ISSN : 2321-9602

Indo-American Journal of Agricultural and Veterinary Sciences




editor@iajavs.com
iajavs.editor@gmail.com

Indo-American Journal of Agricultural and Veterinary Sciences

Vol. 9, Issuse 1, March 2021

Effects of endosulfan and fenvalerate on carbohydrate metabolism of the freshwater fish, Labeo rohita (Hamilton)

1* Dr. D. Rajeshwari, 2*Dr. D. Ravi Babu

1*Professor & Principle at Andhra Mahila Arts and Science college for Women, Osmania University (campus), Hyderabad, Telangana.

2*Professor at Kamineni Academy of Medical Sciences and Research Center (KAMSRC) Abstract

Abstract

There were two insecticides that were unprotected against the freshwater fish, Labeo rohita (Hamilton). An organ chlorine and a synthetic pyrethroid, fenvalerate. LC50 values were established for fenvalerate and endosulfan at 24 hours. 0.6877 and 0.4749 gL-1 were the respective values. The tenth of a day. Sublethal concentrations were defined as those below the LC50 value of either toxin. For 24 hours, the fish were exposed to sub- and fatal doses of toxic chemicals without any protection. Studies were conducted on the simple carbohydrate metabolism of critical fish organs such as the brain (SDH), kidney (MDH), liver, muscles, andgills for fifteen days to determine how enzymes such as SDH and MDH, LDH, and MDH, MDH, and MDH, as well as lactate dehydrogenase (LDH), act.

Introduction

Environmental (toxic waste) contamination sparked the long-term use of lethal chemicals, such as pesticides, in different ecosystems, which because of their effectiveness and ease of use have eliminated some biological methods of pest management. It is common practice to use pesticides on animals and plants to combat pests. However, pesticide use in the natural environment has certain negative consequences, including the accidental intoxication of beneficial birds, animals, insects, fish, and other organisms in terrestrial and aquatic biocenoses1. As a result, the current study focuses on the effects of Fenvalerate and Endosulfan on the carbohydrate metabolism of the local area's edible fish, Labeo rohita(Hamilton). More than 65 countries throughout the world utilize the chlorinated hydrocarbon insecticide Endosulfan (C9H9Cl6O3S) to control pests. Endosulfan is a product of India, the only country to produce it. There were 41,032 metric tons of production from 1995 to 2003, an average annual output of 8203 tons since 1996-97. During 1995-19954, an estimated 5,190 metric tons of endosulfan were expected to be produced just in India. Another class of pesticides includes synthetic pyrethriods, which are toxic to aquatic organisms as well. For more than 35 years, pesticides containing pyrethriods have been used in agriculture to control insect pests in a variety of crops. Farming crops such as cotton, paddy, maize, soybean, cauliflower, tomato, ladyfinger, tea and tobacco use pyrethroid insect repellents such as fenvalerate. Around one-fourth of the global insecticide market is accounted for by them5.

Material and methods

Fish in a pond or lake The freshwater fish Labeo rohita (Hamilton) is a delectable and highly sought after commercial catch. A week of acclimation at 28 20C in the study laboratory was

required for fish weighing 6-8 g and measuring 6-7 1 cm in length. Solutions for shopping at

It was produced in 95 percent acetone to get a 100mg/100ml solution of Endosulfan 35 percent Emulsifiable Concentrate (EC) and Fenvalerate 20 percent Emulsifiable Concentrate (EC) diluted with filtered water. Pure, unchlorinated groundwater was used for acclimatization and study. Ten fish were placed in toxicant glass chambers with a volume of 10 L for each experiment. Observation was made on the fish mortality rate. All of the dead fish had been removed in a flash. During static testing, the hazardous tests led to a mortality range of 10% to 90% for 24 hrs. It was noted that the concentration that resulted in 50% mortality in test species. The LC50 values were determined using Finney's Probit analysis (1971)6.

Assessment of Glycogen

The amount of glycogen might be predicted using the method of Kemp et al .'s (1954) The increase factor, 0.97 (Hawks, 1951)8, was used to convert the glucose into glycogen, which is measured in milligrams of glycogen per kilogram of wet tissue weight. The activity of lactate dehydrogenase (LDH) was measured using the Srikanthan and Krishna Murthy method (1955) Nachlas et almethod .'s was used to measure the activity of SDH and MDH in the body (1960) 10.

