

# Fatty acid content and pattern of epididymal and parametrial adipose tissue lipids in streptozotocin (type 1) and Goto-Kakizaki (type 2) diabetic rats

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**Abstract.** Attention was recently drawn to differences in the fatty acid pattern of liver phospholipids and triglycerides in animal models of type 1 and type 2 diabetes. The present study extends this knowledge to epididymal or parametrial adipose tissue lipids. The fatty acid pattern of such lipids was established in four fed female normal rats, four overnight fasted female normal rats, six fed female rats rendered diabetic by an injection of streptozotocin 3 days before sacrifice (STZ rats), and four female and four male Goto-Kakizaki rats (GK rats) also examined in the fed or fasted state. In addition to the fasting-induced and diabetes-related changes in plasma D-glucose and insulin concentrations, differences in either the weight percentage of fatty acids or the paired ratio between distinct fatty acids were often encountered. For instance, in the GK rats, gender differences were observed in the weight percentage of C18:2 $\omega$ 6, as well as C18:2 $\omega$ 6/C18:3 $\omega$ 6, C18:3 $\omega$ 6/C20:4 $\omega$ 6, C20:5 $\omega$ 3/C22:5 $\omega$ 3 and C22:5 $\omega$ 3/C22:6 $\omega$ 3 ratios. When compared to normal rats, the activity of  $\Delta$ 9-desaturase was markedly increased in GK rats and, to a lesser extent, in STZ rats. Starvation also increased to some extent the activity of  $\Delta$ 9-desaturase. The relative content of C22:6 $\omega$ 3 was also higher in diabetic than in normal rats. Further differences between GK and STZ rats concerned the generation of C18:3 $\omega$ 6 from C18:2 $\omega$ 6, C20:4 $\omega$ 6 from C18:3 $\omega$ 6, and C20:5 $\omega$ 3 from C18:3 $\omega$ 3. Several differences found in the adipose tissue of GK versus STZ rats were reminiscent of those recently identified in the liver triglycerides of these two types of diabetic animals, suggesting a common regulatory mechanism, possibly linked to the higher insulinemia of GK rats versus STZ rats.

## Introduction

It has long been known that the fatty acid pattern of phospholipids and triglycerides may differ in distinct tissues and may be affected, e.g. in liver and adipocytes, by such factors as the nutritional or hormonal status (1). More recently, attention was drawn to differences in the fatty acid pattern of liver phospholipids and triglycerides in two animal models of diabetes mellitus, namely in adult rats rendered diabetic by the administration of the  $\beta$  cytotoxic agent streptozotocin (STZ rats; type 1 diabetes) and in adult Goto-Kakizaki rats (GK rats), a current model of inherited type 2 diabetes (2).

The major aim of the present study was to investigate whether the latter differences are also present in other organs. For such a purpose, the phospholipid and triglyceride content and fatty acid pattern were examined in plasma, liver, spleen and brain and compared to the fatty acid pattern of adipose tissue lipids. The experiments were conducted in fed or overnight fasted female normal and GK rats and fed female STZ rats. Moreover, the situation found in fed or fasted female GK rats was compared to that prevailing in fed or fasted male GK rats.

The present report deals mainly with the metabolic and hormonal status of the animals and the fatty acid content and pattern of epididymal or parametrial adipose tissue lipids.

## Materials and methods

Four fed and four overnight fasted female normal rats, six fed female rats injected 3 days before sacrifice with streptozotocin (STZ rats) and four female and four male Goto-Kakizaki rats (GK rats) were examined. The latter eight animals were also either given free access to food (AO3; SAFE, Villemoisson-sur-Orge, France) up to the time of sacrifice or fasted overnight.

The methods used to measure plasma D-glucose (3) and insulin (4) concentrations, and the fatty acid content and pattern of adipose tissue lipids (5) were previously described in the cited references.

