

TABLE I

G-6-PDH and Δ^5 -3 β -HSDH activities in the testis of *C. batrachus*

Substrates*	Intensity of reactions**	
	Interstitial cells of Leydig	Sertoli cells
1. G-6-PDH	++++	++
2. 3 β -Hydroxyandrost-5-en-17-one (Dehydroepiandrosterone, DHEA)	++	+
3. 3- β -Hydroxypregn-5-en-20-one (Pregnenolone)	+	±
4. Control	—	—

* All the chemicals are of Sigma Grade, obtained from Sigma Chemical Company, U.S.A.

** Intensity of the reaction is graded from (—) to (++++); (—) denotes the absence of reaction and (++++), a maximal reaction.

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EFFECT OF DDT ON SUCCINATE AND GLUTAMATE DEHYDROGENASE ACTIVITIES IN SELECTED TISSUES OF FROG (*RANA HEXADACTYLA*)

Introduction

THE recent studies on highly persistent organochlorine insecticide like DDT (2,2-bis (p-chloro phenyl),1,1,1-trichloroethane) indicated its principal effect on the central nervous system¹ by reducing the acetylcholinesterase activity in rabbit and cats². Koch *et al.*³, showed that DDT and other chlorinated hydrocarbon insecticides can inhibit the action of ATPases including Mg⁺⁺, Na⁺, K⁺ dependent and actomyosin ATPases of nerves, muscles and other tissues of animals. Cytochrome oxidase and succinate dehydrogenase enzyme activities are also known to be inhibited by DDT which directly upsets the oxidative metabolism⁴. Inhibition of oxidative phosphorylation was reported for rat liver mitochondria at fairly low concentrations of DDT⁵. However not much information is available about the exact nature of interaction of this insecticide with the enzymatic systems in amphibians, which are more sensitive to this organochlorine than birds and mammals⁶. Since DDT is known to deplete the carbohydrate reserves and increase the amino nitrogen level in blood⁷, in the present investigation an attempt was made to study the *in vitro* effects of DDT on succinic dehydrogenase and glutamate dehydrogenase activity levels to know the specific effect of this organochlorine insecticide on oxidative patterns and detoxification potential of mitochondrial enzymes in different tissues of frog, *Rana hexadactyla*.

Materials and Methods

Frogs of medium size were collected and double pithed by transecting the spinal cord with least injury to the animal. Liver, kidney, brain and gastrocnemius muscle were excised quickly with least injury and washed in amphibian Ringer medium to recover from the shock effects. 10% (W/V) homogenates were prepared in 0.25 M sucrose solution at 5° C and centrifuged at 2,500 rpm for 15 minutes to remove cell debris. The supernatant fractions were used for the assays of succinate and glutamate dehydrogenase activities.

The SDH (E.C. 1.3.99.1) activity was estimated by the method of Nachlas *et al.*⁸, as modified by Pramamma *et al.*¹⁰ and GDH (E.C. 1.4.1.3) activity was estimated by the method of Lee and Lardy¹¹ with slight modification as described by Pramamma *et al.*¹⁰.

Experimental tubes received 0.01 to 0.1 ml containing 2 to 20 μ M of DDT in addition to the contents of 2.0 ml of reaction mixture, whereas control tubes received distilled water in the place of DDT as per the method described by Desai *et al.*¹², and Suhasini *et al.*¹³.

The enzyme activity levels are expressed in μ moles of formazan formed/mg protein/hr.

Results and Discussion

The activity levels of SDH and GDH in the brain, liver, kidney and muscle (Tables I and II) tissues of frog showed tissue specific variation. The activity level of SDH was highest in liver indicating predominate succinate and associated Kreb's cycle oxidation. The relatively low level of SDH activity in kidney suggests a possible diversion of kreb's cycle intermediaries and consequent depletion of substrates.

respectively. The ratio was found to be higher in the muscle when compared to other tissues suggesting minor involvement of muscle in GDH based ammonia metabolism¹⁴.

The *in vitro* effect of DDT on the activity levels of these two enzymes seem to be tissue specific. In general the SDH and GDH activity levels showed a continuous decrement with increase in DDT concentrations from 2 to 20 μ moles. However, this decrement was found to be low upto 6.0 μ moles and high from 8.0 μ moles of DDT concentration onwards.