Glycogen

The levels of overall glycogen and events of MDH, SDH and LDH reduced in all the tissues related to control.

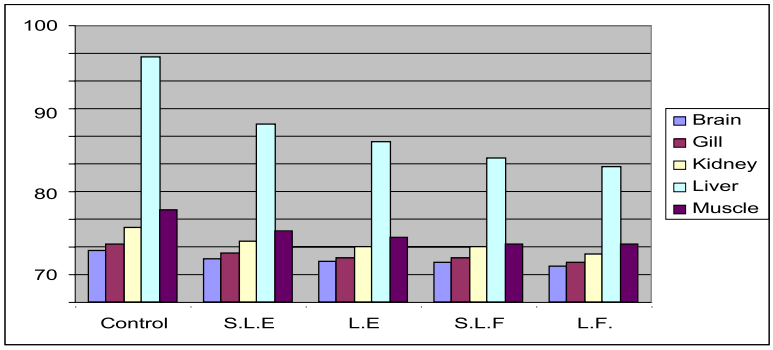

Fig. 1: Changes in the glycogen (mg/g wet weight of tissue) in different tissues of Labeo rohita on exposure to lethal and sub lethal concentrations of endosulfan and fenvalerate for 24 hrs.

S.L.E – Sub lethal Endosulfan, L.E – Lethal Endosulfan, S.L.F - Sublethal Fenvalerate, L.F – Lethal Fenvalerate

Table1:Changesintheglycogen(mg/gwetweightoftissue)indifferenttissuesofLabeorohitao nexposuretolethalandsublethal concentrationsofendosulfanandfenvaleratefor24hrs.

		Sub –Lethal	%Change	Lethal	%Change	Sub-Lethal	%Change	Lethal	%Change
Brain	**18.59± 0.03**	**15.63± 0.03**	**-16.92**	**14.56± 0.01**	**-22.01**	**15.12± 0.02**	**-21.46**	**13.01±0.001**	**-30.04**
Gill	**21.13 ±0.01**	**17.58± 0.03**	**-15.75**	**16.15± 0.02**	**-30.85**	**15.06± 0.01**	**-23.85**	**14.28±0.002**	**-31.36**
Kidney	**27.14± 0.02**	**22.07± 0.02**	**-18.71**	**20.9± 0.002**	**-24.98**	**21.02±0.001**	**-25.27**	**17.40±0.006**	**-34.92**
Liver	**88.61± 0.004**	**64.24± 0.002**	**-26.46**	**58.14± 0.002**	**-33.34**	**51.08±0.005**	**-40.20**	**49.10±0.005**	**-45.57**
Muscle	**33.25 ±0.01**	**25.69± 0.001**	**-23.73**	**23.18± 0.02**	**30.22**	**20.07±0.07**	**-35.60**	**21.08±0.004**	**-35.56**

Values are the means of five clarifications: (±) specifies the standard deviation values are important at P > 0.05