All results are presented as mean values ( $\pm$  SEM; or individual deviation from mean values when derived from only two animals) together with the number of separate determinations (n) or degree of freedom (d.f.). The statistical

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**Key words:** lipid fatty acid pattern, adipose tissue, type 1 and type 2 diabetic rats

Table I. Fatty acid content and pattern in adipose tissue lipids.

Rats	Normal female		STZ female	GK female		GK male	
	Fed (4)	Fasted (4)	Fed (6)	Fed (2)	Fasted (2)	Fed (2)	Fasted (2)
Total fatty acid content ( $\mu\text{g}/\text{mg}$ )	1204 $\pm$ 30	1119 $\pm$ 55	1147 $\pm$ 20	1178 $\pm$ 16	1152 $\pm$ 18	1289 $\pm$ 92	1207 $\pm$ 13
Weight percentage (%)							
C12:0	0.1 $\pm$ 0.0	0.1 $\pm$ 0.0	0.1 $\pm$ 0.0	0.1 $\pm$ 0.0	0.2 $\pm$ 0.0	0.2 $\pm$ 0.1	0.1 $\pm$ 0.0
C14:0	0.9 $\pm$ 0.1	0.9 $\pm$ 0.1	1.0 $\pm$ 0.0	1.1 $\pm$ 0.0	1.2 $\pm$ 0.1	1.2 $\pm$ 0.1	0.8 $\pm$ 0.1
C16:0	22.5 $\pm$ 0.8	21.7 $\pm$ 1.4	22.7 $\pm$ 0.3	25.8 $\pm$ 0.6	25.1 $\pm$ 0.3	22.2 $\pm$ 0.5	18.8 $\pm$ 0.1
C16:1 $\omega$ 7	2.5 $\pm$ 0.5	2.3 $\pm$ 0.6	2.9 $\pm$ 0.1	4.0 $\pm$ 0.1	4.5 $\pm$ 0.3	3.5 $\pm$ 0.5	2.6 $\pm$ 1.0
C18:0	3.2 $\pm$ 0.2	3.4 $\pm$ 0.3	3.1 $\pm$ 0.1	2.9 $\pm$ 0.0	2.7 $\pm$ 0.0	2.7 $\pm$ 0.1	2.1 $\pm$ 0.0
C18:1 $\omega$ 9	21.8 $\pm$ 0.2	22.8 $\pm$ 0.3	22.8 $\pm$ 0.5	27.3 $\pm$ 0.2	28.5 $\pm$ 0.9	22.5 $\pm$ 0.8	25.0 $\pm$ 1.0
C18:2 $\omega$ 6	41.7 $\pm$ 1.4	42.4 $\pm$ 2.5	39.8 $\pm$ 0.7	32.6 $\pm$ 0.6	32.2 $\pm$ 0.7	39.7 $\pm$ 1.1	44.9 $\pm$ 1.6
C18:3 $\omega$ 6	0.2 $\pm$ 0.0	0.2 $\pm$ 0.0	0.2 $\pm$ 0.0	0.3 $\pm$ 0.1	0.2 $\pm$ 0.0	0.1 $\pm$ 0.0	0.1 $\pm$ 0.0
C18:3 $\omega$ 3	3.3 $\pm$ 0.1	2.9 $\pm$ 0.3	3.0 $\pm$ 0.1	2.1 $\pm$ 0.1	2.0 $\pm$ 0.2	2.7 $\pm$ 0.1	2.1 $\pm$ 0.2
C20:1 $\omega$ 9	0.2 $\pm$ 0.0	0.3 $\pm$ 0.0	0.2 $\pm$ 0.0	0.1 $\pm$ 0.0	0.2 $\pm$ 0.1	0.1 $\pm$ 0.0	0.2 $\pm$ 0.1
C20:2 $\omega$ 6	0.3 $\pm$ 0.0	0.3 $\pm$ 0.0	0.4 $\pm$ 0.0	0.3 $\pm$ 0.0	0.3 $\pm$ 0.0	0.5 $\pm$ 0.1	0.5 $\pm$ 0.1
C20:4 $\omega$ 6	1.5 $\pm$ 0.2	1.3 $\pm$ 0.2	1.7 $\pm$ 0.1	1.4 $\pm$ 0.1	1.2 $\pm$ 0.1	1.7 $\pm$ 0.5	1.0 $\pm$ 0.5
C20:5 $\omega$ 3	0.3 $\pm$ 0.1	0.3 $\pm$ 0.0	0.3 $\pm$ 0.0	0.3 $\pm$ 0.0	0.3 $\pm$ 0.0	0.4 $\pm$ 0.1	0.3 $\pm$ 0.1
C22:3 $\omega$ 3	0.3 $\pm$ 0.0	0.2 $\pm$ 0.0	0.4 $\pm$ 0.0	0.3 $\pm$ 0.0	0.3 $\pm$ 0.0	0.4 $\pm$ 0.1	0.3 $\pm$ 0.1
C22:5 $\omega$ 3	0.3 $\pm$ 0.1	0.3 $\pm$ 0.1	0.4 $\pm$ 0.0	0.3 $\pm$ 0.0	0.3 $\pm$ 0.0	0.6 $\pm$ 0.2	0.5 $\pm$ 0.2
C22:6 $\omega$ 3	0.7 $\pm$ 0.1	0.8 $\pm$ 0.1	1.1 $\pm$ 0.1	1.1 $\pm$ 0.1	1.0 $\pm$ 0.1	1.6 $\pm$ 0.7	0.9 $\pm$ 0.5

