THE INABILITY OF THE LION, *PANTHERA LEO*, L. TO DESATURATE LINOLEIC ACID

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1. Introduction

Most studies of the metabolism of polyunsaturated fatty acids have been conducted on laboratory rodents. These animals have relatively high Δ6 desaturase activity and are therefore able to convert linoleic acid (18:2ω6) to the prostaglandin precursors dihomo-gamma-linolenic acid (20:3ω6) and arachidonic acid (20:4ω6). It has been assumed without much evidence that other species can desaturate polyunsaturated fatty acids equally well.

However, recent work on the domestic cat, *Felis catus* L. [1] and the turbot, *Scopthalamus maximus*, L. [2] has shown that these obligate carnivores are unable to desaturate linoleic acid (18:2ω6) or linolenic acid (18:3ω3). It has been suggested that these species, have, therefore, a dietary requirement for the long-chain polyenoic acids (LCP), particularly 20:3ω6 and 20:4ω6, and hence for polyunsaturated lipid of animal origin.

Because of the wider implications of the lack of desaturase activity we have begun a comparative study of fatty acid desaturation in animals of different dietary habits. We wish here to make a preliminary report of studies on the African lion, *Panthera leo*, which demonstrate the absence of Δ6 and Δ8 desaturase activity in this animal.

2. Materials, methods and results

In December 1975 it became necessary to put down an adult African lioness that had been in the collection of the Zoological Society of London for 15 years. The animal had a history of incompatibility with other lions and it had become impossible to maintain her in the collection. The animal weighed 155 kg and was apparently in good health.

Lions in captivity are normally fasted for one day each week. After one such 24 h fast, the lioness was given a piece of ox heart into which had been injected 2 ml of olive oil containing 400 μCi of [1-^{14}C]linoleic acid (98% pure, specific activity 61 mCi/mmole, The Radiochemical Centre, Amersham).

The meat was rapidly and completely consumed; no attempt was made to measure isotope waste. The animal was then returned to its normal diet, ad libitum, and 30 hours later was immobilised by anaesthetic dart and killed by intravenous Euthatal (May and Baker Ltd.).

Post mortem examination showed that a small area of the liver was cystic, possibly due to haemangioma. The animal was otherwise normal. The liver was rapidly removed, washed in ice-cold physiological saline, homogenised and extracted in chloroform–methanol (2:1 v/v) containing approx. 10 mg/litre 2:6 di-tert-butyl-*p*-cresol as antoxidant. Lipid extracts were washed and lipid analyses carried out by procedures described elsewhere [3].

Methyl esters of fatty acids were separated by preparative GLC using a 10% EGSS-X column and operating conditions described in [3]. Approximately 10 mg of methyl esters (10^3 dpm) were put on the column.

The results (table 1) show that almost all the activity in fatty acids of liver total phosphoglycerides was as 18:2ω6, a result which contrasts markedly with the laboratory rat, but is very similar to that obtained in the domestic cat [4]. Analysis of fatty acids from other liver lipid fractions yielded parallel results.

Table 1
Distribution of radioactivity in fatty acids of liver phosphoglycerides of the lion and the rat, following administration of [1-^{14}C]linoleic acid

Fatty acid fraction	% Recovered Activity	
	Lion	Rat[a]
16:0 + 16:1	0.1 ± 0.07	0.9
18:0 + 18:1	0.2 ± 0.19	0.7
18:2ω6	97.5 ± 0.53	68.7
18:3ω3 + 18:3ω6	1.0 ± 0.20	11.8
20:2ω6	0.3 ± 0.07	14.0
20:3ω6 + 20:4ω6	0.1 ± 0.03	
20:5ω3	0.4 ± 0.12	2.2
22:4ω6 + 22:5ω6	0.1 ± 0.07	0.4
22:5ω3 + 22:6ω6	0.2 ± 0.19	0.4

[a]Rat results from adult female albino rat; dose administered by intubation.

The small amount of activity (1%) present in the 18:3ω6 fraction from the lion liver was less than 10 dpm above background, well within the limits of carry-over usually found in the system. Remaining desaturation products contained negligible activity (0.2% of the recovered activity) which did not represent a significant increase over background activity. In contrast, in rat experiments 14.4% of the recovered activity is found in this fraction. In cats the small amount of activity recovered in the slowly eluted GLC fraction was shown by Argentation TLC to be in the long-chain saturated and monoene fatty acids that are not separated by the GLC system used [4], indicating that activity was due to the breakdown of label to acetyl-CoA and the incorporation of this in the endogenous synthesis of fatty acids.

The specific activity of the lipids from the lion liver lipids was too low for such analyses. However, the importance of derived [1-^{14}C]acetyl-CoA as a source of activity in this experiment can be gauged by comparing the ratio of activity in the ω3 LCP fraction (where it must be due to incorporation of acetyl-CoA, since ω6 fatty acids cannot be desaturated to form ω3 fatty acids) to that in the ω6 LCP fraction (where it can be due to desaturation or the incorporation of acetyl-CoA). In the rat which does desaturate linoleic acid this ratio is about 1:5.5; in the cat, which does not desaturate, a ratio of 1:1 was obtained. The ratio in the lion was also 1:1 suggesting strongly that chain elongation was the source of activity in both fractions.

Therefore, it can be concluded that the lion lacks the Δ6 and Δ8 desaturases necessary for the desaturation of linoleic acid and is unable, therefore, to convert a dietary source of 18:2ω6 into its physiologically essential metabolites 20:3ω6 and 20:4ω6. It will therefore require a dietary source of preformed 20:3ω6 and perhaps 20:4ω6, as prostaglandin precursors; in practice the animal will exhibit a specific requirement for polyunsaturated lipid of animal origin.

The present results, coupled with those obtained on the domestic cat, suggest that a similar requirement might be expected in other Felidae and perhaps in other carnivores [1].

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