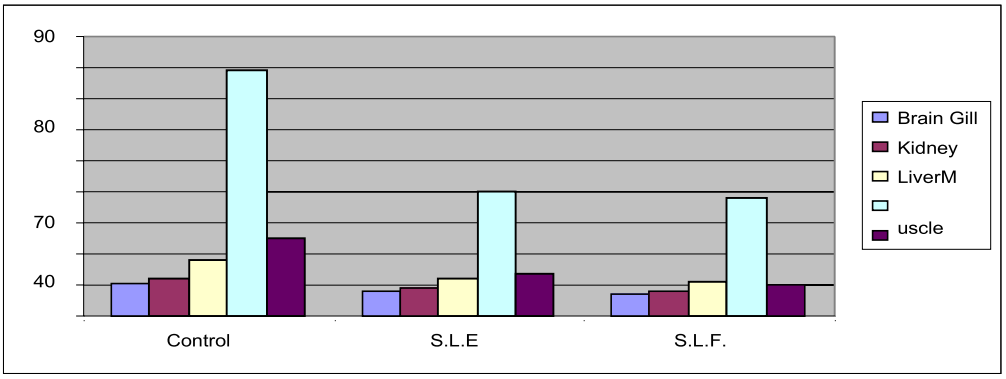

Fig.2:Changesintheglycogen(mg/gwetweightoftissue)indifferenttissuesofLabeorohitaon exposuretolethalandsub lethal concentrationsofendosulfanandFenvaleratefor15days.
S.L.E – Sub lethal Endosulfan; S.L.F – Sub lethal Fenvalerate
Table2:Changesintheglycogen(mg/gwetweightoftissue)indifferenttissuesofLabeorohitao nexposuretolethalandsub lethal concentrationsofendosulfanandFenvaleratefor15days

Organs	Control	Endosulfan		Fenvalerate	
		Sub-Lethal	% Change	Sub-Lethal	% Change
Brain	10.41± 0.01	8.15± 0.02	-21.69	7.06± 0.02	-32.22
Gill	12.06± 0.03	9.05± 0.01	-24.92	8.05± 0.023	-33.31
Kidney	18.06± 0.023	12.17± 0.01	-32.58	10.86± 0.01	-39.91
Liver	79.11± 0.01	40.04± 0.01	-56.83	38.11± 0.03	-58.92
Muscle	25.04± 0.01	13.25± 0.03	-33.85	10.08± 0.03	-49.71

The means of the following five observations are used to get the values: Standard deviations are statistically significant at a P-value of less than 0.05

Endosulfan and Fenvalerate have a significant adverse effect on the liver, which is a crucial organ for carbohydrate metabolism.

Nearly all of the fish gill, brain, and liver tissues.

Tests of endosulfan and fenvalerate combined showed that glycogen levels in kidneys and muscles decreased throughout the exposure period.

It is the primary concern of carbohydrate metabolism to meet the energy demands of animals in the aerobic segment11.

The liver, which has a larger glycogen content, is one of many tissues that is affected.

For this reason, glycogen production and use is dependent on the liver's involvement.

Glycogen is the primary source of energy storage in a healthy liver.

Hexose storage and transport are the primary concerns of the liverglycogen, which is primarily concerned with maintaining blood glucose levels.

Using muscle glycogen as a source of hexose units for glycolysis within the muscle is its primary function12. There was a lack of glycogen in the brain tissue despite the fact that it is highly metabolically active. Many teleost tissues see significant decreases in glucose and glycogen levels. Under sublethal conditions,Tilapiamossambica sodium arsenite concentration and stated that these fluctuations were tissue-specific and time-dependent13. In Labeo rohita, cypermethrin14 exposure lowered the total glycogen levels in the liver, brain, gill, kidney, and muscle. Hepatic cell injury is closely linked to decreased liver glycogen levels in fish,

fossils of Heteropneustes exposed to endosulfan, and other studies15. The fish Labeo rohita, Catlacatla, and Cirrhinusmrigala show a decrease in glycogen levels when exposed to low amounts of chlorpyrifos16. Labeo rohita was exposed to fenvalerate and had its glycogen levels reduced17. The freshwater fish Channa punctatus18 showed a decrease in glycogen levels after exposure to kelthane, an organochlorine insecticide. The tissues of freshwater fish Channa punctatus subjected to alachlor mechanical and lasso 51 percent EC formulation 19 showed a significant drop in glycogen levels. During times of stress, carbohydrate reserves must be depleted in order to meet the body's energy demands. Glycogen depletion may be the result of pesticide stress20 initiating a requirement for its direct utilization in energy generation. Enzymes are fundamental to the functioning of cells. To determine if a cell's integrity has been compromised, enzyme activity can be evaluated in the plasma or serum.

Lactate Dehydrogenase

Almost every cell in the body has the glycolytic enzyme LDH, and changes to its activity can provide direct and indirect evidence of cellular damage as well as illustrate the toxicity mechanism. Anaerobic glycolysis requires LDH as a last enzyme, hence it is critical to muscular physiology, especially under conditions of chemical stress where high levels of energy are needed quickly 22, 23, 24. LDH enzyme activity changes can indicate damage to any or all of the organs that produce this enzyme, such as the kidney or liver.

