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ACUTE TOXICITY OF SOME BYPRODUCTS FROM VINYLCHLORIDE PRODUCTION TO SAITHE (POLLACHIUS VIRENS)

by

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Introduction

Since the widespread occurence of byproducts from vinylchloride production was known (Jensen et al. 1970), much attention has been paid to the toxic effects of these compounds.

Lots of information is available on the toxicity of organochlorine compounds such as Dieldrin, Methoxychlor and others (Lane and Livingstone 1970, Kennedy, et al. 1970).

However, these insecticides contain aromatic hydrocarbons in contrast to most of the vinylchloride byproducts which consist of chlorinated aliphatic hydrocarbons, chain length up to 5 or 6 (Cl-C). Jensen et al. (1970) determined the concentration of Cl-C giving the "indefinite survival time" to be within the magnitude of 20 ppm for different marine organism.

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This work is part of a project worked by the Pollution Group consisting of G. Berge, B. Braaten, L. Føyn, E. Egidius Møllerud and K.H. Palmork.

The present investigation gives some information of the aqute toxicity of vinylchloride waste products on saithe and pollack (age group I and II). The recovery ability of the animals was also studied.

Material and methods

The experimental animals were pollack (Pollachius pollachius L.) and saithe (Pollachius virens L.) all caught in the Bergen area of the Norwegian west coast.

A preliminary experiment was performed with pollack, in the remaining tests saithe was used. Holding conditions, acclimation of the pollack and set up of the preliminary experiment was similar to experiment no. 1 (ICES - C.M. 1971/E:10). The mentioned paper also describes the handling of saithe which was similar to the handling of cod (in experiment no. 2).

Two additional survival tests were accomplished in 100 and 87 ppm respectively using saithe caught in May -71. In the survival test with 28 ppm both fish from December -70 and May -71 were used.

The saithe used in the experiments had a length range from 19 to 28 cm and weight from 86 to 132 grams.

The oval test tanks (appr. 300 l) used for saithe were coated with a plastic film and filled up with 210 l of test solutions. The fish were transferred to the tanks three days prior to the tests started for acclimation in continuous flowing water. Ten fish were used in each tank.

It would have been desirable to carry out the toxicity tests in continuous flowing water, but due to the low solubility of the toxic material in seawater, the experiments had to be carried out in a static system. The solutions were then aerated. Every day 140 l was tapped out of each tank and replaced by a freshly made solution. Water samples for analysis were taken before and after renewal.

In order to determine the medium lethal concentration, LD50, the concentration values were selected from a logaritmic scale (Doudoroff et al. 1951). The following concentrations were used: 100 - 87 - 75 - 65 - 56 - 49 - 42 - 37 - 32 and 28 ppm.

Since renewal of test solutions was essential, a dayly variation in temperature of 3 to 5°C was obtained during the experiments (range 9.5 to 12.5°C in test 2 and range 8.6 to 14.2 in addtitional tests). Salinity was 34.6°/oo ± 2°/oo, oxygen content was not measured. Air flows were checked several times daily and adjusted if necessary, and control fishes were tested under similar conditions.

The material tested was waste products from Norwegian vinylchloride production. A preliminary test was carried out on the crude waste (EDC crude waste), in the remaining experiments a distillate of the waste product (EDC tar distillate) omitting the tar fractions were used. For details in chemical composition of the test material see Jensen et al., in prep.

Analysis were carried out on a Hewlett and Packard 700 Gas Chromatograph fitted with an electron capture detector (nickel) and coupled to an Intorfionics digital integrator (model CRS 100). A SF 96 (10 %) column was used (Jensen and Palmork, in prep.

Time to 50 % mortality and its 95 % confidence limits, were estimated for each bioassay (experiment 2) by probit analysis (Litchfield 1949).

Results

For pollack a LD 50 value between 50 and 100 ppm of EDC crude waste within 24 hours was indicated (table 1).

Table 1. Per cent mortality of pollack exposed to EDC crude waste.