significance of differences between mean values was assessed by the Student's *t*-test or, when required, by covariance analysis.

## Results

**Body weight, plasma D-glucose and insulin concentrations.** At the time of sacrifice, the body weight of the normal and STZ-injected female rats examined in the present study averaged 212 $\pm$ 3 g (*n*=14) and was somewhat lower (*p*<0.005) than that of the female GK rats (234 $\pm$ 8 g; *n*=4). The female GK rats were obviously lighter (*p*<0.001) than the male GK rats (373 $\pm$ 16 g; *n*=4).

The plasma D-glucose concentration was lower (*p*<0.02) in the overnight fasted normal rats (5.25 $\pm$ 0.69 mM; *n*=4) than in the fed normal rats (7.98 $\pm$ 0.64 mM; *n*=4). All STZ rats displayed a plasma D-glucose concentration in excess of the upper limit for the normal range (mean value + *t*<sub>0.05</sub>·SD) of values otherwise found in normal rats (7.03 $\pm$ 0.40 mM; *n*=34). In the STZ rats, there were significant correlations (*p*<0.05 or less) between the plasma D-glucose concentration, severity of glycosuria and changes in body weight over the 3-day period following the injection of STZ. For example, the two STZ rats which gained weight (+6.5 $\pm$ 3.5 g) instead (*p*<0.05) of losing weight (-9.3 $\pm$ 3.2 g; *n*=4) over this period were aglycosuric (zero) instead (*p*<0.02) of being glycosuric (3.5 $\pm$ 0.6 plus; *n*=4), and displayed a plasma D-glucose (12.90 $\pm$ 1.10 mM) significantly lower (*p*<0.001) than that of the other four STZ rats (27.53 $\pm$ 0.73 mM). The latter value, but not the overall mean plasma D-glucose concentration

found in all STZ rats (22.65 $\pm$ 3.13 mM; *n*=6), was significantly higher (*p*<0.001) than that recorded in the fed GK rats (18.38 $\pm$ 0.52 mM; *n*=4).

Likewise, in the STZ rats, there was a significant inverse correlation (*r*=-0.829; *p*<0.05) between the plasma insulin concentration and severity of glycosuria, the two most severely glycosuric rats (4 to 5 plus) displaying a plasma insulin concentration (0.01 $\pm$ 0.00 ng/ml) much lower (*p*<0.001) than that found in the other four STZ rats (1.36 $\pm$ 0.14 ng/ml), which either were aglycosuric (two rats) or displayed a more modest glycosuria (2 to 3 plus).

