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EFFECT OF SANDAPHOS AND β-CYPERMETHRIN EXPOSURE ON CHOLINESTERASE AND ALKALINE PHOSPHATASE ACTIVITY IN LIVER, KIDNEY AND BRAIN OF *EUPHLYCTIS CYANOPHLYCTIS*

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ABSTRACT

The present study was conducted to determine the effects of exposure of two pesticide groups organophosphate and pyrethroid on the activity of enzymes cholinesterase (ChE) and alkaline phosphatase (ALP) in liver, kidney and brain tissue of *Euphlyctis cyanophlyctis*. LD_{50} of each pesticide was determined. The frogs were treated by 5 and 10% of Sandaphos. The results showed decrease in ChE activity in the liver, kidney and brain upto 10.0 and 15.0% ($F_{2,6}$=5.23, P=0.048) in liver, 10.0 and 50.0% ($F_{2,6}$=7.00, P=0.027) in kidney, and 55.55 and 66.66% ($F_{2,6}$=87.17, P=0.001) in the brain, respectively. Under the treatment of same concentrations of β-cypermethrin the ChE activity decreased upto 20.0 and 30.0% ($F_{2,6}$=13.28, P=0.006) in liver, 30.0 and 40.0% ($F_{2,6}$=6.80, P=0.029) in kidney and 33.33 and 44.44% ($F_{2,6}$=22.99, P=0.002) in the brain, respectively. The effects of same concentrations of both pesticides were also observed on alkaline phosphatase (ALP) activity in the liver, kidney and brain of *E. cyanophlyctis*. In case of sandaphos it decreased upto 50.0 and 62.50% ($F_{2,6}$=91.00, P=0.001) in liver, 16.66 and 33.33 % ($F_{2,6}$=1.31, P=0.337) in kidney, and 11.11 and 33.33 % ($F_{2,6}$=2.25, P=0.186) in the brain, respectively, while under the treatment of same concentrations of β-cypermethrin the ALP activity in the liver decreased upto 12.5 and 25.0% ($F_{2,6}$=1.19, P=0.368), 16.66 and 33.33% ($F_{2,6}$=1.66, P=0.267) in kidney, and 22.22 and 55.55 % ($F_{2,6}$=1.92, P=0.227) in the brain, respectively.

Keywords: *Euphlyctis cyanophlyctis,* cholinesterase, alkaline phosphatase, sandaphos, β-cypermethrin.

INTRODUCTION

Globally decline of populations of amphibians is a major environmental issue (Vertucci and Corn, 1996). Pesticides are toxic to biodiversity and the aquatic environment (Reigart and Roberts, 2006). Over two billion pounds of pesticides are sold in US each year for agriculture, commercial and home (Khan *et al.,* 2007[a]). However, the effects of these toxic materials remain to be studied on non-target biodiversity in many regions of the world (Khan *et al.,* 2002[b]). Agricultural areas where pesticides are often used have lower amphibian species richness and abundance than adjacent non-agricultural sites (Bonin *et al*., 1997).

