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Influence of Sex, Spawning, Starvation and Water Temperature on Fatty Acid Composition in *Tilapia mossambica*

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The influence of sex, spawning, starvation and water temperature on the fatty acid composition of *Tilapia mossambia* has been studied. Tilapia egg lipid was found to have unusually high percentage of $C_{22:6}$ fatty acids (9.09%) compared to body and intestinal lipids. The $C_{16:1}$ acid was much less in the egg lipids (3.5%) whereas it was 11% in the body lipids. There was no significant difference in the fatty acid composition of body and intestinal lipids of male and female tilapia... Starvation caused the presence of high content of lower fatty acids (C_6, C_8, C_{10}, C_{12} and C_{13}) in the body lipids. Water temperature also influenced the fatty acid composition of *Tilapia*; the difference was more significant in body lipids than in intestinal lipids.

The influence of dietary fatty acids on the fatty acid composition of body and intestinal lipids of fish has been reported by Kaneko *et al.* (1967 a), Kelly *et al.* (1958), Braekkan *et al.* (1971) and Nair & Gopakumar (1981). The effects of seasonal changes, sex, water temperature and starvation on the fatty acid composition of fish were also reported by a number of workers (Rieser *et al.* 1963; Kaneko *et al.* 1967 b; Ackman & Eaton 1971, and Inui & Ohshima 1966). The influence of sex, spawning, starvation and water temperature on the fatty acid composition of body and intestinal lipids of *Tilapia mossambica* is reported in this paper.

Materials and Methods

Fully grown male and female fishes were allowed to breed in the laboratory. The juveniles were subsequently separated and kept in separate tanks. They were provided with a formulated diet, the fatty acid composition of which was reported by Nair & Gopakumar (1981).

To study the role of sex and effect of spawning in the fatty acid composition, lipid was extracted separately from the body and intestine of six months old ones following the method of Bligh & Dyer (1959). Lipids were extracted from females before and after spawning and from egg also. The fatty acid composition is presented in Table 1.

To determine the effect of starvation, forty fishes were kept in another tank and allowed to starve for 30 days under aeration. After 30 days the fishes became very sluggish. They were killed and lipid extracted from the body and intestine separately. The proximate composition before and after starvation (Table 2) was determined by the method of AOAC (1975). The fatty acid composition is given in Figs. 1 and 2.

For understanding the effect of temperature on fatty acid composition, fishes grown in the tank at 27±1°C was taken as the ambient temperature. Twenty fishes were kept in a tank at 17±1°C and another 20 at 37±1°C. Temperature was maintained by an electronic immersion thermostat and heater. The water was constantly aerated and fishes were fed with the same diet. After one month, lipid was extracted from the body and intestine of fishes kept at three different temperatures. Fatty acid composition is given in Figs. 3 and 4.

From the lipid samples, fatty acid methyl esters were prepared using BF_3 methanol reagent as per AOAC (1975) and stored in ampoules, sealed under nitrogen and kept in deep freezer.

Table 1. *Effect of sex and spawning on fatty acid composition of Tilapia*

	Female (Before spawning)			Female (After spawning)		Male	
	Body	Intestine	Egg	Body	Intestine	Body	Intestine
C_{12}	1.50	1.70	0.46	0.7	0.6	1.99	3.86
C_{13}	—	—	—	0.14	0.20	—	—
C_{14}	5.23	5.79	4.00	4.09	6.00	5.01	7.47
C_{15}	2.14	1.37	1.63	1.65	2.00	1.63	1.00
$C_{16:0}$	25.07	24.24	25.38	24.52	27.00	20.25	19.29
$C_{16:1}$	10.86	11.11	3.52	14.66	13.80	12.65	12.29
$C_{18:0}$	7.85	8.62	10.47	8.24	9.70	8.5	6.97
$C_{18:1}$	28.41	25.41	24.34	24.05	17.70	25.86	29.12
$C_{18:2}$	6.61	6.91	8.20	6.52	7.75	8.40	8.36
$C_{18:3}$	2.80	4.1	3.78	3.3	3.89	3.79	3.24
$C_{18:4}$	0.47	1.38	1.02	1.29	1.21	1.76	1.23
$C_{20:1}$	—	0.8	—	0.33	0.36	—	—
$C_{20:2}$	0.19	0.59	—	0.35	0.43	0.52	0.78
$C_{20:3}$	0.31	0.53	1.06	0.53	0.43	1.10	0.6
$C_{20:4}$	1.79	1.92	3.3	2.00	2.01	2.00	1.34
$C_{20:5}$	0.37	0.59	0.53	0.84	0.66	0.66	0.45
$C_{22:2}$	—	—	0.32	0.33	0.25	0.25	—
$C_{22:3}$	0.78	0.59	0.73	0.35	0.40	0.50	0.3
$C_{22:4}$	0.52	0.46	0.95	0.33	0.36	0.49	0.2
$C_{22:5}$	1.12	1.34	1.66	1.50	1.75	1.21	0.97
$C_{22:6}$	2.87	3.34	9.09	3.91	3.50	3.45	2.13