In the GK rats, the plasma D-glucose concentration was not significantly different in male versus female animals. It was decreased (*p*<0.005) by overnight fasting, however, from 18.38 $\pm$ 0.52 mM to 14.35 $\pm$ 0.70 mM (*n*=4 in both cases). Likewise, in the GK rats, the plasma insulin concentration recorded in the fasted rats only represented 17.8 $\pm$ 9.0% (*n*=4; *p*<0.001) of the mean values found in fed GK rats of the same sex (100.0 $\pm$ 3.6%; *n*=4). In the fed male GK rats, the plasma insulin concentration (3.29 $\pm$ 0.28 ng/ml; *n*=2) was significantly higher (*p*<0.03 or less) than that found in either the fed female GK rats (1.54 $\pm$ 0.03 ng/ml) or the fed female STZ rats (0.91 $\pm$ 0.30 ng/ml; *n*=6). The plasma insulin concentration found in the female fed GK rats was higher (*p*<0.07) than that otherwise found in the female fed normal rats (0.93 $\pm$ 0.08 ng/ml; *n*=32).

The insulinogenic index, i.e. the paired ratio between plasma insulin and D-glucose concentration, was lower (*p*<0.005), however, in the female fed diabetic rats (59.6 $\pm$ 16.0  $\mu\text{g}/\text{mol}$ ; *n*=8), i.e. in the female fed GK rats

Rats	Normal female		STZ female	GK female		GK male	
	Fed (4)	Fasted (4)	Fed (6)	Fed (2)	Fasted (2)	Fed (2)	Fasted (2)
C16:0/C16:1 $\omega$ 7	9.76 $\pm$ 1.62	8.51 $\pm$ 1.06 <sup>a</sup>	8.02 $\pm$ 0.35	6.44 $\pm$ 0.03	5.52 $\pm$ 0.32	6.53 $\pm$ 1.01	5.30 <sup>a</sup>
C18:0/C18:1 $\omega$ 9	0.149 $\pm$ 0.009	0.147 $\pm$ 0.011	0.135 $\pm$ 0.005	0.106 $\pm$ 0.000	0.094 $\pm$ 0.004	0.116 $\pm$ 0.002	0.085 $\pm$ 0.004
(C16:0 + C16:1 $\omega$ 7)/ (C18:0 + C18:1 $\omega$ 9)	1.003 $\pm$ 0.048	0.920 $\pm$ 0.084	0.991 $\pm$ 0.020	0.987 $\pm$ 0.016	0.950 $\pm$ 0.028	1.023 $\pm$ 0.033	0.793 $\pm$ 0.060
C18:2 $\omega$ 6/C18:3 $\omega$ 6	183.8 $\pm$ 7.1	321.1 $\pm$ 85.6	275.2 $\pm$ 51.7	128.5 $\pm$ 7.0	148.2 $\pm$ 6.2	356.7 $\pm$ 40.7	562.0 $\pm$ 94.5
C18:3 $\omega$ 6/C20:4 $\omega$ 6 ( $\times 10^3$ )	163.7 $\pm$ 24.6	131.0 $\pm$ 26.9	102.9 $\pm$ 14.2	186.4 $\pm$ 1.7	186.7 $\pm$ 2.0	71.4 $\pm$ 6.9	98.2 $\pm$ 22.0
C18:2 $\omega$ 6/C20:4 $\omega$ 6	30.59 $\pm$ 5.93	36.31 $\pm$ 7.80	25.12 $\pm$ 1.58	23.96 $\pm$ 1.53	27.66 $\pm$ 0.86	26.16 $\pm$ 8.93	31.39 <sup>a</sup>
C18:3 $\omega$ 3/C20:5 $\omega$ 3	9.21 $\pm$ 1.14 <sup>a</sup>	9.14 $\pm$ 1.02	8.91 $\pm$ 0.44	6.28 $\pm$ 0.25	6.47 $\pm$ 0.01	6.98 $\pm$ 1.20	9.02 $\pm$ 0.78
C20:5 $\omega$ 3/C22:5 $\omega$ 3	0.97 $\pm$ 0.04 <sup>a</sup>	0.96 $\pm$ 0.06 <sup>a</sup>	0.93 $\pm$ 0.05	1.03 $\pm$ 0.08	1.00 $\pm$ 0.02	0.64 $\pm$ 0.09	0.65 $\pm$ 0.20
C22:5 $\omega$ 3/C22:6 $\omega$ 3	0.391 $\pm$ 0.045	0.364 $\pm$ 0.020	0.333 $\pm$ 0.013	0.294 $\pm$ 0.006	0.324 $\pm$ 0.008	0.420 $\pm$ 0.050	0.538 $\pm$ 0.082

