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Study of serum glucose in *Rattus norvegicus* under the stress of few pesticides

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ABSTRACT

The present study includes toxicological profile of different pesticides as investigated. The experiment has been evaluated in male *Rattus norvegicus* using various parameters. This study was carried out to investigate the blood glucose of normal and understress of three groups of pesticides (organochlorine-endosulfan, carbamate-carbaryl and Organophosphorous-malathion). The study has drawn few possible correlations and conclusions to understand the effects of above pesticides with relation to their developmental days in laboratory rats. The present study includes the percentage increase or decrease of blood glucose level with relation to days (age) under the stressful effect of above three categories of hazardous chemicals.

Figures : 06 References : 18 Tables : 02

KEY WORDS : Carbaryl, Endosulfan, Malathion, *Rattus norvegicus,* Serum glucose, Stress.

Introduction

The demand of various insecticides has increased in present time and the trial of these powerful insecticides have controlled most of the obnoxious insects and other pests of agricultural importance like an avenging angel. Since the use of such insecticides have given spectacular results in many cases but high hopes raised by their introduction has not been fully achieved in view of many serious problems arising from their large scale use. These include, among others, development of the resistant population of insects, hazards to human health[4] and other mammals[16], environmental pollution, undesirable side effects on non-target animals[1] (*in vitro* study)and plants, and disruptive impacts on ecosystem. Under the circumstances, as an alternative strategy, the use of hormones (pesticides of the third generation), analogues and antagonist of insect growth regulators (Juvenile hormones and ecdysone), could have been recommended but whether their use is safe, *i.e.,* whether they do not pollute the ecosystem, is yet to be settled. However, the evidence at ground level suspect that the juvenile hormones, are also ambient molecules, may affect vertebrates has not been analyzed thoroughly. Thus recommending them for the control of various pests (Invertebrates[11] and vertebrates) is not advisable. So some selective agents or chemicals (*viz.,* attractants, arrestants, repellants, antifeedants and pheromones) should be looked into. These have already been employed for the control of some pests. Thus there is no alternative than to use more powerful insecticides subject to their minimum use so as to reduce the pollution of the ecosystem and other hazards. To achieve this, the approach must aim for making control operations fit well with the biology of the pest. This is the main concept of the recent control strategy designated as integrated control/pest management /harmonious control/rational pest control which emphasizes the regulation of the population below the economic injury level incorporating economically feasible known alternative control measures.

Pesticide applicators should understand the hazards and risks associated with the pesticides they use. Pesticides vary greatly in their toxicity *via* the inhalation route[17] or by ingestion and dermal absorption[3,]. Toxicity depends on the chemical and physical properties of a substance and may be defined as the quality of being poisonous or harmful to occupational/agricultural workers[4,13] or plants which are unwanted. Pesticides have many different modes of action, but in general they cause biochemical changes which interfere with normal cell functions.

Aim/Purpose –

1. To calculate the blood glucose changes due to the effects of various pesticides.

TABLE-1: Effect of Pesticides (1/10th of LD_{50}) on blood glucose (g/100ml) of *Rattus norvegicus*

S. No	Toxicants	Days										
		0	7	% + Incr. - Decr.	15	% + Incr. - Decr.	21	% + Incr. - Decr.	35	% + Incr. - Decr.	56	% + Incr. - Decr.
1.	***Endosulfan (0.011 g/kg/day)***	93.5 ± 0.145	105.00 ± 0.192[a]	+ 12.29	101.26 ± 0.191[a]	+ 8.29	96.20 ± 0.148[c]	+ 2.88	115.18 ± 0.199[a]	+ 23.18	112.65 ± 0.196[a]	+ 28.48
2.	***Carbaryl (0.085 g/kg/day)***	93.5 ± 0.145	105.12 ± 0.194[a]	+ 12.29	112.65 ± 0.196[a]	+ 20.48	113.92 ± 0.198[a]	+ 20.42	98.73 ± 0.152[c]	+ 5.59	101.26 ± 0.196[a]	+ 8.29
3.	***Malathion (0.28 g/kg/day)***	93.5 ± 0.145	101.2 ± 0.190[a]	+ 8.29	113.92 ± 0.198[a]	+ 21.83	113.92 ± 0.198[a]	+ 21.83	92.40 ± 0.141[c]	- 1.17	101.26 ± 0.196[a]	+ 8.29