Table3:ChangesintheLDH(µmolesofformazan/mgprotein/h)indifferenttissuesofLabeorohitaone xposuretolethalandsublethal concentrationsofendosulfanandfenvaleratefor24hrs.

Organs	Control	Endosulfan – 24 hrs				Fenvalerate- 24 hrs			
		Sub –Lethal	%Change	Lethal	%Change	Sub-Lethal	%Change	Lethal	%Change
Brain	0.17± 0.02	0.16± 0.02	-11.10	0.15± 0.02	-16.65	0.15± 0.02	-16.65	0.14± 0.01	-22.21
Gill	0.36± 0.03	0.30± 0.01	-16.64	0.27± 0.02	-25.01	0.28± 0.02	-22.21	0.23± 0.03	-36.15
Kidney	0.23± 0.02	0.20± 0.03	-13.05	0.19± 0.05	-17.33	0.18± 0.04	-21.72	0.15± 0.04	-34.77
Liver	0.47± 0.01	0.40± 0.03	-27.66	0.32± 0.03	-31.90	0.33± 0.02	-29.75	0.28± 0.06	-40.43
Muscle	0.42± 0.03	0.34± 0.01	-19.03	0.31± 0.01	-26.15	0.32± 0.01	-23.81	0.26± 0.04	-38.03

Values are the means of five observations: (±) indicates the standard deviation values are significant at P > 0.05

[Fig. 3:Changes in the LDH (µ moles of formazan/mg protein/h) in different tissues of Labeo rohita on exposure to lethal and sub lethal concentrations of endosulfan and fenvalerate for 24hrs.

S.L.E – Sublethal Endosulfan, L.E – Lethal Endosulfan; S.L.F – Sublethal Fenvalerate,

L.F – Lethal Fenvalerate

Table4:ChangesintheLactatedehydrogenaseofLabeorohita(µmolesofformazan/mgprotein/h)one xposuretosub lethal concentrationsofendosulfanandfenvaleratefor15days

Organs	Control	Endosulfan		Fenvalerate	
		Sub-Lethal	% Change	Sub- Lethal	% Change
Brain	0.29± 0.02	0.26± 0.03	-10.32	0.23± 0.02	-20.65
Gill	0.39± 0.06	0.33± 0.02	-15.34	0.30± 0.02	-23.04
Kidney	0.27± 0.06	0.24± 0.02	-11.16	0.21± 0.02	-22.23
Liver	0.51± 0.08	0.40± 0.01	-21.54	0.36± 0.03	-29.40
Muscle	0.48± 0.01	0.39± 0.04	-18.72	0.36± 0.03	-25.0

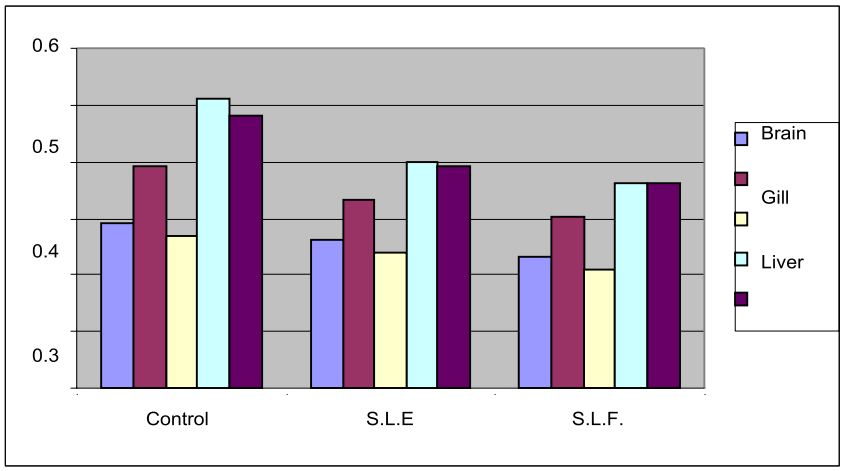

Fig.4:ChangesintheLactatedehydrogenaseofLabeorohita(µmolesofformazan/mgprotein/ h) Exposure to endosulfan and fenvalerate for 15 days resulted in the death of the subjects

"S. L. E." stands for "Sublethal Endosulfan." "S. L. F." denotes "Sublethal Fenvalerate." Depending on NAD27's accessibility, LDH interrupts the interconversion of lactate topyruvated. Endosulfan and fenvalerate were given to freshwater fish Hamilton for 15 days at sub-lethal and lethal doses, and it was found that the activity of LDH decreased as a result.