<sup>a</sup>Excluding value(s) beyond the confidence interval.

(81.3 $\pm$ 1.9  $\mu$ g/mol; n=2) and female fed STZ rats (52.5 $\pm$ 20.9  $\mu$ g/mol; n=6), than in the female fed normal rats (144.8 $\pm$ 13.1  $\mu$ g/mol; n=32).

**Fatty acid content and pattern of adipose tissue lipids.** Relative to the wet weight of epididymal or parametrial adipose tissue, the total amount of lipid fatty acids was comparable in all cases (Table I).

In the fed female normal rats, the most abundant fatty acids were C18:2 $\omega$ 6 (41.7 $\pm$ 1.4%), C16:0 (22.5 $\pm$ 0.8%) and C18:1 $\omega$ 9 (21.8 $\pm$ 0.2%). As a rule, the relative contribution of these and other fatty acids was not vastly different in the other groups of animals (Table I). Nevertheless, significant differences in the weight percentage of selected fatty acids were on occasion observed between distinct types of rats, as illustrated by the two following sets of data. First, the relative contribution of C18:2 $\omega$ 6 was lower ( $p < 0.005$  or less) in the female GK rats (32.4 $\pm$ 0.4%; n=4) than in either the female normal rats (42.0 $\pm$ 1.3%; n=8) or the male GK rats (42.3 $\pm$ 1.7%; n=4). Second, the weight percentage of C22:6 $\omega$ 3 was higher ( $p < 0.005$ ) in the fed female STZ rats (1.13 $\pm$ 0.07%; n=6) than in the fed female normal rats (0.66 $\pm$ 0.07%; n=4), and also higher ( $p < 0.03$ ) in the female GK rats (1.01 $\pm$ 0.06%; n=4) than in the female normal rats (0.72 $\pm$ 0.07%; n=8).

In light of these findings, attention was paid to the paired ratios between selected fatty acids engaged in reactions catalyzed by desaturase and/or elongase (Table II).

The C16:0/C16:1 $\omega$ 7 was significantly lower ( $p < 0.05$ ) in the female GK rats (5.98 $\pm$ 0.30; n=4) than in the female normal rats (9.22 $\pm$ 0.99; n=7), with an in-between value in the female STZ rats (8.02 $\pm$ 0.35; n=6). Likewise, the C18:0/C18:1 $\omega$ 9 ratio was significantly lower ( $p < 0.001$ ) in the female GK rats (0.100 $\pm$ 0.004; n=4) than in the female normal rats (0.148 $\pm$ 0.007; n=8), with an in-between value in female STZ rats (0.135 $\pm$ 0.005; n=6). For these two ratios, there was no obvious gender difference in the GK rats, the values found in male rats averaging 99.7 $\pm$ 4.7% (n=7) of the corresponding

values found in female rats (100.0 $\pm$ 1.3%; n=8) examined in the same nutritional state (fed or fasted). Both the C16:0/C16:1 $\omega$ 7 and C18:0/C18:1 $\omega$ 9 ratios were somewhat lower, however, in the overnight fasted rats than in the fed animals. Such a difference failed to achieve statistical significance in the normal rats (d.f.=13;  $p > 0.5$ ), whilst being highly significant ( $p < 0.001$ ) in the GK rats in which the mean value found in the fasted animals averaged 82.0 $\pm$ 2.8% (n=7) of the corresponding values found in the fed animals of the same sex (100.0 $\pm$ 2.9%; n=8). It should be acknowledged, however, that the former percentage was not significantly different (d.f.=12;  $p > 0.1$ ) from that found in normal rats.