TABLE-2 : Effect of Pesticides (1/20th of LD_{50}) on blood glucose (g/100ml) of *Rattus norvegicus*

S. No	Toxicants	Days												
		0	15	% + Incr. - Decr.	30	% + Incr. - Decr.	45	% + Incr. - Decr.	60	% + Incr. - Decr.	75	% + Incr. - Decr.	90	% + Incr. - Decr.
1.	***Endosulfan (0.0055 g/kg/day)***	93.5 ± 0.145	89.85 ± 0.150[c]	- 3.8	98.74 ± 0.152[c]	+ 5.60	113.92 ± 0.196[a]	+ 21.06	117.72 ± 0.198[a]	+ 25.90	108.86 ± 0.195[a]	+11.07	110.73 ± 0.195[a]	+ 18.47
2.	***Carbaryl (0.0425 g/kg/day)***	93.5 ± 0.145	115.18 ± 0.199[a]	+ 23.18	105.06 ± 0.192[a]	+ 12.29	98.20 ± 0.51[c]	+ 5.02	110.7 ± 0.195[a]	+ 19.46	112.13 ± 0.196[a]	+ 19.92	108.20 ± 0.196[a]	+ 15.72
3.	***Malathion (0.14 g/kg/day)***	93.5 ± 0.145	117.7 ± 0.197[b]	+ 25.88	98.46 ± 0.151[c]	+ 5.30	110.5 ± 0.195[a]	+ 18.18	107.5 ± 0.194[a]	+ 14.97	103.7 ± 0.190[a]	+ 10.90	111.7 ± 0.195[a]	+ 19.47

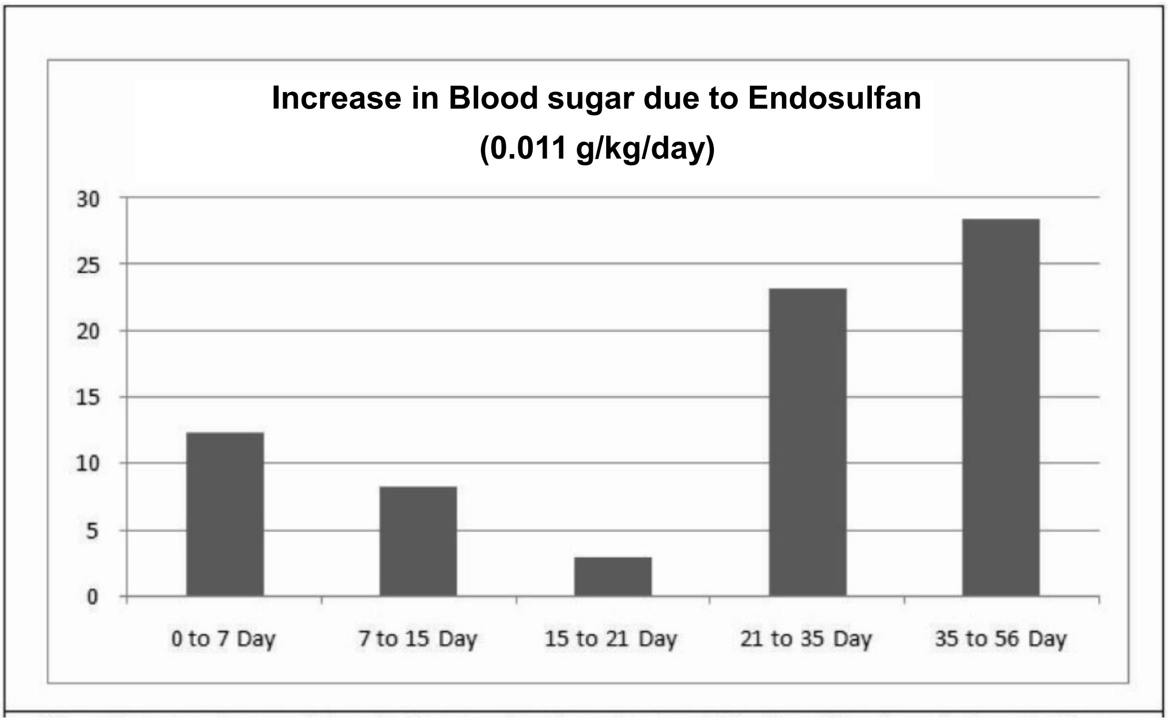

Fig. 1 : Percentage ± blood glucose in the stress of Endosulfan in relation to Days

2. To study the changes in blood glucose during the specific gap of days.
3. To calculate the vitality harm as blood glucose changes .
4. To study the percentage increase or decrease in blood glucose level at various stress parameters.
5. To calculate the complete blood chemistry changes during the stressful condition of various pesticides.