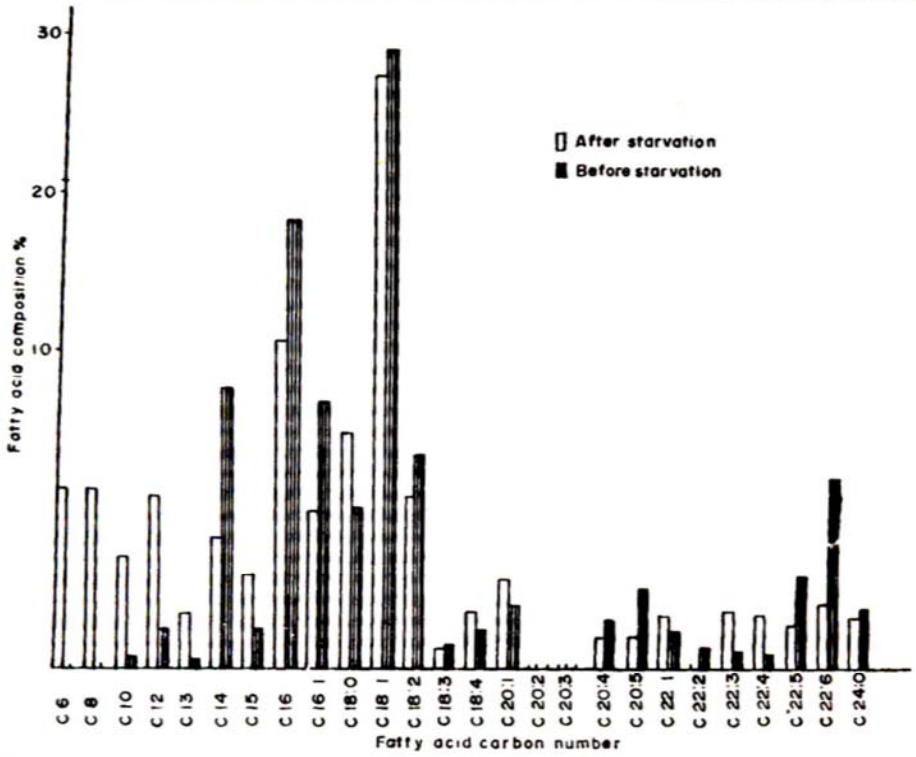

Fig. 1. Effect of starvation on the fatty acid composition of body fat of *Tilapia mossambica*

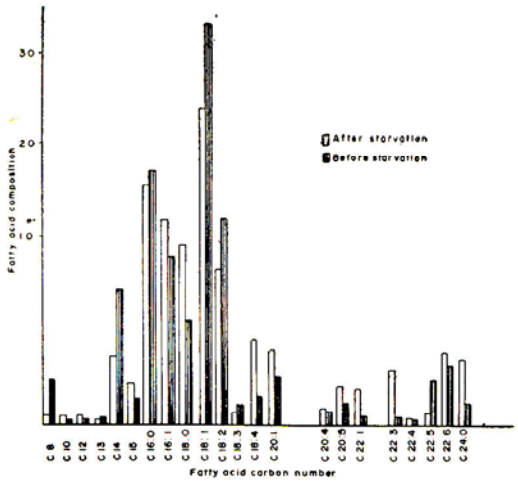

Fig. 2. Effect of starvation on the fatty acid composition of intestines with contents of *Tilapia mossambica*

Table 2. *Proximate composition of Tilapia muscle before and after starvation*

	Before starvation	After starvation
	%	%
Moisture	69	74.5
Ash	2.7	2.75
Protein	13.3	13.4
Fat	11.5	2.3