The (C16:0 + C16:1 $\omega$ 7)/(C18:0 + C18:1 $\omega$ 9) ratio failed to differ significantly in the female normal rats (0.962 $\pm$ 0.048; n=8), the female STZ rats (0.991 $\pm$ 0.020; n=6) and the female GK rats (0.968 $\pm$ 0.017; n=4). It was not significantly different (d.f.=6;  $p > 0.4$ ) in the male and female GK rats. It also failed to differ significantly in the fed versus the overnight fasted animals; the trend being towards a lower value in the fasted than in the fed rats. The elongase relevant ratio averaged, in the fasted rats, 89.3 $\pm$ 4.9% (n=8;  $p < 0.07$ ) of that found in the fed animals of the same strain and sex (100.0 $\pm$ 2.3%; n=8).

The C18:2 $\omega$ 6/C18:3 $\omega$ 6 ratio was somewhat higher ( $p < 0.05$ ) in the overnight fasted animals than in the fed rats, averaging in the former animals 155.6 $\pm$ 24.0% (n=8) of the mean corresponding values found in the fed rats of the same strain and sex (100.0 $\pm$ 3.0%; n=8). In the GK rats, it was about thrice higher (328.5 $\pm$ 41.4%; d.f.=6;  $p < 0.005$ ) in male than female animals. In female animals and relative to the value found in normal rats of the same sex examined in the same nutritional state (fed or starved), it was lower (d.f.=8;  $p < 0.09$ ) in the GK rats (58.0 $\pm$ 7.1%; n=4) than in the STZ rats (149.7 $\pm$ 28.1%; n=6).

A mirror image was found for the C18:3 $\omega$ 6/C20:4 $\omega$ 6 ratio. On the one hand the ratio was 2-3 times lower ( $p < 0.001$ ) in the male GK rats (0.085 $\pm$ 0.016; n=4) than in the female GK rats (0.187 $\pm$ 0.001; n=4). On the other hand,

relative to the value found in normal rats of the same sex examined in the same nutritional state, the C18:3 $\omega$ 6/C20:4 $\omega$ 6 ratio was higher (d.f.=8;  $p<0.001$ ) in the female GK rats ( $128.2\pm 8.3\%$ ;  $n=4$ ) than in the STZ rats ( $62.8\pm 8.7\%$ ;  $n=6$ ).

As expected from these findings, the C18:2 $\omega$ 6/C20:4 $\omega$ 6 ratio was not significantly different in any of the rat types under consideration, with overall mean values of  $29.9\pm 2.9$  ( $n=14$ ) in the female normal and the STZ rats and  $26.7\pm 2.2$  ( $n=7$ ) in the male and female GK rats.

The C18:3 $\omega$ 3/C20:5 $\omega$ 3 ratio averaged  $9.17\pm 0.70$  ( $n=7$ ) and  $8.91\pm 0.44$  ( $n=6$ ) in the female normal and the STZ rats; these values not being significantly different from one another. It was lower ( $p<0.02$ ) in the female GK rats ( $6.38\pm 0.12$ ;  $n=4$ ). Whether in the normal or GK rats, this ratio failed to be affected by fasting. In the GK rats, it was not significantly different in male and female animals.