Materials and Methods

1. Pesticides

(A) Endosulfan is an organochlorine biocide used for controlling pests and mites by generating neurotoxic effects (*i.e.*, hyper-stimulation).Upon application, receiving soils act as primary reservoir of endosulfan

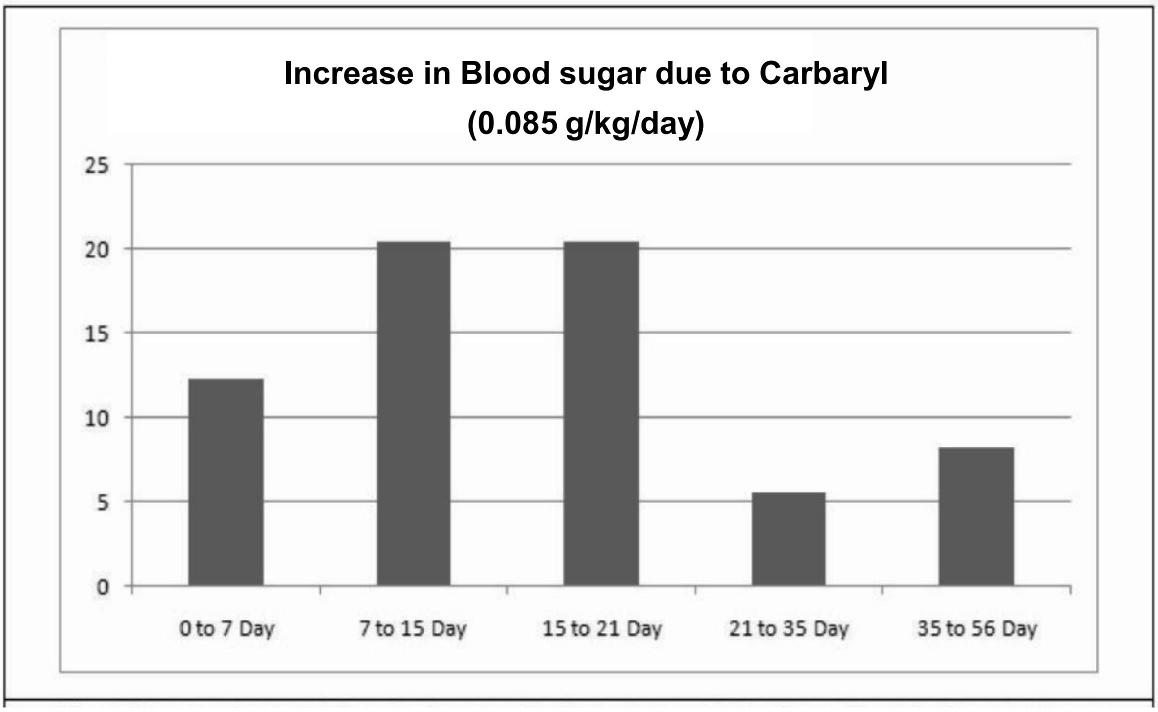

Fig. 2 : Percentage ± blood glucose in the stress of Carbaryl in relation to Days