The fatty acid methyl esters were analysed in a gas chromatograph equipment (Toshniwal India Ltd.) using flame ionisation detector and strip chart recorder (10 mv, Varian Techtron; chart speed 30 cm/h). The column was made of stainless steel (182.88 cm x 6.35 mm o.d.) packed with silar 10C, 10% on Anakrom ABS (110–120 mesh). Operating conditions were as follows. Column temperature 196°C, injection port temperature 250°C, detecter 275°C, carrier

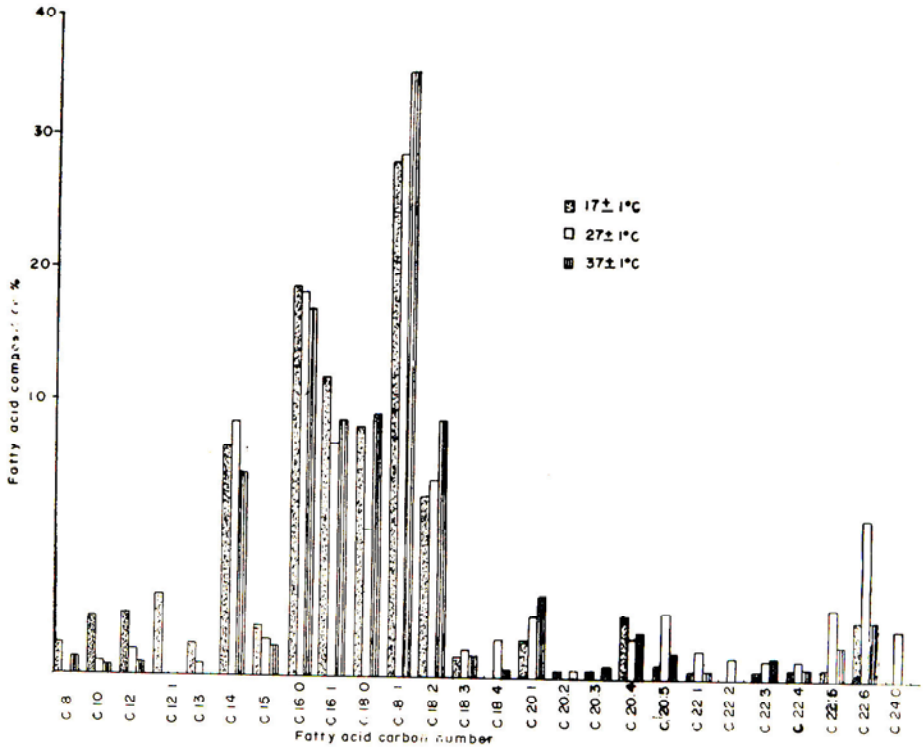

Fig. 3. Effect of temperature on fatty acid composition of body fat of *Tilapia mossambica*

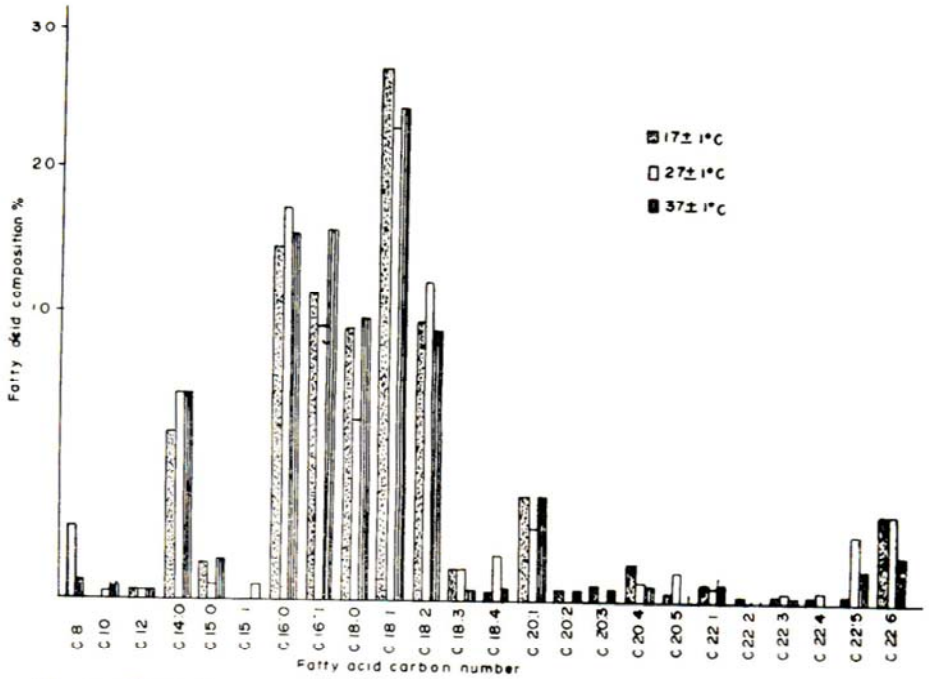

Fig. 4. Effect of temperature on the fatty acid composition of intestines with contents of *Tilapia mossambica*

gas nitrogen 40 ml/m. Identification and quantification were done as reported earlier (Ramachandran & Gopakumar, 1977).