The C20:5 $\omega$ 3/C22:5 $\omega$ 3 ratio also failed to be significantly affected by fasting, whether in normal or GK rats. It averaged  $0.961\pm 0.034$  ( $n=5$ ) in the female normal rats,  $0.929\pm 0.046$  ( $n=6$ ) in the female STZ rats and  $1.013\pm 0.037$  ( $n=4$ ) in the female GK rats; none of these mean values being significantly different from one another. The C20:5 $\omega$ 3/C22:5 $\omega$ 3 ratio was significantly lower ( $p<0.01$ ), however, in the male GK rats ( $0.646\pm 0.090$ ;  $n=4$ ) than in the female GK rats ( $1.013\pm 0.037$ ;  $n=4$ ).

The C22:5 $\omega$ 6/C22:6 $\omega$ 3 ratio was not significantly different in the female normal rats ( $0.377\pm 0.023$ ;  $n=8$ ), the female STZ rats ( $0.333\pm 0.013$ ;  $n=6$ ) and the female GK rats ( $0.309\pm 0.010$ ;  $n=4$ ). It failed to be significantly affected by fasting, whether in normal or GK rats. This ratio was significantly higher ( $p<0.02$ ), however, in the male GK rats ( $0.479\pm 0.052$ ;  $n=4$ ) than in the female GK rats ( $0.309\pm 0.010$ ;  $n=4$ ).

## Discussion

The results of the present study draw attention to the four following major findings. First, the results strongly suggest an increased activity of  $\Delta 9$ -desaturase in GK rats and, to a lesser extent, in STZ rats as compared to normal rats. Fasting also apparently increased to some extent the activity of  $\Delta 9$ -desaturase.

Second, the stepwise conversion of C18:2 $\omega$ 6 to C20:4 $\omega$ 6 reveals mirror images in terms of both the comparison between either GK or STZ rats versus normal animals and that between the enzyme(s) involved in the generation of C18:3 $\omega$ 6 from C28:2 $\omega$ 6 and C20:4 $\omega$ 6 from C18:3 $\omega$ 6. The C18:2 $\omega$ 6/C20:4 $\omega$ 6 ratio was comparable, however, in all types of rats.

Third, the results unexpectedly document the facilitated conversion of C18:3 $\omega$ 3 to C20:5 $\omega$ 3 in female GK rats as compared to either normal or STZ rats, this coinciding with a higher relative content of C22:6 $\omega$ 3 in diabetic animals.

Lastly, it documents, in the GK rats, dramatic gender differences in the composition of adipose tissue lipids. In this respect, the most salient findings were the lower relative content of C18:2 $\omega$ 6 in female GK rats, the contrasting differences in the C18:2 $\omega$ 6/C18:3 $\omega$ 6 and C18:3 $\omega$ 6/C20:4 $\omega$ 6 ratios, and the opposite gender difference in the C20:5 $\omega$ 3/C22:5 $\omega$ 3 and C22:5 $\omega$ 3/C22:6 $\omega$ 3 ratios.

Within the limits of information so far available, several of the present findings are reminiscent of those recently observed in liver triglycerides of male STZ and GK rats (2). For instance, in terms of the relative contribution of individual fatty acids, the weight percentage of C16:1 $\omega$ 7 was higher and that of C18:2 $\omega$ 6 and C18:3 $\omega$ 3 lower in both the liver triglycerides of GK versus STZ fed male rats and the adipose tissue lipids of GK versus STZ fed female rats. Likewise, as judged from the C16:0/C16:1 $\omega$ 7 and C18:0/C18:1 $\omega$ 9 ratios, in both liver triglyceride and adipose tissue lipids, the activity of  $\Delta 9$ -desaturase appeared higher in GK rats than in STZ rats. Finally, the activity of elongase, as judged from the (C16:0 + C16:1 $\omega$ 7)/(C18:0 + C18:1 $\omega$ 9) ratio in either liver triglycerides or adipose tissue lipids was comparable in GK and STZ rats.

Further work is now in progress to extend this study to include both other organs such as the spleen and brain and circulatory unesterified fatty acids, triglycerides and phospholipids.

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