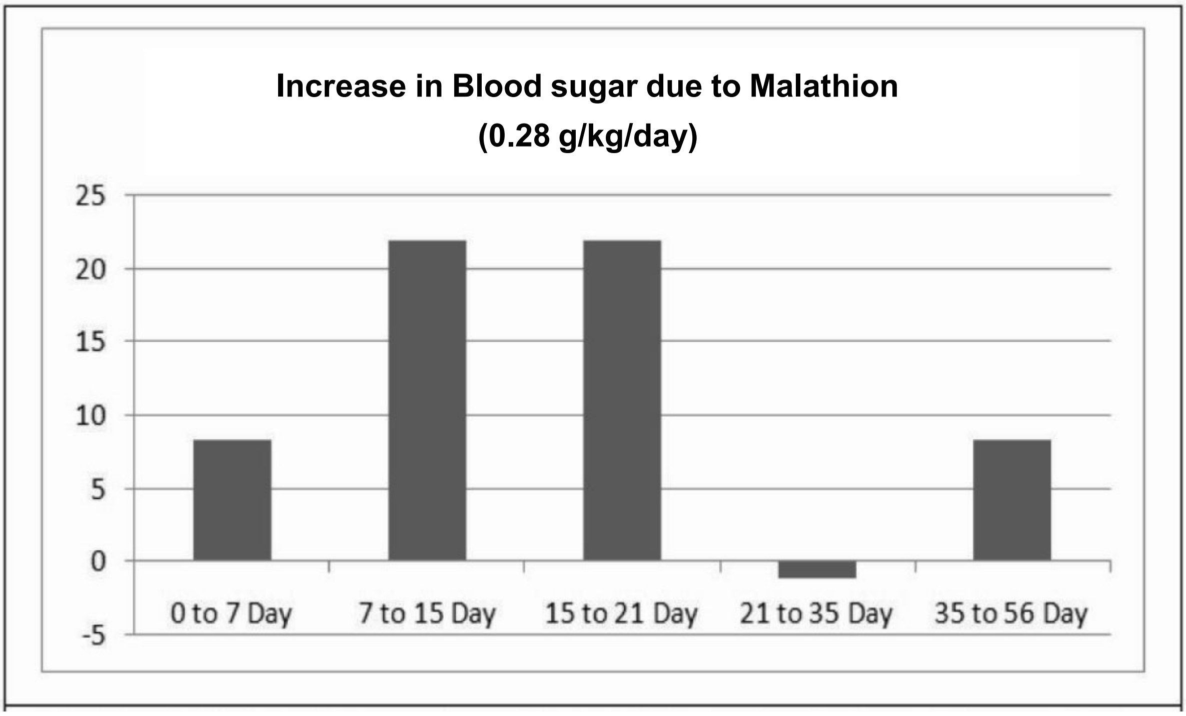

Fig. 3 : Percentage ± blood glucose in the stress of Malathion in relation to Days

in the environment; because of its hydrophobic properties, endosulfan has shown high mobility across environmental compartments. Classified as a semi-volatile compound, endosulfan is prone to evaporation, subsequent atmospheric transportation may occur, resulting in wide dispersion and remote deposition from application sites. Endosulfan transfers to water bodies through runoff and favors accumulation on to sediments once in the water column[6]. Both microbial and abiotic processes transform endosulfan in the environment: bacteria oxidize endosulfan to the respective sulfate, whereas endosulfan diol forms after alkaline hydrolysis. These intermediates exert similar toxic effects on biota and humans. Chronic exposure to endosulfan leads to bioaccumulation in fish; acute exposure results in neurotoxicity (hyperactivity and convulsions) in animals and humans; severe poisoning can lead to organ failure and death.

(B) Carbaryl-(chemical name 1-naphthyl methyl-carbamate) is sold under many trade names, the most common being Sevin. It is widely used in agriculture, in horticulture and in residential settings. The primary mechanism of action is reversible inhibition of acetyl cholinesterase and it is generally regarded as being safe with respect to human health[7].

(C) Malathion- Malathion is a broad-spectrum organo phosphorus insecticide for agricultural, industrial, and outdoor home uses, and for treating ectoparasites. It has low persistence in the environment. Humans are exposed through inhalation, dermal contact, diet, and water[4,14,]. Oxidative de sulfuration converts malathion to malaoxon, which inhibits acetyl cholinesterase in neural tissues. Acetylcholine accumulation at synapses results in toxicity from cholinergic hyper stimulation. Alternate toxicity mechanisms are possible. Detoxification through carboxyl esterase converts malathion to carboxylic acids for further metabolism. Reproductive, developmental, and immunologic toxicity are plausible under some circumstances. Malathion exhibits moderate to high toxicity in non target organisms[2].

2 Test animals

The experiments were carried out using male albino rats (*Rattus norvegicus,* wistar strain). Two hundred eighty five (285) male albino rats (average body weight 145 g ± 10 g) were housed under uniform animal husbandry conditions in Department of Zoology D.A.V. College, Kanpur.

3 Vehicle and route

Samples of insecticides : endosulfan, carbaryl and malathion[9,10] were dissolved in refined peanut oil (postman brand) and administered orally to all the animals of both experiment in predetermined doses for a period of 56 and 90 days.