TABLE I

Activity levels of succinate dehydrogenase (SDH) and glutamate dehydrogenase (GDH) in brain and liver of frog, exposed to different concentrations of DDT

(Activity levels are expressed in μ moles of formazan for med/mg protein/hr)

Sl. No.	Concentration of DDT in μ M	Brain			Liver		
		SDH activity	GDH activity	SDH/GDH ratio	SDH activity	GDH activity	SDH/GDH ratio
1.	0.00 (control)	0.1472 $\pm 0.0028^*$	0.236 ± 0.008	0.623	0.2081 ± 0.0181	0.4113 $\pm 0.0081^*$	0.506
2.	2.0	0.1286 $\pm 0.0042^*$	0.1686 $\pm 0.004^*$	0.763	0.1408 $\pm 0.164^{**}$	0.3655 $\pm 0.0008^*$	0.385
3.	4.0	0.1167 $\pm 0.0056^*$	0.1167 $\pm 0.0056^*$	1.006	0.0988 $\pm 0.016^*$	0.275 $\pm 0.0006^*$	0.359
4.	6.0	0.0508 $\pm 0.0017^*$	0.0888 $\pm 0.0056^*$	0.572	0.0779 $\pm 0.0117^*$	0.2305 $\pm 0.0007^*$	0.338
5.	8.0	0.0361 ± 0.0028	0.0341 $\pm 0.0043^*$	1.057	0.548 $\pm 0.0034^*$	0.0777 $\pm 0.0018^*$	0.705
6.	10.0	0.0212 $\pm 0.0017^*$	0.0269 $\pm 0.00086^*$	0.787	0.0376 $\pm 0.00096^*$	0.0298 $\pm 0.0023^*$	1.262
7.	12.0	0.0186 $\pm 0.0005^*$	0.0255 $\pm 0.00097^*$	0.731	0.0215 $\pm 0.00089^*$	0.0229 $\pm 0.0002^*$	0.938
8.	14.0	0.0168 $\pm 0.0004^*$	..	..	0.0183 $\pm 0.00076^*$	0.0147 $\pm 0.00048^*$	1.242
9.	16.0	0.0165 $\pm 0.0042^*$	..	..	0.01398 $\pm 0.00082^*$	0.0122 $\pm 0.0005^*$	1.140
10.	18.0	0.0145 $\pm 0.0003^*$	..	..	0.01156 $\pm 0.00113^*$	0.0100 $\pm 0.0002^*$	1.156
11.	20.0	0.0145 $\pm 0.00045^*$	..	..	0.00753 $\pm 0.00096^*$	0.0064 $\pm 0.0065^*$	1.167

* $P < 0.001$, ** Not significant.

All the values are means of six observations.

Liver exhibited highest GDH activity when compared to other tissues indicating prominent ammonia detoxification potential operating in this tissue. The SDH/GDH ratio indicates the coupling of kreb's cycle with ammonia metabolism. A decrement and increment in the ratio indicate greater and lesser coupling potential

it is also observed that at lower concentrations of DDT, the decrease in GDH activity was found to be more than that of SDH in all tissues except liver. But at higher concentrations of DDT both GDH and SDH activities are inhibited almost to a same level. In liver, inhibition of succinate oxidation is more than

TABLE II
Activity levels of succinate dehydrogenase (SDH) and glutamate dehydrogenase (GDH) in kidney and muscle of frog, exposed to different concentrations of DDT
(Activity levels are expressed in μ moles of formazan formed/mg protein/hr)

Sl. No.	DDT concentration in μ M	Kidney			Muscle		
		SDH activity	GDH activity	SDH/GDH ratio	SDH activity	GDH activity	SDH/GDH ratio
1.	0.00 (Control)	0.1234 $\pm 0.0045^{**}$	0.2455 ± 0.0073	0.503	0.1563 $\pm 0.024^*$	0.0406 $\pm 0.0037^*$	3.849
2.	2.0	0.1164 $\pm 0.0036^*$	0.2005 $\pm 0.0028^*$	0.581	0.0818 $\pm 0.0174^*$	0.0146 $\pm 0.0104^*$	5.603
3.	4.0	0.1038 $\pm 0.0049^*$	0.1678 $\pm 0.0064^*$	0.619	0.0661 $\pm 0.008^*$	0.01163 $\pm 0.0023^*$	5.679
4.	6.0	0.0657 $\pm 0.0018^*$	0.1625 $\pm 0.0038^*$	0.405	0.0419 $\pm 0.004^*$	0.0105 $\pm 0.0017^*$	3.99
5.	8.0	0.0312 $\pm 0.0014^*$	0.0545 $\pm 0.0018^*$	0.573	0.0195 $\pm 0.009^*$	0.0056 $\pm 0.002^*$	3.488
6.	10.0	0.0284 $\pm 0.0009^*$	0.0376 $\pm 0.0028^*$	0.755	0.0167 $\pm 0.003^*$	0.0028 $\pm 0.0001^*$	6.000
7.	12.0	0.0178 $\pm 0.0005^*$	0.0327 $\pm 0.0048^*$	0.545	0.0130 $\pm 0.006^*$	0.00233 $\pm 0.00023^*$	5.59
8.	14.0	0.0174 $\pm 0.00036^*$	0.0273 $\pm 0.0048^*$	0.638	..	..	..
9.	16.0	0.01533 ± 0.00036	0.0193 $\pm 0.002^*$	0.794	..	..	..
10.	18.00	0.0128 $\pm 0.0004^*$	0.0086 $\pm 0.0007^*$	1.503	..	..	..
11.	20.00	0.0109 $\pm 0.0008^*$	0.0122 $\pm 0.007^*$	0.893	..	..	..

