

Cholinesterase Depression Among Senegalese Crop Protection Workers Exposed To Organophosphorous Pesticides

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The inhibitory effect of organophosphorus pesticides (OP) on animal cholinesterase has been reported by a great number of workers. The increased use of OP by the Crop Protection Service (CPS) in Senegal has resulted in an important exposition of workers in the field. The survey of blood cholinesterase activity gives an indication of the degree of exposition and therefore of the associated risks (Wills 1972; Ryhanen et al. 1984; Ducan et al. 1986).

The purpose of the present study was to measure the plasma (PChE) and red blood cells (AChE) cholinesterase activity in CPS pesticide applicators during the 1987 cropping season and to compare the effects of two different formulations (fenithroton alone and fenithroton + fenvalerate) under field conditions.

MATERIALS AND METHODS

Eight applicators were selected among the CPS staff. There was no change in their working conditions throughout the experiment. The blood collections were performed at the Pasteur Institute in Dakar. Blood samples were taken by venipuncture into heparinized tubes according to a time schedule given in table 1.

As recommended by WHO (1983), an initial blood sample collection (three times, every 24 hours) should be done prior to exposure to the chemicals. These initial samples will give the ChE reference value (base line) for each worker. During the post-exposure period, blood sampling was repeated three times, respectively 10 days, 17 days, 32 days after the last application.

Two preparations were used which both contained an O.P. (fenitrothion):
Sumithion® : 500 g/liter Fenitrothion
Sumicombi® : 250 g/liter Fenitrothion + 50 g/liter Fenvalerate

Table 1. Details on the application.

Periods	1st period 13 to 20 August 1987	2nd period 16 to 29 Sept. 1987	3rd period 20 to 29 Sept. 1987	4th period 02 to 17 Oct. 1987
Insecticide	SUMITHION® Fenitrothion 500 g/l	SUMICOMBI® Fenitrothion 250 g/l + Fenvalerate 50 g/l		Last application october 1st
Method	Spraying ULV 500 g/l	Spraying		
Sprayer	Jacto mounted on vehicle UNIMOG	Backpack Motorized Polyjacto Sprayer		
Daily delivery	150 - 300 l.	150 - 300 l.		
Daily exposure time	6 hours	7 hours		
Protection clothes	yes	yes	yes	
Date of blood sampling	September 1	September 19	September 29	October 10 October 17 and November 2nd
Time between last application and blood sampling	24 hours	1 hour	1 hour	
Number of workers (n=8)	all	all but n° 1	all but n° 1	all but n° 1

Plasma and red cells were separated by a centrifugation of 10 minutes at 3000 rpm. The electrometric method of Michel (1949) modified by Mohammed and S T Omer (1982) and tested in our laboratory (Sido, 1987) was used. 1 ml of plasma sample was diluted in 99 ml of distilled water. Then, 8 ml of a buffer (0.315 g sodium barbital, 0.142 g bromothymol per liter, pH 8) was added to 10 ml of the sample dilution. The mixture was allowed (10 minutes) to equilibrate at 37°C in a water bath (Tempette - TE - 8A). The reaction was started by the addition of 2 ml of a 1% aqueous solution of acetylcholine chloride. A pH measurement (Corning

816 pH-meter, USA)* was done immediately before Acetylcholine addition and 60 minutes later.

A sample blank (with no added enzyme) was also run. Its variation represents non enzymatic (spontaneous) acetylcholine chloride hydrolysis.

The red cells are hemolyzed in 0.1% saponin solution (0.53 g of erythrocytes in 49.5 ml of saponin solution). 10 ml of this mixture was utilized for pH measurement.

RESULTS AND DISCUSSION

There are distinguishing characteristics between acetylcholinesterase ("true" cholinesterase E C 3.1.1.7 : AChE) and butyrylcholinesterase (non specific or pseudocholinesterase, E C 3. 1. 1. 8 : PChE). AChE is found in the central nervous system, motor end plates of skeletal muscle and erythrocytes. PChE is found in smooth muscle, liver, adipocytes and plasma.

Due to its wide insecticidal spectrum, Fenitrothion is largely used in the world and specifically by the Senegalese Crop Protection Service in its plant protection programs. It has been utilized for pest control on vegetables, fruits and pasture; against locusts, grasshoppers and insects of medical importance, e.g. against mosquitoes vectors of malaria (Miyamoto, 1987). Sometimes, fenitrothion may be associated with a pyrethrinoid e.g. fenvalerate (Sumicombi®).

