggests that lipids accumulated in rat body have a lower potential to develop active oxygens hazardous to health. Therefore, to have an appropriate level of animal fat as in the case of an average amount of fat intake by Japanese people (12% of lipid/total diet intake, wt/wt)such as beef tallow isn't so hazardous to health as has been adviced by medical societies.

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