Results and Discussion

Effect of spawning on the fatty acid composition of *Tilapia* was in agreement with the observation reported by Ackman *et al.* (1963). *Tilapia* egg lipids were found to have unusually high content of $C_{22:6}$ acid (9.10%), whereas the body and intestines before and after spawning contained only about 3.5%. $C_{20:4}$ acid was also slightly higher in the case of *Tilapia* egg lipids. $C_{16:1}$ acid was very low (3.5%) compared to body lipids (11%). There is no significant variation in fatty acid composition either in body or intestines for both male and female similar to the observation of Ackman & Eaton (1971).

Effect of starvation

After one month's starvation, the body lipid was reduced to 2.3% from 11.5% and the intestinal lipids to 4.4% from 30.7%. Starvation caused significant loss in weight also. Average weight of a fish decreased from 23.5 to 17 g. After starvation the body lipids were found to have unusually high content of C_6 (5.6%), C_8 (5.5%), C_{10} (3.5%), C_{12} (5.5%). C_{13} (1.5%) C_6 and C_8 were absent in the case of *Tilapia* body fat before starvation. C_{10}, C_{12} and C_{13} were 0.4%, 1.2% and 0.3% respectively in the cases of body fat before starvation. After starvation concentration of C_{14}, $C_{16:0}$, $C_{18:2}$, $C_{20:4}$, $C_{20:5}$, $C_{22:5}$ and $C_{22:6}$ acids were considerably decreased. Since fat is the obvious source of energy for the fish under the period of starvation these acids would have undergone direct catabolism.

In the case of intestinal lipids, even though the total lipid content was subsequently decreased after starvation, no significant variation was observed in the fatty acids composition. After starvation fatty acid of following chain length $C_{14:0}$, $C_{16:0}$, $C_{18:1}$, $C_{18:2}$ and $C_{18:3}$ acids were found to be reduced in the intestinal lipids. But after starvation $C_{16:1}$, $C_{18:4}$, $C_{20:1}$, $C_{20:4}$, $C_{20:5}$, $C_{22:1}$, $C_{22:3}$, $C_{22:6}$, $C_{24:0}$,

are more in the intestinal lipids compared to body lipids.

Effect of temperature

The fatty acid composition of *Tilapia* grown at different temperatures showed significant variations especially in body fat. Fatty acid C_8, C_{10} and C_{12} were found to be slightly high in body fat of fish grown at 17±1°C, whereas fish at 27±1°C and 37±1°C showed very little of these acids. At 17±1°C, the body was found to contain $C_{12:1}$, 2.7%, whereas this was absent in the fish at 27±1°C and 37±1°C. At temperature 17±1°C body fat contained 1.2% $C_{13:0}$ at 27±1°C it was only 0.3% and absent at 37±1°C. At 37±1°C, $C_{18:1}$ was 34.5%, at 27±1°C, 27.9% and at 27±1°C it was 28.5%. The levels of $C_{22:6}$ acid was 6% at 27±1°C and 2.2% at 17±1°C and 37±1°C. $C_{20:4}$ was more than $C_{20:5}$ at 17±1°C, and 37±1°C but it was in the reverse order at 27±1°C.

The effect of temperature on quantitative variation was not so significant in the case of other fatty acids.

Intestinal lipids also showed alteration in fatty acid composition with variation in temperature. At temperature 27±1°C, $C_{16:0}$ was 17.1%, but it was only 14.5% and 15.0% at 17±1°C and 37±1°C respectively. But this trend was reversed for $C_{16:1}$ acid. At 27±1°C it recorded the lowest level (8.9%). Similar trend was observed in the case of $C_{18:0}$ (at 27±1°C, 5.3%, 17±1°C, 8.78% and at 37±1°C 9.4%). Marginal variations were also seen for $C_{18:3}$ and $C_{18:4}$ with alteration in adaptation temperature.

On the whole it can be seen that spawning, starvation and variation in adaptation temperature have got significant influence on the fatty acid composition in *Tilapia*.

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