The plasma reference (PChE) value of the workers in the pre-exposure period is 0.90 ± 0.10 pH unit/hour (range : 0.80 - 1.15) (Figure 1). Our values compare well with those reported by Ducan et al. (1986) : 0.94 pH unit/hour. The erythrocyte reference value (AChE) is 1.85 ± 0.05 pH unit/hour (range : 1.75 - 1.90) (Figure 2).

The PChE and AChE of workers did not show any significant change following application of fenitrothion alone (1st period).

When all workers (except n°1) turned to Sumicombi® (2nd and 3rd period) significant and gradually deepening depression of both PChE and AChE (38 to 75 % and 6 to 23 % respectively) was observed. There was a some heterogenicity in the response of workers: one of them showed only a minimal change (n°7).

In view of this large decline of PChE it was decided to withdraw workers (n°1 excepted) from their work and to follow the rate of PChE regeneration. Regeneration was indeed very low : 30 days after

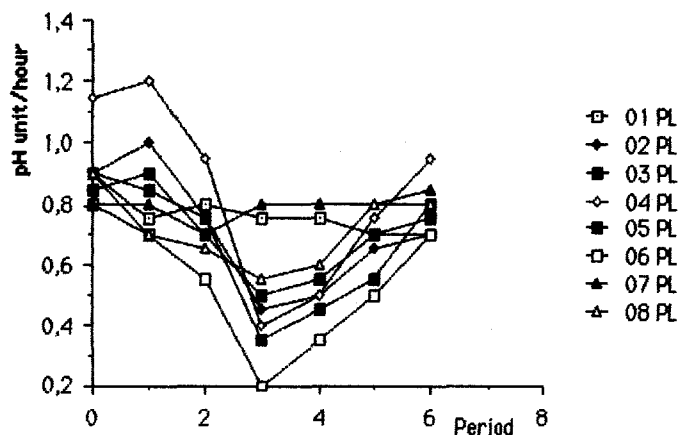


Fig. 1. Plasma cholinesterase (PChE) values in applicators following exposure to fenitrothion (period 1) to fenitrothion + fenvalerate (periods 2-3) and during recovery (periods 4-5-6).

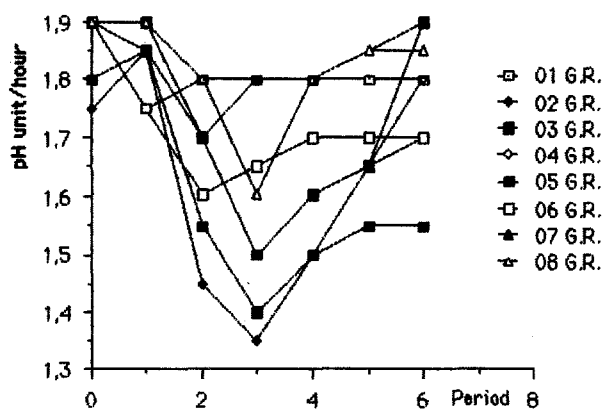


Fig. 2. Erythrocytic cholinesterase (AChE) values in applicators: same conditions as in Figure 1.

application a 15 % depression was still observed (figure 3).

Cholinesterase is a non specific indicator of exposure to OP. The monitoring of changes can be used to evaluate the safety measures before appearance of poisoning symptoms (Vasilic et al. 1987).

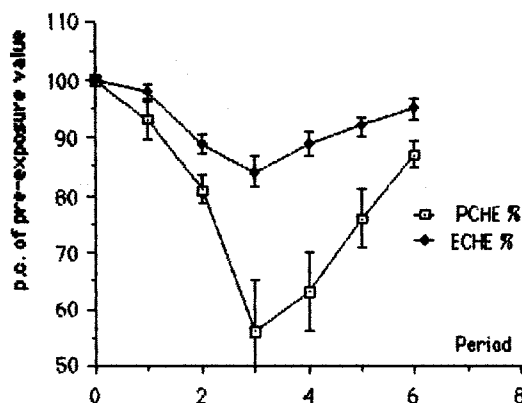


Fig. 3. Mean depression values of PChE and EChE (p.c. of pre-exposure values) in applicators: same conditions as in Figure 1.

Our results suggest synergic effects of fenitrothion and fenvalerate on cholinesterase inhibition. The same observation was found with the use of azinphosmethyl and deltamethrin. Nowadays OP and pyrethroids are currently associated.

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