

varies. In rats receiving a diet with a high proportion of carbohydrates and a correspondingly low quantity of fat, the rate of complex formation of lipids with protein is higher than in animals receiving a balanced diet. This could be the reason for the difference in the change produced by them in the lipid content in the blood and liver.

Inclusion of sucrose in diets with a high or normal carbohydrate content thus accelerates the synthesis of apoproteins of pre- β -lipoproteins in the liver and their loading with endogenous lipids and it leads to a more intensive secretion of VLDLP into the blood stream and an increase in the blood triglyceride level. However, the rate of formation of lipid-protein complexes of pre- β -lipoproteins in the liver also depends on the relative proportions of the carbohydrate and fat components in the diet. If the diet contains sucrose and the ratio between carbohydrates and fats is physiological (2 : 1), a lower level of lipid loading of the apoproteins of pre- β -lipoproteins is found, with a consequent increase in the lipid content in the liver.

LITERATURE CITED

1. A. I. Gusev and A. K. Yazova, *Biokhimiya*, No. 1, 172 (1970).
2. B. G. Lyapkov, Yu. M. Zaleskaya, and V. F. Markelova, *Vopr. Pitaniya*, No. 2, 38 (1974).
3. V. F. Markelova, "Effects of qualitatively different diets on lipid metabolism," Doctoral Dissertation, Moscow (1974).
4. V. F. Markelova and Yu. M. Zaleskaya, *Byull. Éksp. Biol. Med.*, No. 5, 41 (1974).
5. R. P. Eaton and D. D. Kipnis, *Am. J. Physiol.*, 217, 1153 (1969).
6. R. H. Hinton, Y. al-Tamer, A. Mallinson, et al., *Clin. Chim. Acta*, 44, 267 (1973).
7. N. A. Kaufman and H. Stein, *Atherosclerosis*, 11, 365 (1970).
8. O. E. Michaelis and B. Szepesi, *J. Nutr.*, 104, 1597 (1974).
9. G. Schonfeld, *J. Lab. Clin. Med.*, 75, 206 (1970).
10. D. Zakim, R. S. Pardini, H. H. Herman, et al., *Biochim. Biophys. Acta*, 144, 242 (1967).
11. J. Verheyden and J. Nys, *Clin. Chim. Acta*, 7, 262 (1962).

ACTIVITY OF ENZYMES OF GLUCOSE-6-PHOSPHATE METABOLISM IN THE LIVER OF RATS WITH EXPERIMENTAL VALEXON POISONING

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Activity of hexokinase, glucose-6-phosphatase, and glucose-6-phosphate dehydrogenase in the liver of rats was studied after a single peroral dose of the organophosphorus insecticide Valexon. Administration of the compound caused increased activity in the homogenate and solubilization of glucose-6-phosphatase, activation of glucose-6-phosphate dehydrogenase, and inhibition of hexokinase. The changes were maximal 1 h after administration. It is postulated that the reduction in the intensity of formation and conversions of glucose-6-phosphate is a pathogenetic factor in the development of Valexon poisoning.

KEY WORDS: hexokinase; glucose-6-phosphatase; glucose-6-phosphate dehydrogenase; organophosphorus insecticide Valexon; rat liver

An important role in the formation and conversions of glucose-6-phosphate is played by the activity of hexokinase, glucose-6-phosphatase (G6Pase), and glucose-6-phosphate dehydrogenase (G6PD). Data are given in the literature on the effect of various chemicals containing chlorine, used as insecticides, on G6Pase and G6PD activity [1-3]. However, insecticides belonging to different classes of chemical compounds, notably the

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TABLE 1. Hexokinase, Glucose-6-Phosphatase, and Glucose-6-Phosphate Dehydrogenase Activity in Supernatant Fraction of Liver at Various Times after Administration of Valexon ($M \pm m$, $n=8-9$)

Time after administration	Activity			
	hexokinase, nmoles NADP/g tissue/min	glucose-6-phosphatase, mg P/g tissue		glucose-6-phosphate dehydrogenase, optical density units $\times 1000$ /g tissue
		homogenate	supernatant	
Control	332,0 \pm 24,6	6,41 \pm 0,25	0,82 \pm 0,06	223,0 \pm 9,5
1 h	143,0 \pm 14,7*	10,97 \pm 0,39*	1,87 \pm 0,12*	335,0 \pm 18,0*
1 day	237,0 \pm 30,0*	9,63 \pm 0,55*	0,95 \pm 0,06	191,0 \pm 14,4
5 days	198,0 \pm 12,5*	7,73 \pm 0,57	0,84 \pm 0,06	260,9 \pm 14,9

* $P < 0.05$ compared with control.

organophosphorus group, are extensively used at the present time. The effect of this group on the conversions of glucose-6-phosphate has not been studied.