24hrs. Anaerobic egment, glycolysis, is likely to have a lower lactate dehydrogenase activity and a higher level of lactic acid. 27.

When channa punctatus was exposed to monocroophos, the amount of (LDH) lactate dehydrogenase activity decreased28. LDH activity was decreased in Channa Punctatus tissues treated to Euphorbiaroyeleanalatex, researchers found. 29. Endosulfan and fenvalerate exposure reduced LDH activities in freshwater fish Clarias Batrachus, showing a decrease in aerobic cannabinoid size of fish30.

Succinate Dehydrogenase (SDH)

Accurately oxidizing succinate to fumarate requires the vigor of SDH, an enzyme in the citric acid cycle responsible for this process. Fenvalerate and Endosulfan have been shown to reduce SDH activity rapidly in all tissues of fish Labeo rohita when compared to their equivalent controls in the current investigation. SDH activity was highest in the liver, followed by muscle, gills, and the kidney in the control fish. To explain why liver and muscle have such high levels of SDH, it is hypothesized that there is an increased supply of 12 mitochondria in these tissues.

Table5:ChangesintheSDH(µmolesofformazan/mgprotein/h)indifferenttissuesofLabeorohitaonex posuretolethalandsublethal concentrationsofendosulfanandfenvaleratefor24hrs

Organs	Control	Endosulfan – 24 hrs				Fenvalerate- 24 hrs			
		Sub –Lethal	%Change	Lethal	%Change	Sub-Lethal	%Change	Lethal	%Change
Brain	0.69± 0.02	0.64± 0.02	-7.23	0.60± 0.02	-13.05	0.62± 0.00	-10.16	0.56± 0.04	-18.85
Gill	0.78± 0.01	0.68± 0.023	-12.81	0.65± 0.01	-15.37	0.61± 0.01	-15.35	0.59± 0.01	-24.34
Kidney	0.76± 0.01	0.67± 0.01	-11.83	0.65± 0.03	-14.46	0.65± 0.02	-14.46	0.60± 0.02	-21.04
Liver	0.92± 0.02	0.78± 0.02	-15.20	0.71± 0.04	-22.81	0.76± 0.03	-17.37	0.65± 0.03	-29.33
Muscle	0.83± 0.002	0.72± 0.01	-13.24	0.67± 0.04	-19.25	0.69± 0.01	-16.85	0.60± 0.05	-27.70

Values are the means of five observations: (±) indicates the standard deviation values are significant at P > 0.05

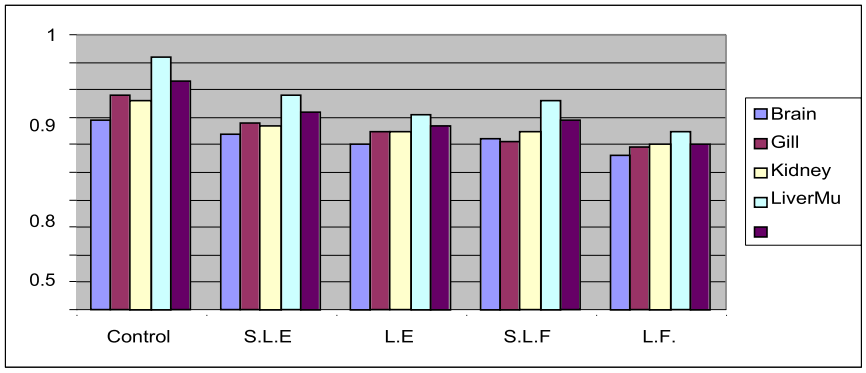

Fig.5:ChangesintheSDH(µmolesofformazan/mgprotein/h)indifferenttissuesofLabeorohitaonexposuretolethalandsublethal concentrationsofendosulfanandfenvaleratefor24hrs.
S.L.E – Sublethal Endosulfan, L.E- Lethal Endosulfan; S.L.F - Sublethal Fenvalerate, L.F - Lethal Fenvalerate.