Amphibians are of particular concern because they are declining more rapidly than either birds or mammals. They are important for the overall ecosystem balance. The large biomass of amphibians makes them significant prey for other animals (Khan *et al.,* 2007[a]). The global loss of amphibian populations was first recognized in 1989 as a phenomenon that deserved worldwide attention (Barinaga, 1990; Wake, 1991; Blaustein, 1994; Alford and Richards, 1999). Generally most obvious factors contributing to amphibian population declines are habitat destruction and alteration (Alford and Richards, 1999). A wide array of contaminants may affect amphibian populations which include pesticides, herbicides, fungicides, fertilizers and numerous pollutants (Sparling *et al.,* 2000; Boone and Bridges, 2003). A diversity of pesticides and their residues are present in a wide variety of aquatic habitats (Harris *et al.,* 1998; McConnell *et al.,* 1998; LeNoir *et al.,* 1999; Kolpin *et al.,* 2002). While pesticides have the potential to affect many aquatic taxa (Blaustein and Wake, 1990; Houlahan *et al.,* 2000; Kiesecker *et al.,* 2001) and the amphibians living in these habitats exhibit physiological signatures of pesticides (i.e. reduced acetylcholine esterase activity; Sparling *et al*., 2001) and declining populations are correlated with greater amounts of upwind agriculture where pesticide use is common (Davidson *et al.,* 2001, 2002). Pesticides can severely affect amphibians in a variety of ways, as destroy the natural biotic balance in agricultural soils and reduce the diversity and abundance of biodiversity with cascading effects at higher trophic levels (Larson *et al.*, 1997). They can kill amphibians directly, affect their behaviour, reduce their growth rates, act as endocrine disrupters or induce immunosuppression (Bishop, 1992; Carey and Bryant, 1995; Alford and Richards, 1999). The causes of these declines include human involvement in an effort to increase agricultural products and indiscriminate use of pesticides. The pesticides, organophosphate and carbamate are widely used and have a variety of lethal and sublethal effects on non-target wildlife species (Parsons *et al*., 2000; Khan *et al.*, 2003[a]). Pyrethroids appear to effective voltage-dependent neuromuscular sodium channels producing tremors, hyperexcitation and convulsions (Van den Bercken, 1977; Vijverberg *et al*.,

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1982; Ruigt and Van den Bercken, 1986). Therefore, pesticides have been reported to have reduced enzyme activity of cholinesterase in frog *Rana tigrina* (Khan *et al.*, 2002[a,b]; Khan *et al.*, 2003[a,b]) in skittering frog *Rana cyanophlyctis* (Khan *et al.*, 2003[b,c,d]; Khan and Yasmeen, 2005; Khan *et al.,* 2007[a]; Khan *et al.,* 2008). Khan *et al. (*2007[b]) determined the induced effect of chlorpyrifos (organophosphate) on skin of *E. cyanophlyctis.* The effects of pesticides on alkaline phosphatase activity in liver, kidney and brain of *E. cyanophlyctis* were reported in Pakistan by Yasmeen (2007). In the present study, the effects of Sandaphos (organophosphate) and β-cypermethrin (pyrethroid) were observed on activity of two enzymes cholinesterase and alkaline phosphatase in liver, kidney and brain of skittering frog *E. cyanophlyctis.*

MATERIALS AND METHODS

The biochemichal experimental work was carried out on same weight of adults *Euphlyctis cyanophlyctis*, collected from several selected study areas of Province of Sindh. Collected frogs were brought in laboratory and kept in glass aquarium in the Wildlife Lab, Department of Zoology, University of Karachi. During the captivity, frogs were fed with prawns and insects. Two concentrations of both pesticides were applied, i.e. 5 and 10%. Single pesticide was injected in the sub-cutaneous abdominal region of frog by using insulin syringe. The effects of pesticide were observed in liver, kidney and brain tissue after 24 hours of post treatment. The liver, kidney and brain were taken as per Shakoori and Ahmad's (1973) techniques. Organs (liver, kidney and brain) were crushed in 2 ml bidistilled water with the help of motor and pestle and homogenized. The homogenates were centrifuged in Labofuge 15000 at 5000 rpm for 30 minutes and placed in cold chamber. Supernatents were taken in separate glass tubes to use in estimation of enzyme activity. The activity of enzyme cholinesterase (ChE) was estimated by Randox Kit No. CE-190. In colorimetric method (Knedel and Boetteger, 1967) the reagent composition was consisting of Buffer (Phosphate buffer=50 mmol/l having pH 7.7 and DTNB=0.25 mmol/l) and Substrate (Butyrylthiocholine iodide=6 mmol/l). The method based upon the hydrolysis of butyrylthiocholine by the action of enzyme butyryl cholinesterase. The reaction between thiocholine and dithiobis (nitrobenzoate) gave 2-nitro-5-mercaptobenzoate, a yellow compound which was measured at 405 ηm.

