Bull. Environm. Contam. Toxicol. 25, 113-117 (1980)

Acute Toxicity of Potassium Dichromate to *Daphnia magna* as a Function of the Water Quality

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In many countries, e.g. all countries of the European Community and the USA, toxicological testing with D. magna will have to be done along with the increased testing of chemical products for their ecological effects. For legislative purposes the results obtained by such tests have to be comparable and there is an urgent need for an adequate standardization of appropriate test methods. There are already some proposals (INTERNATIONAL ORGANISATION FOR STANDARDIZATION 1979, DEUTSCHES INSTITUT FÜR NORMUNG 1980). Both methods use $K_2Cr_2O_7$ as a reference substance. In 1978 a ring-test was carried out by 46 laboratories (COMMISSION OF THE EUROPEAN COMMUNITIES 1979) to test the ISO-method. For the toxicity of $K_2Cr_2O_7$ on D. magna a mean value of 1.7 mg/L with a standard deviation of 0.9 mg/L was obtained that gives a variation of 56 %. These results gave a strong indication that the test method used either did not take important test parameter(s) into consideration or that some test parameters were not described exactly enough. Our own experiments showed an important influence of the water quality on the toxicity of $K_2Cr_2O_7$ with D. magna (MÜLLER 1980). If the use of a reference compound were to be meaningful at all, systematic research work about all parameters influencing the toxicity of this substance would be indispensable and the results obtained should be used to work out standard methods.
This paper deals with the influence of the water quality, e.g. total hardness, alkalinity and the Ca:Mg-ratio on the toxicity of $K_2Cr_2O_7$ to D. magna.

MATERIALS AND METHODS

Breeding of D. magna was done according to the ISO draft "Water quality-Determination of the Inhibition of the mobility of Daphnia magna STRAUS (Cladocera, Crustacea)" (INTERNATIONAL ORGANISATION FOR STANDARDIZATION 1979).
Testing was done following the same draft but with two deviations from the method given. The daphnids used were not older than 24 h. The test water was made up by

0007-4861/80/0025-0113 $01.00

using deionised water ($\leqslant 0.1 \mu S/cm$) to which different amounts of the following reagents were given to obtain the different water qualities. ($CaCl_2.2H_2O$, KCl, $MgSO_4.7H_2O$, $NaHCO_3$).
The test water was aerated for about ten min to have air saturation and left for another 48 h to be stabilized.
All reagents used, including the $K_2Cr_2O_7$ were analytical grade and were obtained from Merck, Germany.

RESULTS

The influence of the alkalinity on the toxicity of $K_2Cr_2O_7$ to D. magna was examined using a test water with a total hardness of 2.5 mmol/L, a Ca:Mg ratio of 4:1, and a Na:K ratio of 10:1. The results together with the corresponding pH-curve are shown in figure 1.

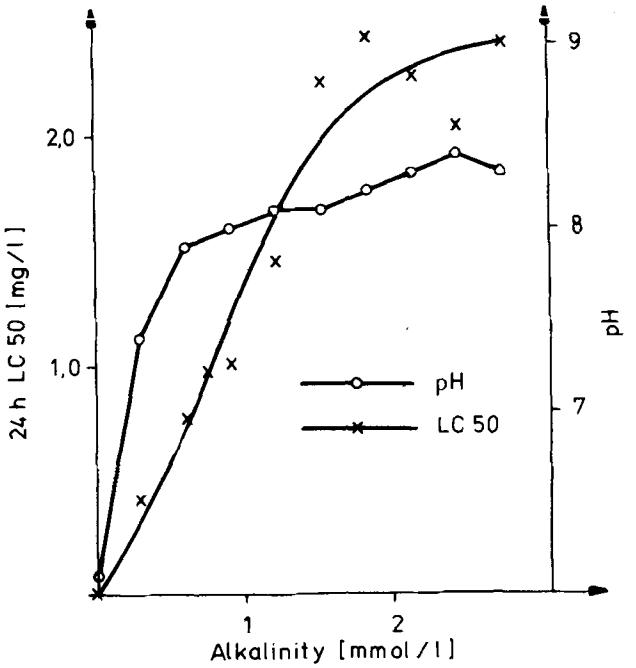

Figure 1. Influence of the alkalinity and the pH on the toxicity of $K_2Cr_2O_7$ to Daphnia magna

It should be mentioned that the toxicity curve is a predicted line where each point represents the mean of two values. It is clear that, if there is a need for a more precise curve, the higher alkalinity range should

be especially subjected to further investigation.