Table6:ChangesintheSDH(µmolesofformazan/mgprotein/h)indifferenttissuesofLabeorohitaonexposuretolethalandsublethal concentrationsofendosulfanandfenvaleratefor15days

Organs	Control	Endosulfan		Fenvalerate	
		Sub-Lethal	% Change	Sub- Lethal	% Change
Brain	0.60± 0.02	0.54	-8.32	0.50± 0.06	-16.63
Gill	0.75± 0.01	0.65	-14.65	0.55± 0.02	-26.63
Kidney	0.63± 0.06	0.54	-12.68	0.52± 0.02	-17.43
liver	0.85± 0.02	0.60	-28.22	0.55± 0.04	-35.28
Muscle	0.78± 0.04	0.61	-23.06	0.54± 0.02	-30.75

Values are the means of five observations: (±) indicates the standard deviation values are significant at P > 0.05

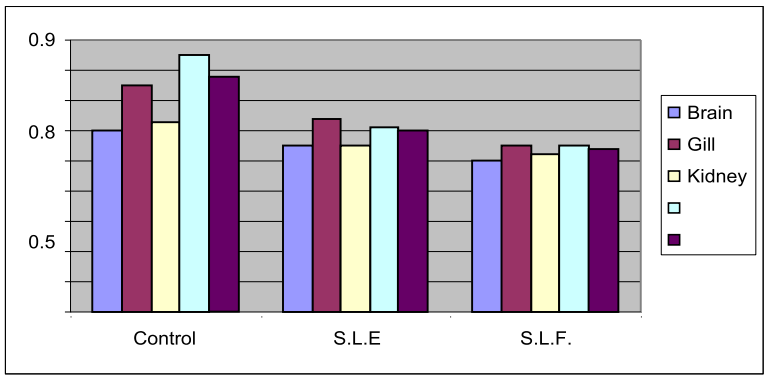

Fig.6:ChangesintheSDH(µmolesofformazan/mgprotein/h)indifferenttissuesofLabeorohitaonexposuretolethalandsublethal concentrationsofendosulfanandfenvaleratefor15days
S.L.E – Sublethal Endosulfan; S.L.F– Sublethal Fenvalerate,

SDH activity was likewise reduced in different kinds of fish that were unprotected from different chemicals. Cypemethrin31 exposure reduces the activity of LDH and SDH in the fish Colisa fasciatus. ethanolicexcerptofNeriumindicummilllatex32 was found to inhibit LDH and SDH activities in fresh water fishColisafasciatus.

When exposed to pesticides, SDH activity was reduced because of alterations in mitochondrial ultrastructure and structural integrity, as well as permeability and permeability33.

Inhibition of SDH activity and transition from aerobic to anaerobic metabolism are the results of this interruption of electron transfer to molecule oxygen34. The enzyme Malate Dehydrogenase (MDH)

NAD is required for the conversion of malate to oxaloacetate and the reversible oxidation of fumarate back to malate by an enzyme known as malate dehydrogenase. A mitochondrial and a cytosolic isozymic mechanism can both produce it. Malate is converted to oxaloacetate by this enzyme, which also plays an important role in CO2 addiction and luconeogenesis11.

To make Oxaloacetate, you need NAD+ and Malate.

Table7:ChangesintheMDH(µmolesofformazon/ mgprotein/h)indifferenttissuesofLabeor ohitaonexposuretolethalandsublethal

concentrationsofendosulfanandfenvaleratefor24hrs.

A low-lethal dose of endosulfan; a low-lethal dose of fenvalerate

Endosulfan 35 exposure reduced MDH levels in Clarias batrachus tissues. After exposure to Folidol 60036, matrinxa, Bryconcephalus showed a decrease in MDH activity.

Conclusion

Labeo rohita fish tissues treated with fenvalerate showed extra decrementinglycogenvalues and inhibition in the events of carbohydrate metabolic enzymes, which may be attributable to the additional pesticide stress.. Carbohydrate metabolism enzymes may be disrupted if glycogen was completely removed from the body37. Pesticides have been shown to dramatically decrease aerobic and anaerobic metabolism in animals exposed to them38.