Principle:

$$\text{Butyrylthiocholine} + H_2O \xrightarrow{\text{Cholinesterase}} \text{thiocholine} + \text{butyrate}$$

$$\text{Thiocholine} + \text{DTNB} \rightarrow \text{2-nitro-5-mercaptobenzoate}$$

DTNB = Dithiobis (nitrobenzoate)

The activity of enzyme alkaline phosphatase (ALP) was estimated by Randox Kit No.AP-307. In colorimetric method (Rec.GSCC, 1972) the reagent composition was Buffer (Diethanolamine buffer=1 mol/l, pH=9.8 and $MgCl_2$= 0.5 mmol/l) and Substrate (p-nitrophenylphosphate=10 mmol/l). The reaction based upon the hydrolysis of p-nitrophenylphosphate by the action of alkaline phosphatase.

Principle:

$$\text{p-nitrophenylphosphate} + H_2O \xrightarrow{\text{ALP}} \text{phosphate} + \text{p-nitrophenol}$$

Statistical analyses were conducted by Micro Soft Excel and Minitab (Minitab Inc, 1996). Data presented as percentages were arcsine–square-root transformed before analyses. One way analysis of variance (ANOVA) was used to compare the effect of two concentrations of each pesticide on activity of enzymes cholinesterase and alkaline phosphatase.

RESULTS AND DISCUSSION

Examination of the results of this study indicates that the effect of two concentrations of Sandaphos on cholinesterase in the liver, kidney and brain were decreased upto 10.0 and 15.0% in liver ($F_{2,6}$=5.23, P=0.048) (Table1), 10.0 and 50.0% in kidney ($F_{2,6}$=7.00, P=0.027) (Table 2), and 55.55 and 66.66% in the brain, ($F_{2,6}$=87.17, P=0.001), respectively (Table 3).

Under the effect of two concentrations of β-Cypermethrin the ChE activity decreased in liver, kidney and brain of were upto 20.0 and 30.0% in liver ($F_{2,6}$=13.28, P=0.006) (Table 4), 30.0 and 40.0% in kidney ($F_{2,6}$=6.80, P=0.029) (Table 5), whereas 33.33 and 44.44% in the brain, ($F_{2,6}$=22.99, P=0.002), respectively (Table 6).

The effects of same concentrations of both pesticides were also observed on alkaline phosphatase activity in liver, kidney and brain of *E. cyanophlyctis*. In the case of sandaphos the ALP activity was decreased upto 50.0 and 62.50% in liver ($F_{2,6}$=91.00, P=0.001) (Table 7), 16.66 and 33.33 % in kidney ($F_{2,6}$=1.31, P=0.337) (Table 8) and 11.11 and 33.33% in brain, ($F_{2,6}$=2.25, P=0.186), respectively (Table 9).

Under the effect of same concentrations of β-cypermethrin the ALP activity was decreased upto 12.5 and 25.0% in liver ($F_{2,6}$=1.19, P=0.368) (Table 10), 16.66 and 33.33% in kidney ($F_{2,6}$=1.66, P=0.267) (Table 11) and 22.22 and 55.55 % in the brain, ($F_{2,6}$=1.92, P=0.227), respectively (Table 12).

Amphibians are known to be vulnerable to pesticides that are cholinesterase inhibitors (Wang and Murphy, 1982). There is some indication, that field application of these

chemicals may be deleterious to amphibians (Jolly *et al*., 1978; Thybaud, 1990; Berril *et al*., 1993; Materna *et al*., 1995). A number of non-target species can be affected when pesticides are used because of their affect on cholinesterase activity. The enzyme inhibition occurs in a number of species and reduction can result in sub-lethal toxicity and death (Cooper, 1991). Anticholinesterase pesticides function by binding with this enzyme in animals and disrupting nervous system activity, usually causing death by respiratory failure. Decreased cholinesterase activity can indicate exposure to some commonly used pesticides and can be harmful to wild animals (Catherine and Gloria, 2000).