4 Doses

The following dose schedules in both the experiments were used for the treatment of animals

I. Endosulfan -Two dosage of endosulfan were selected for the study

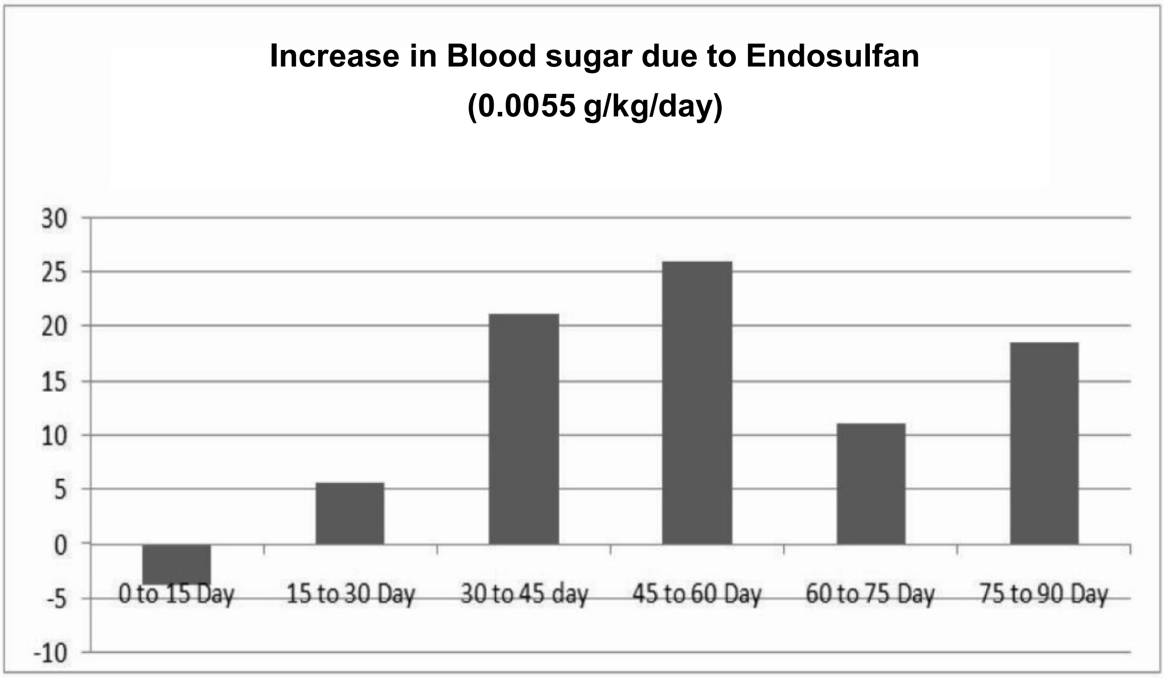

Fig. 4 : Percentage ± blood glucose in the stress of Endosulfan in relation to Days

(i) 0.011 g/kg/day *i.e.*, 1/10th of LD_{50} for 56 days

(ii) 0.0055 g/kg/day *i.e.,* 1/20th of LD_{50} for 90 days.

II. Carbaryl - Two dosage of Carbaryl were selected for the study

(i) 0.085 g/kg/day *i.e.,* 1/10th of LD_{50} for 56 days

(ii) 0.0425 g/kg/day *i.e.,* 1/20th of LD_{50} for 90 days.

III. Malathion - Two dosage of Malathion were selected for the study

(i) 0.280 g/kg/day *i.e.,* 1/10th of LD_{50} for 56 days

(ii) 0.140 g/kg/day *i.e.,* 1/20th of LD_{50} for 90 days.