The object of this investigation was to study activity of hexokinase, G6Pase, and G6PD in the liver of rats during experimental poisoning with the organophosphorus insecticide Valexon (O,O-diethylthiophosphoryl- α -hydroxyiminophenylhydrazide).

EXPERIMENTAL METHOD

Experiments were carried out on male albino rats weighing 180-220 g. Experimental Valexon poisoning was produced by a single peroral administration of the compound in a dose of 310 mg/kg, equivalent to 0.5 LD₅₀. The animals were decapitated 1 h and 1 and 5 days after the dose of Valexon, the liver was removed, a homogenate (1 : 10) was prepared from it in 0.25 M sucrose, and the supernatant fraction was obtained by centrifugation of the homogenate for 60 min at 50,000g. Activity of hexokinase [6], G6Pase [7], and G6PD [5] was determined by the SF-16 spectrophotometer.

The Valexon content was determined in the subcellular fractions of the liver homogenate by thin-layer chromatography [4].

EXPERIMENTAL RESULTS

As the results in Table 1 show, 1 h after the single dose of Valexon hexokinase activity was significantly reduced (by 57% compared with the control) whereas there was a sharp increase in G6PD (by 50%) and G6Pase activity (by 71% in the homogenate and 127% in the supernatant). Hexokinase activity still remained low (by 30%) and G6Pase remained high (by 50%) after 24 h, whereas G6PD activity at this time was back to normal. G6Pase and G6PD activity were within the control limits after 5 days and only the hexokinase activity still remained low (by 40%).

Analysis of these data suggests that in experimental poisoning by the organophosphorus insecticide Valexon, on account of the inhibition of hexokinase activity and the increase in G6Pase and G6PD activity, conditions are created in the liver tissue under which the level of glucose-6-phosphate, the metabolically active form of glucose, may be reduced.

Considering that hexokinase and G6PD are the key enzymes of glycolysis and of the pentose phosphate pathway, opposite changes in their activity can be regarded as a compensatory reaction of the tissue aimed at the maintenance of homeostasis during exposure to the toxic agent. The observed increase in G6PD activity may also be associated with the specific function of the enzyme as a supplier of NADPH, required for the detoxication of the insecticide entering the body.

The sharp increase in G6Pase activity in the supernatant fraction, not containing microsomes, 1 h after administration of the compound will be noted. The solubilization of the enzyme which was observed, evidence of injury to the microsomal membranes, can be explained by the direct action of the compound on the membranes, for during this period of observation Valexon was found in the liver in a concentration of 0.117 μ g/g, 40% of it concentrated in the fraction containing microsomes and cytosol. Penetration of Valexon into the liver cells may also be a cause of the observed change in the activity of hexokinase and G6PD — enzymes located in the cell cytoplasm. However, disturbances in the structure of the microsomes, leading to destabilization of G6Pase in this form of poisoning, are reversible, as is shown by the restoration of normal enzyme activity in the supernatant fraction 24 h after administration of the compound.

This could be to some extent connected with the 75% decrease in the Valexon concentration in the sub-cellular fraction containing microsomes observed at this period.

Since, of all the enzymes studied, the most marked and lasting changes were found in hexokinase activity, this suggests that an important pathogenetic role in the development of poisoning by the organophosphorus insecticide Valexon is played by a decrease in the intensity of formation of glucose-6-phosphate and of its conversion in the principal energy pathway of the cell.

LITERATURE CITED

1. U. A. Kuz'minskaya and V. E. Yakushko, *Gig. San.*, No. 7, 97 (1970).
2. B. I. Khaikina, V. E. Yakushko, and N. P. Novikova, *Gig. San.*, No. 11, 117 (1975).
3. V. E. Yakushko, in: *Hygiene of Use and the Toxicology of Pesticides and the Clinical Features of Poisoning* [in Russian], No. 10, Moscow (1973), p. 195.
4. H. Ackerman, *J. Chromatogr.*, 37, 309 (1968).
5. H. Bergmeyer (cited by V. S. Asatiani), *Enzymic Methods of Analysis* [in Russian], Moscow (1969), p. 596.
6. D. L. Di Pietro and S. Weinhouse, *J. Biol. Chem.*, 235, 2542 (1960).
7. M. Swanson, cited in: *Modern Methods in Biochemistry* [in Russian], Vol. 2, Moscow (1968), p. 51.