Organophosphate can be affecting on cholinesterase activity in both red blood cells and in blood plasma, and can act directly, or in combination with other enzymes, on cholinesterase in the body. The first notable studies to examine the effects of organophosphates on amphibians were reported in the early sixties (Edery and Schatzberg-Porath, 1960; Mulla, 1962; Mulla *et al.,* 1963). More recently several studies indicated that standard field application rates of organophosphates may have a deleterious effect on amphibian population (Anguiano *et al*., 1994; Berril *et al.,* 1993 and1994; Schuytema *et al.*, 1995; Sparling *et al.,* 1997). The pyrethroids have emerged as a major class of active pesticides due to their high bio-efficacy and relatively low toxicity in comparison to organochlorine and organophosphorous pesticides (Casida *et al*., 1983) and are used worldwide in households, cereals, vegetable, cotton, tobacco, and other crops (Clickman and Lech, 1982; Smith and Stratton, 1986).

In the present study, under the effect of 5 and 10% concentrations of sandaphos, the ChE activity was decreased upto 10.0 and 15.0% in the liver (P<0.0 48), 10.0 and 50.0% in the kidney (P<0.027) and 55.55 and 66.66% in the brain, (P<0.001), respectively. In the case of β-Cypermethrin the ChE activity was also decreased upto 20.0 and 30.0% in the liver (P<0.006), 30.0 and 40.0% in kidney (P<0.029), while 33.33 and 44.44% in the brain, (P<0.002), respectively.

Tilak *et al*. (2003), investigated that the effect of fenvalerate in Indian bullfrog to sublethal dose (1/3 of LC_{50} I.E. 1.166 mg/kg) and the effect was studied on the specific activity of acetyl-cholinesterase in the different tissues of frog liver, kidney, brain, muscle, and testis at different time periods viz., 3, 6, 12, 24, 48 and 72 hours. It was found that the inhibition in activity of acetyl-cholinesterase was in the order of kidney > brain > muscle > liver > testis. A significant inhibition was noticed in kidney at 12 hours (-64.33%) and no effect was noticed at 3 hours in testis (+0.67%). It was concluded that the AChE activity was inhibited in first three hours of administration of fenvalerate in all the tissues tested. The inhibition continued upto 6 hours or 2 hours in different tissues but the recovery was started by 24 hours and almost completed by 72 hours.

Another study, Khan *et al*. (2003[a]), investigated the effect of cypermethrin and permethrin on cholinesterase in *Rana tigrina* and reported that the ChE activity decreased in the treated frogs. The present findings are generally in accordance with the previous reports.

Khan *et al*. (2003[b]), compared the effect of two pyrethroids lambda cyhalothrin with permethrin on cholinesterase in *R. cyanophlyctis* and *R. tigrina* and reported that the amphibian in general are sensitive and *R. cyanophlyctis* is more sensitive to *R. tigrina,* and lambda cyhalothrin is more toxic among the pesticides tested. In the present finding also, it was observed that β-Cypermethrin inhibited the ChE activity in the liver, kidney and brain.

Khan *et al.* (2003[c]) determined the adverse induced effect of lambda cyhalothrin and monocrotophos on ChE in the liver, kidney and brain of *R. cyanophlyctis*. According to results it was decreased upto 34.6 and 46.3% in the liver, 25.08 and 57.1% in the kidney and 31.64 and 50.7% in the brain under the effect of lambda cyhalothrin, while under the treatment of monocrotophos, ChE decreased upto 37.7 and 57.7% in liver, 57.5 and 67.5% in kidney and 47.6 and 65.9% in the brain, respectively. The effect of Chlorpyrifos and Dathrin exposure for 24 hours on liver, kidney and brain of *E. cyanophlyctis* indicated that the activity of ChE was decreased upto 30.0 and 45.0% in liver (P<0.001), 20.0 and 50.0% (P<0.016) in kidney and 33.33 and 55.55 % (P<0.001) in the brain respectively. Under the effect of two concentrations of Dathrin i.e. 0.04 and 0.08% the ChE activity in the liver was decreased upto 15.0 and 45.0% (P<0.005), 20.0 and 40.0% (P<0.025) in the kidney, while 22.0 and 44.0% in the brain (P<0.029), respectively (Khan *et al.,* 2008). The present findings are generally in accordance with the previous reports.