Conc. (ppm)	time in hours				
	1	1½	6	24	48
300	100	-	-	-	-
200	100	-	-	-	-
150	100	-	-	-	-
100	0	100	-	-	-
50	0	0	0	10	-
10	0	0	0	0	-
1	0	0	0	0	0

Bioassays using saithe with the EDC tar distillate gave approximately similar results within 24 hours, although variable results were encountered (table 2). For example, a higher LD50 value was obtained in 42 ppm compared to the lower values in 37 and 32 ppm respectively.

Table 2. Survival times of saithe exposed to EDC tar distillate in 96 hours. b - additional test, C - control.

Conc. (ppm)	Time to 50 % mortality and 95 % confidence limits (hr)	Mortality in test %
100	1 - 2	100
100 (b)	½ - 1	100
87	3 - 4	100
87 (b)	5 (4, 6½)	100
75	28 (21, 37)	100
65	28 (25, 31)	100
56	49 (42, 56)	100
49	53 (40, 70)	80
42	70 (63, 77)	80
37	42 (34, 53)	70
32	57	50
28	-	20
C	-	0

Analysis of the water samples gave extremely variable results, the lowest value was usually found after renewal of the toxic solution. This can be explained by assuming an incomplete mixing of water and toxic compounds. It is most probable that some hours will elapse before the solution is equilibrated. However, abnormally high values were also found among the samples. indicating water from the surface film in the sample. A glossy film with a rather stiff membrane was often observed on the surface.

A test-fish in continuous motion might be exposed to variable concentrations the first period after renewal of the toxic solution, depending on low solubility and incomplete mixing. The observed variation in temperature will probably also influence on the mortality. On this background a certain unexpected variance in the results seems reasonable.

It must be emphasized that all concentrations used were based on weight/volume. Earlier results (ICES - C.M. 1971/E:10) showed that the actual concentrations in average were 2.5 times lower than expected. If the same relationship exists in the present material, the actual LD50 will be close to 16 ppm, instead of cc. 40 ppm.

An introductory experiment of the ability to recover when transferred to fresh sea-water was performed. After two hours exposure in 100 ppm, all ten fish laid on the bottom of the tank and only weak opercular movements were seen. One fish was then transferred to fresh sea-water and within 5 minutes it was able to swim. With intervals of ten minutes respectively two and seven fish were transferred to fresh sea-water. One of the two survived, but only one of the remaining seven started to swim.

A similar test was done in 87 ppm. After three hours all ten fish were taken into fresh sea-water and six of them survived. Some of them could be characterized as complete dead, but they still recovered. Of the three recovered fish from the first and six from the last experiment, all seemed to live quite normal for a week.

Discussion and conclusion.

The present data indicate that fairly high concentrations (about 40 ppm, weight/volume) are needed to cause acute toxicity on Gadidae of age group I and II. The results are in conformation with some preliminary studies reported by Berge, Ljøen and Palmork (1970) using 1.2 dichloropropane, a main component from industrial containers found in the North Sea. On the contrary, the studies of Jensen et.al. (1970), showed that within the same period of time (96 hr.), only 1/10 of the concentration was necessary to produce a similar acute effect on cod. This great difference in susceptibility might partly be explained by species, and age differences, variabilities in chemical composition of the waste material, and finally different experimental conditions, for example temperature. Further, it was surprising to see that larvae even seemed to be less susceptible (ICES - C.M. 1971/E:9). The reasons for this findings are not obvious, but might be due to a specific action of the toxic material on certain organs in the young fish that is not developed in the larva.

Since the acute toxic effect to a great extent was reversible, this observation indicates a toxication effect of physical nature (Crisp et.al. 1967). The results also suggest the possibility of survival for fish exposed temporarily to high concentrations if they are able to leave the toxic area. Still nothing is known about the sublethal and chronic effects caused by such an exposure or exposures to lower concentrations.

Abstract

The survival of I and II age group saithe and pollack in waste products from Norwegian vinylchloride production was tested and time to 50 % mortality and 95 % confidence limits were estimated. Recovery tests on apparently dead fish (100 and 87 ppm of the toxic substances were performed.)

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