Utilization of Iron-Medium Chain Fatty Acid Complexes in Growing Rats

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Medium chain fatty acids (MCFAs) are composed of caproic (6:0), caprylic (8:0), capric (10:0) and lauric (12:0) acids¹⁾. The metabolism of MCFAs is largely different from long chain fatty acids (LCFAs). For instance, the path for the transport of MCFAs in the rat is different from that of LCFAs, because the former is transported via the portal vein and lymph and the latter entirely in the lymph²⁾. After transport to the liver, MCFAs are quickly oxidized and are not incorporated in the lipid ester moieties of lipoproteins⁸⁾. In the previous study, the efficacy of iron-medium chain fatty acid complexes on the prevention of anemia in pregnant rats was investigated⁷⁾, but no significant improvement was observed in iron contents of serum and tissues compared with iron-long chain fatty acid complexes and ferric citrate. Conversely, the lower absorption rate of iron-medium chain fatty acid complex was suggested by the serum ferritin concentration.

The present study was conducted to clarify whether or not the absorption and retention of

iron was altered by the form of medium chain fatty acid complex in growing rats.

Materials and Methods

Animals and diets: Five-week-old Wistar rats (ST strain) were purchased from Japan SLC Inc. (Hamamatsu). The animals were housed individually in wire-mesh cages in a controlled environment (24°C) with a 12-hr (0500-1700) light cycle. Rats were ranked by body weight and divided into four treatment groups of five rats each to equalize initial body weight among treatments.

Four experimental diets were designed to contain equivalent iron levels. The composition of an experimental diet was described previously⁷⁾. The reference group was fed a diet containing ferric citrate (0.210 g/kg diet). Other three groups (two iron-medium chain fatty acids and one iron-long chain fatty acid complexes) were given diets containing iron as iron-caprylic acid complex (C 8-Fe, 0.299 g/kg), iron-lauric acid complex (C 12-Fe, 0.446 g/k) or iron-palmitic acid complex (C 16-Fe,

成長中のラットにおける鉄-中鎖脂肪酸複合体の利用性: 古瀬充宏・梁 晟益・林 正治*・奥村純市 (名古屋大学農学部 名古屋市千種区 464-01, *花王和歌山研究所 和歌山市 640)

0.495 g/kg).

Experimental procedure: Rats were given respective diets *ad lib.* and allowed free access to iron-free distilled water for 10 days. The feces and urine were collected individually during the last 3 days of the experimental period. Feces were air-dried at 55°C and ground for analysis and urine was frozen at -20°C until analysis. At the final day of the experiment, rats were sacrificed by decapitation under diethyl ether anesthetization and blood sample was obtained. Serum iron concentration was determined by using a kit (Automate Fe (AZ), Sinotest, Tokyo). After killing animals, the liver and spleen were removed immediately and blotted and weighed. These samples were ashed with an electric muffle at 550°C. Feces and urine were ashed with nitric and sulfuric acids. Iron contents of the organs, feces and urine were determined by using an inductively coupled plasma emission spectrometry (ICAP-575, Nippon Jarrell-Ash, Tokyo).

Statistical procedure: Data were subjected to analysis of variance, and significance of difference between means was determined by the DUNCAN's multiple range test³⁾ using a commercially available statistical package⁹⁾.

Results and Discussion

Table 1 shows the effect of iron-medium chain fatty acids complexes on the iron metabolism in growing rats. The food intake was significantly lower in the C8 Fe group than in other groups, but iron contents in the liver and spleen and serum iron concentration were not different among treatments. So far, we have reported that the food intakes were decreased by dietary medium chain triglyceride (MCT) compared with dietary long chain triglyceride (LCT) in both growing rats⁴⁾ and chicks^{5,6)}. These effects were induced by large amounts of MCT (more than 18 percent in the diet). However, the reduction of food intake in MCT diet could not be explained by the difference in the palatability between LCT and

Table 1. Iron content in tissues and iron balance of growing rats fed diets containing iron-medium chain fatty acid complexes

	Control	C8-Fe	C12-Fe	C16-Fe	Pooled SEM
Food intake (g/10 days)	166 ^A	145 ^B	165 ^A	162 ^A	5.2
Body weight gain (g/10 days)	69.0	60.6	67.8	69.2	2.99
Liver weight (g)	11.4	9.6	10.7	11.4	0.57
Liver iron content (mg/liver)	0.497	0.507	0.532	0.402	0.0469
Spleen (g)	0.532	0.478	0.532	0.520	0.0280
Spleen iron content (mg/spleen)	0.0583	0.0577	0.0641	0.0568	0.0051
Serum iron (μg/100 ml)	293	246	254	291	19.7
Iron intake (mg/3 days)	2.10 ^A	1.50 ^C	1.93 ^{AB}	1.81 ^B	0.063
Fecal iron excretion (mg/3 days)	0.56	0.48	0.54	0.55	0.0516
Iron absorption (mg/3 days)	1.54 ^A	1.02 ^C	1.38 ^B	1.25 ^B	0.053
Iron absorption rate (%) [*]	73.4	67.8	72.4	69.5	2.43
Urinary iron excretion (mg/3 days)	0.009	0.015	0.007	0.009	0.0031
Iron balance (mg/3 days)	1.54 ^A	1.00 ^C	1.38 ^B	1.24 ^B	0.052
Iron retention rate (%) ^{**}	73.0	66.8	72.0	69.0	2.42

^{A-C} Means having different superscript letters are significantly different at $P < 0.05$.

^{*} Iron absorption $\times 100$ /iron intake.

^{**} Iron balance $\times 100$ /iron intake.

Abbreviations: C8-Fe, iron-caprylic acid complex; C12-Fe, iron-lauric acid complex; C16-Fe, iron-palmitic acid complex.

MCT in rats⁴⁾. Only a small amount of C 8-Fe induced the reduction in food intake in the present study. The palatability of medium chain fatty acids would be different between the triglyceride and iron salt forms. The reduction of food intake due to iron-medium chain fatty acid complex could be explained, partly but not entirely, by the palatability of iron-medium chain fatty acids. For example, caprylic acid has a slightly unpleasant smell and taste, and consequently food intake might be reduced. The different responses of food intake by iron sources influenced the iron intake in growing rats. The lower iron intake directly caused the lower absorption and balance of iron in the C 8-Fe group, because iron absorption rate and retention rate were not significantly different compared with the control diet. In general, the efficiency of iron absorption increases in iron deficiency¹⁰⁾. The reason for the discrepancy remained unclear. To equalize the food intake among dietary treatments is important to investigate the mineral metabolism. On the other hand, we think that to investigate the response and behavior of animals for the experimental diet under an *ab lib.* feeding is also important. In any event, it was concluded that the usage of iron-medium chain fatty acid complex was not advantage as an animal feed at the present time.

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