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COMPARATIVE STUDY ON APPARENT DIGESTIBILITY OF BEEF TALLOW AND VEGETABLE OILS IN RATS

Abbas Fotovati, T. Hayashi, K. Jono, T. Ito*

Laboratory of Biological and Functional Chemistry, Division of Bioresource and Bioenvironmental Sciences, Graduate School of Kyushu University (Former affiliation was the Lab. of Chem. and Tech. of Anim. Products, Fac. of Agricu., Kyushu Univ.)

6-10-1 Hakozaki, Higashi-ward, Fukuoka 812-8581, Japan

Keywords: Dietary lipids, lipid digestibility, Feed efficiency, Animal fats, Vegetable oils

Background:

Lipids are one of the major parts of human food. Dietary lipids used by human being have different origins that can be categorized into two main groups i.e., lipids with animal origin and lipids with plant origin. One of the important topics of lipid metabolism is the "fate of intaked lipid" in the body. Although it is clear that the ingested lipids undergo several digestive and absorptive processes which break down and change them to the chylomicrons, digestibility of different dietary lipids and patterns of distribution is still under the investigation. The difference of origin results in a very important difference in fatty acid composition of accumulated fats. As a general rule, the level of saturated fatty acids (SFA) in fats with animal origin is more than those with plant origin and in the case of unsaturated fatty acid ,including mono (MUFA)- and poly (PUFA)-unsaturated fatty acid the situation is reverse. Of course, there are some exceptions such as palm oil which has a plant origin but contains high level of SFAs or fish oil which contains high levels of UFAs. Studies have shown that these groups of FAs have different digestibility. Studies on fat digestibility have shown that it differs according to the type of intaked fats. For example, fat digestibility in the rats fed beef tallow is significantly lower than that of rats fed fish oil or peanut oil (De Schrijver R. et al, 1991).It is also believed that such difference is possibly because of the difference in FA content. For example some SFAs, such as stearic acid (18:0) showed poor digestibility. Poor digestibility of such fatty acids also affects dietary lipids as a whole. Previous studies of authors have also shown some patterns of distribution and metabolism of different dietary intaked fats rich in SFA, PUFA and MUFA in the rats body.

Objective:

In this study, patterns of digestion of different dietary lipids including beef tallow as a lipid with animal origin and canola oil, olive oil and safflower oil with vegetable origin and also a possible relationship of 18:0 FA content of these diets and their digestibility have been comparatively studied.

Materials and Methods:

Twenty 7-weeks old male SD rats (purchased from Seac Co. Ltd., Japan) were raised on commercial diet (purchased from the same company) for one week for adaptation. Then, they were divided into 4 groups fed different diets containing 12% of beef tallow, canola oil, olive oil or safflower oil and other ingredients were the same for all groups, including 20% beef powder, 1% AIN-76 vitamin mixture, 3.5% AIN-76 mineral mixture, 0.3% DL-methionine, 0.2% choline bitartrate, 5% cellulose, 27.9% corn starch, sucrose 30%, 0.1%cholesterol. In beef tallow diet, 0.03% alpha-tocopherol (wt/wt) was added to beef tallow itself before mixing with other ingredients, as an antioxidant. Fatty acid contents of diet are shown in Table.1. All rats were raised on these diets and under a controlled condition (12 hr. light/day, 20C temperature and 60% relative humidity) for 6 weeks in separated cages in animal rising facilities of Biotron Institute of Kyushu University. Weight gain and feed intake were measured every other day. Feces out-put was also measured weekly throughout the study. After six weeks, the rats after anesthetization by ether were killed (carried out under the control of guideline for Animal Experiment in Faculty of Agriculture and the Graduate Course, Kyushu University and the

Table.1. Fatty acid composition of diets .

Fatty acids	14:0	16:0	16:1	18:0	18:1	18:2	18:3	20:4	others
Beef Tallow	2.13	26.5	4.45	10.04	48.52	1.79	0.11	0.26	6.2
Canola Oil	0.0	9.51	1.21	4.42	52.53	17.86	8.59	1.14	4.74
Olive Oil	0.5	15.2	1.72	2.63	68.73	6.95	0.84	1.06	2.37
Safflower Oil	0.09	10.7	0.09	2.23	41.21	39.62	0.76	1.24	4.06

Law[No.105]and Notification[No.6]of the Government) and their abdominal fat mass and liver were weighted. Fat content of feces, collected throughout the study, was extracted by Folch's method and their fatty acid composition was analyzed by gas chromatography (GC-14B, GAS CHROMATOGRAPH, SHIMADZU Co. Ltd., Japan). Apparent lipid digestibility (%) was calculated as dietary lipid intake minus fecal lipid excretion and multiplied by 100, divided by dietary fat intake.

Results:

The results are shown in Table.2. Final weight was the lowest in beef tallow group and the highest in olive-fed groups. Daily weight gain was the lowest in beef tallow-fed group . However, the differences were not statistically significant. The differences among the

Table 2. Final body weight, feed intake, fecal output, and apparent lipid digestibility in rats raised on 4 different dietary lipids

Diet	Final body weight(*g*)	Daily weight gain *g/d*	Feed intake *g/d*	Fecal output *g/d*	lipid digestibility %	Feed efficiency
Beef Tallow	416.98±71.23	3.63±1.242	17.74±6.113	2.15±0.632	93.7	4.88
Canola oil	454.52±55.27	4.52±0.869	22.08±2.826	2.01±0.343	97.4	4.88
Olive oil	473.32±38.27	4.98±0.584	22.68±2.452	2.04±0.430	98.7	4.55
Safflower oil	452.67±41.25	4.16±1.204	20.49±4.437	1.87±0.446	97.3	4.92

other dietary groups was not statistically significant. Fecal out put was not significantly different among the 4 dietary groups. The proportion of stearic acid (18:0) in the feces was higher than that in all dietary groups. Apparent lipid digestibility of beef tallow was lower than all other dietary lipids. Olive oil diet showed the lowest and safflower oil diet the highest feed efficiency rate.

Discussion:

Some studies have shown that stearic acid (18:0) of naturally occurring dietary triacylglycerols have a poor absorption in the gastrointestinal tract of rats (Monsma et al, 1995). In our study, the main fatty acids detectable in the feces were palmitic acid (16:0) stearic acid (18:0) and oleic acid (18:1) and the proportions of the first two acids were higher than the latter. It has been shown that in spite of low level of 18:0 in vegetable oil, e.g. canola (4.42%), olive (2.63) and safflower oil (2.23%), its proportion in the feces is considerably higher (43.6%, 36.3% and 46.05% respectively).Palmitic acid and oleic acid were two other major FAs in the feces. It indicates that other fatty acids, specially PUFAs which formed major parts of these dietary lipids were completely absorbed. In beef tallow, although the fecal stearic acid proportion (24.1%) was not apparently as high as canola and safflower, its lower apparent digestibility of beef tallow (93.7%) is mostly due to the high content of 18:00 in it(10.04%).

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This study was partly supported by a grant from Ministry of Education and Welfare and Uehara Memorial Foundation