5 Treatment schedule All the 285 animals were divided equally into 15 groups with 30 animals for 56d, 35

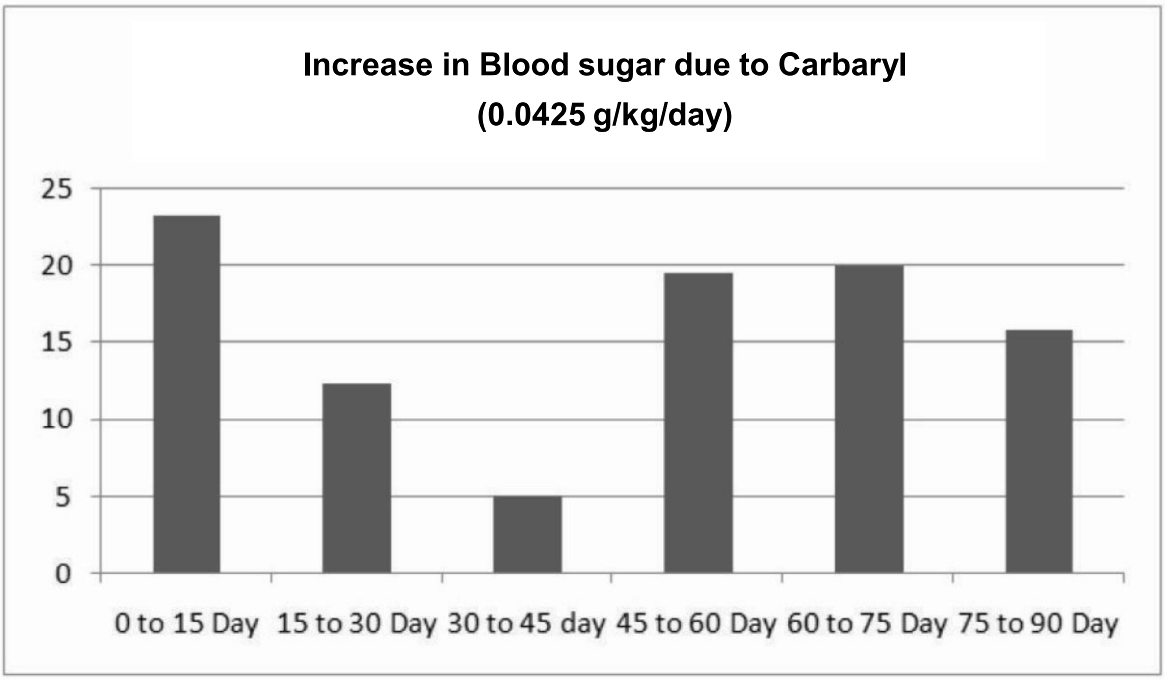

Fig. 5 : Percentage ± blood glucose in the stress of Carbaryl in relation to Days

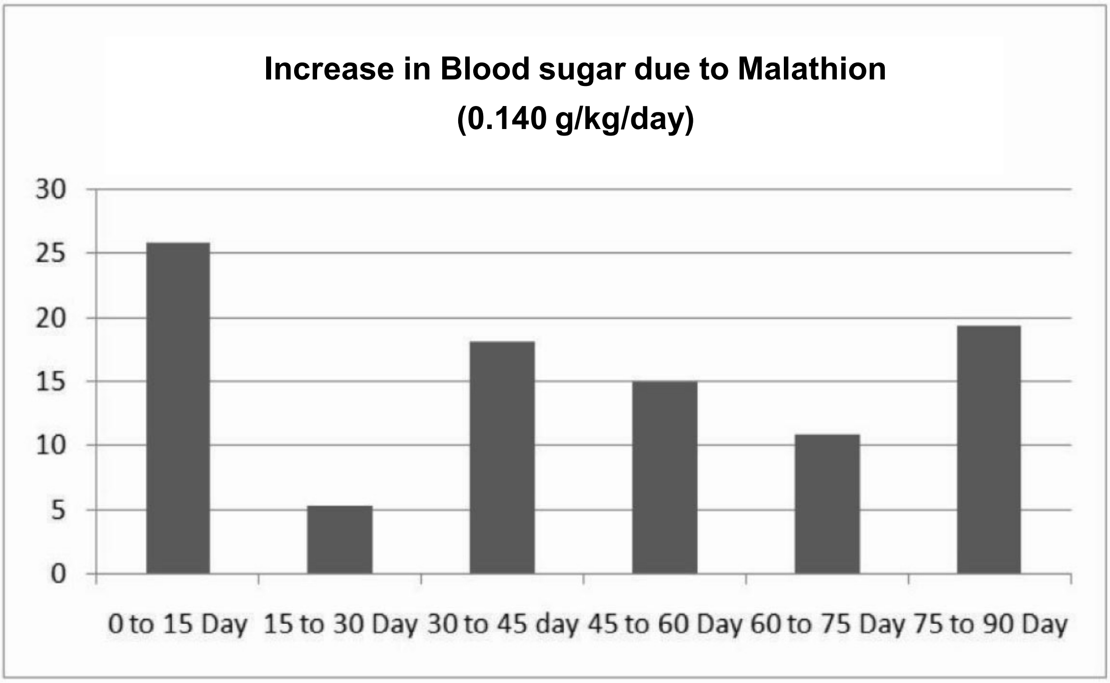

Fig. 6 : Percentage ± blood glucose in the stress of Malathion in relation to Days

a = P < 0.05 = Significant
b = P < 0.001 = More significant
c = P < 0.01 = Not significant
Values represent mean ± SE of five animals
**** The pesticides were given by gavage***

animals for 80d. 10 animals for blood sugar experiment of 56d & 90d and 10 animals for normal control group. 95 animals for one insecticide and total 285 animals for all the three insecticides. The treatment schedule of different groups are shown in Table-1 and Table-2.

