



## *Project Summary*

# **Influence of Diet and Starvation on Toxicity of Endrin to Fathead Minnows (*Pimephales promelas*)**

Goran Dave

Endrin toxicity to fathead minnows, *Pimephales promelas*, was determined in flow-through toxicity tests at 25°C for periods of up to 30 days.

Three months prior to endrin exposure six groups of fish were fed artificial diets containing an increasing percentage of fat, and two groups were fed either a high or low ration of frozen brine shrimp. Fish fed frozen brine shrimp showed better growth, survival and fewer deformities (hemorrhagic kidney lesions and lordosis) than fish fed artificial diets. Based on 96-hr LC<sub>50</sub> values, fish fed diets low in dietary fat were 2.4 times more susceptible to endrin than fish fed frozen brine shrimp. On the same basis (96-hr LC<sub>50</sub>) fish fed a low ration level of brine shrimp were 2.0 times more susceptible to endrin than fish fed an unrestricted ration level of brine shrimp.

In another series of experiments, adult fathead minnows starved for 80 days were 2.0 times more susceptible to endrin than recently fed fish. Fathead minnows captured in a small pond on April 30 were also about 2.0 times more susceptible than recently fed fish. There was no detectible relationship between body weight and susceptibility of fathead minnows to acute endrin toxicity.

The reduced tolerances to endrin caused by a low percentage of dietary

fat, reduced ration level and starvation were correlated to an increased total body water content. The underlying reason is assumed to be a concomitantly decreased total body lipid content.

*This Project Summary was developed by EPA's Environmental Research Laboratory, Duluth, MN, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).*

### **Introduction**

The purpose of this study was to examine the influence of dietary composition and ration level (including starvation) on the toxicity of a fat soluble chemical, endrin, to the fathead minnow (*Pimephales promelas*). Special emphasis was focused on lipid metabolism by depleting depots in the minnows prior to testing the endrin toxicity by subjecting the fathead minnows to starvation for up to three months.

For the diet influence study, one group of minnows was fed a commercially available reference research diet, five groups were fed this same diet compounded with varying amounts of lipids (corn oil, salmon oil, or a mixture of the two oils), and two groups were fed frozen brine shrimp, one of these at restricted ration. The dietary pretreat-

ment continued for 78 to 100 days prior to toxicity testing. In order to insure that previous history was eliminated as a variable, three sources of fathead minnows were used in making up the groups—laboratory stock, wild minnows which were kept in the laboratory for several months and fed laboratory diet, and wild minnows which were captured in the spring and used immediately.

Eight other groups of fathead minnows were established, from the same three sources, and were starved up to 95 days in order to deplete lipid depots before exposing them to endrin.

All 16 groups of minnows were exposed to endrin under controlled conditions, at 5 different concentrations for up to 29 days. Mortality rate, growth rate, rate of development of deformities (hemorrhagic kidney lesions and/or lordosis) and total body moisture content (an inverse relationship between body water content and lipid content has been established for fish) were monitored.

The effect of the percentage of dietary fat, reduced ration level and starvation on tolerance of endrin was determined, and the reduced tolerances to endrin were correlated to increased body water content (decreased total body lipid content).

## Conclusions

1. Fathead minnows (*Pimephales promelas*) fed frozen brine shrimp showed better growth and survival, and fewer deformities (hemorrhagic kidney lesions and lordosis) than those fed recommended reference research diets. In those fish fed only the reference research diet supplemented with either 10% corn oil, 10% salmon oil, or a mixture of the two oils, no improvements were observed in survival, growth or the number of deformities.
2. Acute toxicity to endrin was increased 2.4 times by lowered percentage of dietary fat (the reference research diet alone), 2.0 times by a restricted ration (brine shrimp), and approximately 2 times by starvation for 80 days prior to exposure to endrin. There appeared to be no significant difference between the diets supplemented with corn oil or salmon oil. Fathead minnows trapped in a

pond in the spring were approximately two times more susceptible to endrin than the laboratory stock fed brine shrimp. The higher susceptibility in wild minnows reflected their poor nutritional status in the spring.

3. Starved minnows had greatly increased total body moisture contents over minnows receiving a diet of brine shrimp. Compared to minnows fed brine shrimp, which had body water contents of about 68%, starved minnows approached 85% (post-mortem determinations of total body water content reached nearly 87%). Minnows fed the reference research diet alone had total body water contents of about 79%, whereas those receiving lipid supplements ranged from 70% to 74%. An increased susceptibility to endrin was positively correlated with increased total body water content, which is assumed to reflect a lowered total body fat content. Relocalization of endrin in non-target tissues such as adipose tissue seems to be an important mechanism for resistance to the toxic effects of endrin.
4. A dose-related reduction in total body water content of fathead minnows exposed to endrin was also observed.
5. There was no detectable relationship between body weight and susceptibility of fathead minnows to acute endrin toxicity.

## Recommendations

1. Reference research diets should not be used for the culture of fathead minnows (*Pimephales promelas*) since they result in an increased mortality, a greater incidence of deformities (hemorrhagic kidney lesions and lordosis) and decreased growth compared to fish fed frozen brine shrimp (*Artemia salina*).
2. A lowered level of dietary fat, a lowered ration level and long-term starvation prior to toxicity tests with a lipophilic chemical such as endrin can produce significantly lower LC<sub>50</sub> values. This should be

considered in standardized toxicity tests with this type of chemical.

3. No influence of acclimation to test temperature from 2 to 23 days was evident on the acute toxicity of endrin in wild fathead minnows. On the other hand, feeding for one week prior to exposure made the wild minnows more resistant to endrin. Therefore, a more detailed study of the differences in susceptibility to lipophilic chemicals between laboratory fish and field-collected fish on a seasonal basis should be made. Such a study should be preferably complemented by measurements of condition factor, water content and lipid content for different groups of fish, in order to achieve a better understanding of the variations in susceptibility of different lots of fish.
4. Considering the findings in the present study, acclimation to test conditions for one week without feeding, with both laboratory stock and wild fish, seems to be a sound basis for the comparison of 96-hr LC<sub>50</sub> values.

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*The complete report, entitled "Influence of Diet and Starvation on Toxicity of Endrin to Fathead Minnows (Pimephales promelas)," (Order No. PB 81-244 436; Cost: \$9.50, subject to change) will be available only from:*

*National Technical Information Service*

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