Figure 2 shows the influence of the total hardness on the toxicity of $K_2Cr_2O_7$ to D. magna.

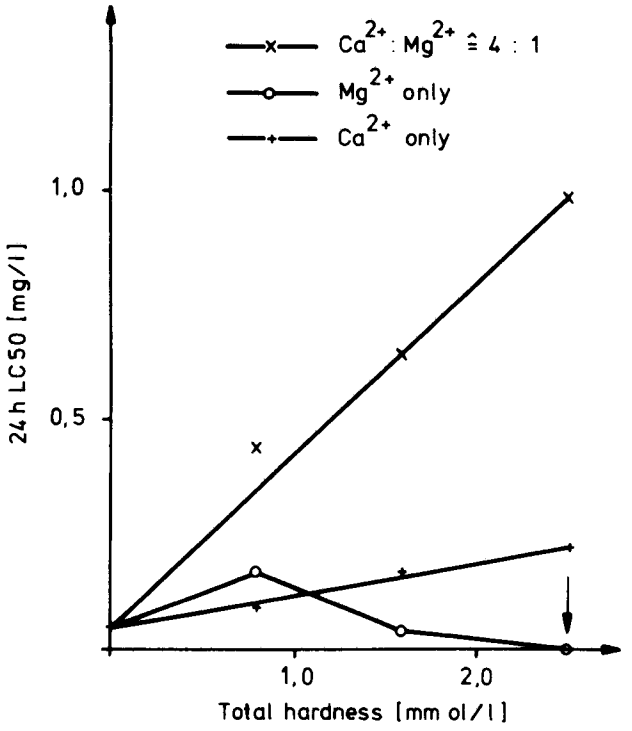

Figure 2. Influence of the total hardness on the toxicity of $K_2Cr_2O_7$ to Daphnia magna

These results were obtained using a test water with an alkalinity of 0.8 mmol/L and a Na:K ratio of 10:1. On the lowest curve the arrow indicates the concentration in which 50 % of the test animals died even in the control vessels. The three curves represent the results obtained with test waters which differed only in their Ca:Mg-ratio.

DISCUSSION

From figure 1 it is apparent that the alkalinity of the test water influences the toxicity of $K_2Cr_2O_7$ to D. magna very much. It is well known that there exists a pH-dependent balance between chromate and dichromate.

Assuming two different toxicities of chromate and dichromate it might be possible that the decreasing toxicity with an increase of the alkalinity is only a function of the pH-value. However, from our results a direct influence of hydrogen carbonate to D. magna cannot be excluded either and might be possible as well. Further work will have to be done to clear up the interrelationship between D. magna, $K_2Cr_2O_7$ and alkalinity.

Our experiments clearly show the importance the total hardness of the test water plays on the toxicity of $K_2Cr_2O_7$ to D. magna. But it can also be seen that the ratio between Ca and Mg is at least as important. In this connection it is interesting to observe that with increasing amounts of Mg-ions the toxicity first decreases but that we soon arrive at a concentration in which the Mg itself becomes toxic. A similar effect could not be seen using Ca as the only source of total hardness but otherwise we could only find a slight decrease of toxicity with increasing amounts of Ca. Increasing the total hardness of the test water having a ratio between Ca and Mg of 4:1 has an important effect on toxicity. This can hardly be explained by an only chemical interaction between these ions and the toxicant. Ca and Mg clearly show synergistic effects and according to the terminology of SPRAGUE (1970) we can call this a potentiation of the detoxifying effect.

Far from a full understanding of the above described effects we can come to the following conclusions:

Strictly following the ISO test description we could at least find a LC 50 range from 0.01 - 2.5 mg/L giving a factor 250.
Of course this does not mean that the test with $K_2Cr_2O_7$ as a standard compound is useless. On the contrary because of the effects described above it seems to be a quite useful possibility to detect deviations from the standard test method, but only under the condition that the standard test description will be more precise as it is now.

Even for acute toxicity tests with D. magna an exact specification of the test water is indispensable, as far as the total hardness, the ratio between Ca and Mg and the alkalinity is concerned.

It might be that there are some further effects on the toxicity of $K_2Cr_2O_7$ depending on the Na-K ratio or various combinations between total hardness, Ca-Mg ratio,

and alkalinity. Further work on this subject is in progress.

Acknowledgements. I thank Miss Ohnesorg, Mr. Eckhardt, and Mr. König for their technical assistance.

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