Reference

1. Organochlorine pesticides and polychlorinated biphenyls accumulate in sediments, aquatic creatures, birds, bird eggs, and bats gathered from southern India. Environmental Science and Pollution Research International, 2001, 8, 35-47.
2. Trace detection in human serum of - and -endosulfan and three metabolites by gas chromatography tandem mass spectrometry by Vidal, M.L.J., Frias, M.M., Frenich, A.G., Olea-Serrano, F. and Olea, N. Massspectrum, 2000;14: 939-946. Rapid Communication.
3. Regional Assessment of Persistent Toxic Substances- Indian Ocean Regional Report on Chemicals- UNEP- Global Environment Facility, 2002, by Anon:
4. Toxic effects of endosulfan and how selenium reduces them: A
5. a combination of behavioral, hematological, and peroxidative stress testing was performed.
6. The Journal of Toxicology.2006, 3(1), 345-351..
7. Golden age of insecticide research: past, present, or future? Casida, J.E. and Quistad, G.B. Entomological Reviews, 1998; 43(1): 1–16.
8. The 3rd Edition of Finney's Probit Analysis, Cambridge University Press, London, 1971 has 330 pages.
9. Accurate determination of glycogen in tissues can be achieved by using a calorimetric technique. In Bio. Chem. J. 1954,56,646-648.

10. the physiological chemistry of Hawks (ed) TATA McGrawHill Publishing Company Limited, New Delhi, 1951, Bernard L. Oser.

11. T.N. Srikanthan and CR Krishnamurthi: Tetrazolium test for dehydrogenation. 1955, 14,206. J.Sci.Industrial Research

12. 24. M. M. Nachlas, S. P. Margulius, and M. Seligman: A colorimetric approach for the measurement of succnic dehydrogenase activity. 25. 1960, 235, 11. 499–504 in J. Biol. Chem.

13. 5th edition of Lehninger's Principles of Biochemistry. Cox, Michael M., and Nelson, David L. 2008. New York City.

14. Robert K. Murray, Daryl, K. Granner, and Victor W. Rodwell are the authors of Harper's illustrated Biochemistry (27th edition). Singapore, 2006, Lange Medical publications.

15. The effect of sodium arsenite on glucose and glycogen levels in freshwater teleost fish (Tilapia mossambica) was studied by Shoba Rani, Sudharshan, Reddy, P.V.M. and Raju, T.N. Poll.Res, 2000, 19(1): 129-131.

16. Symposion on the harmful effects of cypermethin (technical) on freshwater fish's organic contents. Proceedings of the Academy of Environmental Biology, 1998, 7(2), 143-148

17. Heteropneustes fossils were subjected to a correlative research of liver glycogen and endosulfan toxicity by Rawat D.K., Agrawal N.C., and Bais, VS. Environmental Biology, 2002, 23(2), 205-207.

18. toxicity and bioaccumulation of chlorpyrifos in Indian carp Catlacatla (Hamilton), Labeo rohita (Hamilton), and Cirrhinus mrigala, 30. Tilak, K. S., K. Veeraiah, and D. K. Rao (Hamilton). Environmental Contaminants and Toxicology, 2004, 73: 933–941.

19. Blood glucose and glycogen levels of freshwater fish, Labeo rohita, under fenvalerate intoxication can be used as indications of stress. Journal of Ecotoxicology and Environmental Monitoring, 15, 1–5, 2005.

20. Channa punctatus was exposed to kelthane (Dicofol 18.5 percent EC), an organochlorine insecticide, and its toxicity and effects were evaluated. (2006) 21(2), 1-7 in Journal of Aquatic Biochemistry (JAB).

21. Biochemical effects of alachlor on the freshwater fish Channapunctatus were studied in this study (Bloch). Environmental biology journal, 30(3), 421-426

22. Biological effects of Nuvan on Indian catfish Mystusvittatus, by T. Arasta, V.B. Bais, and P. Thakur. "Journal of Environmental Research," 1980, 80-83.