* $P < 0.001$, ** $P < 0.01$.
All the values are means of six observations.

that of glutamate oxidation, which suggests that liver GDH is perhaps more resistant to this insecticide effect than the GDH of other tissues, because of high detoxification potential operating in liver.

Regarding the sensitivity of tissues to DDT, Kidney SDH and GDH were less affected when compared to other tissues at lower concentrations suggesting a relatively greater tolerance or a better inbuilt protective mechanism in kidney to combat the hazards of insecticide, resulting in sustained succinate and glutamate oxidations. Muscle enzymes were affected more with DDT because muscle being a contractile tissue with extensive neuromuscular junctions with acetylcholine system, the sensitivity was highest because of neurotoxic nature of the insecticide^{15,16}.

In general it can be presumed that the amphibian tissues show tissue specific differential response to this insecticide depending on the detoxification mechanisms operating in them.

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The Council of The Institute of Physics has made the following awards for 1979; (1) *Bragg Medal and Prize* to Sister Maureen Hurst, La Re traite High School, London; (2) *Charles Chree Medal and Prize* to Prof. J. T. Houghton, University of Oxford; (3) *Charles Vernon Boys Prize* to Dr. D. C. Robinson, Culham Laboratory; (4) *Duddell Medal and Prize* to Dr. J. R. Sandercock, Laboratories RCA, Ltd., Zurich;

(5) *Glazebrook Medal and Prize* to Dr. T. G. Pickavance, formerly of the Rutherford Laboratory; (6) *Guthrie Medal and Prize* to Prof. D. H. Perkins, University of Oxford; (7) *Maxwell Medal and Prize* to Dr. C. H. Llewellyn Smith, University of Oxford and (8) *Thomas Young Medal and Prize* to Prof. C. Cohen-Tannoudji, Collège de France, Paris.

AWARD OF RESEARCH DEGREES

Sri Venkateswara University, Tirupati, has awarded the Ph.D. degree in Physics to Sri, P. Parabrahma Reddy; Ph.D. degree in Chemistry to Sri B. S. Prasanna Chith; Ph.D. degree in Psychology to (Miss) S. Ushasri; Ph.D. degree in Chemistry to Sri. L. Krishna Reddy; Ph.D. degree in Chemistry to Sri. R. Seshadri Naidu; Ph.D. Degree in Chemistry to Sri. P. Balakrishna Naidu; Ph.D. degree in Botany to Smt. M. Subhadra Devi; Ph.D. degree in Botany to Sri K. Veeranjanyulu; Ph.D. degree in Zoology to Sri. G. Rajarami Reddy; Ph.D. degree in Zoology to Sri. S. Krupanidhi.

Utkal University, Bhubaneswar, has awarded the Ph.D. degree in Mathematics to the following: Shri Damodar Pratihari, Shri Sudarasan Padhy; Shri Manoranjan Bhatta Charya; Ph.D. degree in Chemistry to the following; Sri Choudhury Krushna Chandra Mohapatra, Shri Rajanikanta Samal, Shri Amalendu Nayak, Shri Maheswar Patra, Shri Mohapatra Suresh Kumar, Shri Mangaraj Surat Chandra, Ph.D. degree in Botany to Shri C. Gangadharan. Ph.D. degree in Zoology to Shri J. S. Prasad, Shri Aditya Prasad Dash.

ERRATA

In the article "Study of the amino acids and fatty acids in the stromatolites of Someshwar area in Kumaun Himalaya" [*Curr. Sci.*, July 20, 1979, 48 (14), 623], the address of the author A. K. MATTOO may be read as follows :

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