I. Clinical signs of toxicity
II. Haematological and blood chemistry studies
III. Physiological studies
IV. Histopathological studies
V. Statistical analysis

Climate and Temperature

Kanpur experiences mainly three seasons *i.e.* Summer (March, April May, June), Rainy (July, August, September, October) and Winter (November, December, January, February). In summer, the average maximum temperature goes up to 47.5°C, accompanied by dust storms and heat-waves. Temperatures during cold weather drop down with minimum of almost 12- 14^{0}C. Kanpur experiences severe fog in December and January almost every year

Result and Discussion

Blood - Glucose

The level of glucose in blood raised to 12.29, 8.29, 2.88, 23.18 and 112. 65 percent (P < 0-05) after 7, 15, 21, 35 and 56 days) respectively in animals of group-13 treated with endosulfan (1/10th of LD_{50}) *i.e* 0.011g/kg/ day). The level of glucose was observed to be highest after 35 days which is highly significant (P < 0.05) while it was not significant (P < 0.01) after 21 days (Table 1)

Endosulfan (0.055 g/kg/day *i.e.,* 1/20th of LD_{50}) increased the level of glucose in blood t o 3.8, 5.60, 21.06, 25.90, 11.07, 18.47 percent after- 15, 30, 45, 60, 75 and 90 days. respectively .

The increase and decrease of blood glucose is given in Table-1. The level of glucose was observed to be highest after 60 days which is highly significant (P < 0.05) while it is not significant (P < 0.01) in 15 and 30 days.

Blood glucose increased in blood of the animals (14th group) treated with **carbaryl** (0.085 g/kg/day *i.e,* 1/ 10th of LD_{50}). The level increased to 12.29, 20.48 percent

(P < 0.05), 20.42 (P < 0.05) after 7, 1 5, 21, 35 and 56 days; respectively. The blood glucose level increased most significantly (P < 0.05) after 21 days while it was not significant (P < 0.01) after 35 days (Table-1)

The animals (group-17) treated with carbaryl (0.425 g/kg/day *i.e.,* (1/20th of LD_{50}) showed increased level of blood glucose to 23.18 (P < 0.05), 12.29, 5.02 (P < 0.01 , 19.46 , 19 .42 and 15.72 percent after 15, 30, 45, 60, 75 ·and 90 days as compared to control (Table-2)

The animals treated with malathion (0.280 g/kg/ day 1/10th of LD_{50}) showed the same hyperglycemic condition[18]. The level of glucose in blood raised to 8.29, 21.83, 21.83 (P < 0.05), 1.17 (P < 0.01) and 8.29 percent after 7, 15, 21, 35 and 56 days respectively in 15th group (Table-1)

The animals treated with malathion (0.140 g/kg/ day *i.e.,* 1/20th of LD_{50}) showed the same hyperglycemic condition[10]. The level of glucose in blood raised to 25.08 (P < 0.001), 5.30 (P < 0.01), 18.18, 14.97, 10.90 and 19.97 percent at 15, 30, 45, 60, 75 and 90 days respectively in group 18. (Table-2)

Hyperglycemic condition was observed in animals treated with endosulfan[12], carbaryl and malathion (1/10th of LD_{50}). The toxicant increased the level of blood glucose[14,18] in the whole duration of experiment and mostly it was significant (P < 0.05) and sometimes it was not significant (P < 0.01). In the toxicants endosulfan, carbaryl and malathion (1/20th of LD_{50}) same hyperglycemic conditions[9,14] were observed in the blood glucose in the whole duration of the experiment as compared to control. The blood glucose level is also disturbed due to the histopathological changes in the thyroid gland, which alters the secretory activity and also the changes in hormonal level[8].

Conclusion

Blood glucose of animals. kept under the stress of all the three pesticides, showed hyperglycemic conditions which indicates weakness throughout the experiment. It also induces histopathological changes in liver, kidney and intestine[5, 15].

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