23. Enzymatic activity variations in the bloodstream of the Bullfrog, Ranacatesbeina, are examined in this study (Shaw, 1802). There are 22 to 27 pages in Rev. Vet., 2002/12/13

24. Reactive oxygen species (ROS), DNA damage and lactate dehydrogenase leakage by selected pesticides have been studied by Baghi, M, Hassoun, E.A and Stohs, S.J. Chemical and Environmental Toxicology, vol.

25. In rabbit muscle and bovine heart, the inhibitory impact of pentachlorphenol on lactate dehydrogenase allowed researchers to identify the presence of pentachlorphenol. "Pestic. Biochemistry and Physiology. 1999," pgs. 1-8.

26. A biomarker-based approach to Daphnia magna toxicity assessment V. De Coen, W. M., Jansen, C. R., and Segner, H. Sublethal amounts of mercury and lindane modify Daphnia magna's glucose metabolism in vivo. Environ. Toxicology and Toxicology 48:223-234

27. Intoxication biomarkers in the liver: a toxicologist's handbook, Human and Experimental Toxicology 21 (2002) 253–262.

28. Researchers found that an Opuntiaficusindica extract shielded the mice's livers against chlorpyrifos-induced damage in a study by Ncibi, Ben Othman, Akacha, Krifi, and Zourgui. 2008, 46(2), 797-802. Food ChemToxicol.

There is evidence that pesticides have an affect on fish metabolism, according to SambasivaRao KRS (1999), published by Discovery Publishing in New Delhi (India).

Biochemical changes in the blood plasma of Channa punctatus fish as a result of monocrotophos exposure are discussed in this study (Bloch). 2007, 88(3), 268-272, Pesticide biochemistry and physiology

In freshwater fish, Channa punctatus, cycloart-24-en-3-ol from Euphorbia royleana latex causes neuroenzyme pain and increases oxidative metabolism, according to Sudhanshu Tiwari, R.P. Pandey and Ajay Singh. In 2008, the African Journal of Traditional Complementary and Alternative Medicines published its fifth issue, with articles ranging from 332 to 339.

Freshwater fish are affected by Endosulfan-induced Biochemical Changes. 2004, 17, 47-56 Biomedical and Environmental Sciences

Catfish Clarias batrachus was subjected to Fenvalerate-induced metabolic enzymes, RNA and protein alterations CB&P, 2004,138(1): 75-79 (Comparative Biochemistry and Physiology, Section C).

Toxicological and Biochemical Changes of Cypermethrin (Synthetic Pyrethroids) against Freshwater Teleost Fish Colisa fasciatus at Different Seasons by Shailendra Kumar Singh, Sunil Singh and Ram P. Yadav The World Journal of Zoology. 2010; 5(1): 25-32.

A toxic ethanolic extract of Neriumindicum mill (Lalkaner) latex alters various metabolic parameters in the liver and muscle of Colisa fasciatus. Radiance of natural products., 2009, 8(1), 48-54

Freshwater fish Gambusiaaffinis had a significant decrease in SDH and LDH activity when exposed to nitrate, as well as an increase in LDH activity after nitrate was removed. Studies in Public Opinion Polling (1998) 17, 177-179.

Carbohydrate metabolism pathways of the common carp, Cyprinuscarpio, are affected by the use of pyrethroids. Pest management science, 2001, 57, 1151-1154. [Pest management science].

Research on the effects of Endosulfan on the cytoplasmic and mitochondrial liver of Rajnikant Mishra and SP Shukla Freshwater Catfish Malate Dehydrogenase (Clarias batrachus). "Comparative Biochemistry and Physiology," Volume117,Number1,Pages7-8(1997). Lucia Helena de Aguiar,GilbertoMoraes,IveMarchioniAvielez, Alexander EneasAltran and C.F.Christiana Ferro Correa: Metobolical effects of folidol 600 on the neotropical freshwater fish matrinxa, Bryconcephalus. Environmental Research., 2004,95(2), 224- 230

Tilak, K.S. Veeraiah, K. and Sastry, L.V.M.: A study on the effect of fenvalerate technical grade on carbohydrate metabolism of the Indian bullfrog Ranatigerina (Daud). Asian J. Microbiol. Biotech.Environ.Sci., 2001,3(4), 369-373.