The alkaline phosphatase is a unique enzyme that is usually present in the tissues involved in transport function and regeneration (McGomb *et al*., 1979). This enzyme has been extensively studied in liver, bone, placenta, intestine and serum. The localization of this enzyme in plasma membrane strongly suggests its involvement in membrane functions (Fishman, 1974). Yora and Sakagishi (1986), studied the activity of alkaline phosphatase isozymes in fish, amphibians, reptiles, birds and mammals. The alkaline phosphatases from the liver, kidney and intestine in various vertebrates were strongly inhibited by beryllium, 2-mercaptoethanol, potassium cyanide and EDTA. The enzymes showed various sensitivities to the inhibition by zinc and to heat denaturation at 56 degrees Celsius for 5 min at pH 7.0.

Table 1. Activity of cholinesterase in liver of *E. cyanophlyctis* treated with Sandaphos.

Treatment	Mean (U/l)	S.D. ±	S.E. ±	Range at 95% Confidence limit	Inhibition %
Control	18.4	10.449	6.039	6.576 - 30.223	00
5%	16.56	9.951	5.752	5.285 - 27.834	10.0
10%	15.64	10.449	6.039	3.801 - 27.478	15.0

$F_{2,6} = 5.23$, $P = 0.048$

Table 2. Activity of cholinesterase in kidney of *E. cyanophlyctis* treated with Sandaphos.

Treatment	Mean (U/l)	S.D. ±	S.E. ±	Range at 95% Confidence limit	Inhibition %
Control	9.2	6.373	3.684	1.978 - 16.421	00
5%	8.28	7.302	4.220	0.006 - 16.553	10.0
10%	4.6	3.186	1.842	0.989 - 8.210	50.0

$F_{2,6} = 7.00$, $P = 0.027$

Table 3. Activity of cholinesterase in brain of *E. cyanophlyctis* treated with Sandaphos.

Treatment	Mean (U/l)	S.D. ±	S.E. ±	Range at 95% Confidence limit	Inhibition %
Control	8.28	2.76	1.595	5.153 - 11.406	00
5%	3.68	1.593	0.921	1.874 - 5.485	55.55
10%	2.76	0.00	0.00	-	66.66

$F_{2,6} = 87.17$, $P = 0.001$

Table 4. Activity of cholinesterase in liver of *E. cyanophlyctis* treated with β-Cypermethrin.

Treatment	Mean (U/l)	S.D. ±	S.E. ±	Range at 95% Confidence limit	Inhibition %
Control	18.4	10.449	6.039	6.561 - 30.238	00
5%	14.72	11.154	6.447	2.082 - 27.357	20.0
10%	12.88	8.431	4.873	3.327 - 22.432	30.0

$F_{2,6} = 13.28$, $P = 0.006$

Table 5. Activity of cholinesterase in kidney of *E. cyanophlyctis* treated with β-Cypermethrin.

Treatment	Mean (U/l)	S.D. ±	S.E. ±	Range at 95% Confidence limit	Inhibition %
Control	9.2	6.373	3.684	1.978 - 16.421	00
5%	6.44	4.215	2.436	1.663 - 11.216	30.0
10%	5.52	4.780	2.763	0.103 - 10.936	40.0

$F_{2,6} = 6.80$, $P = 0.029$

Table 6. Activity of cholinesterase in brain of *E. cyanophlyctis* treated with β-Cypermethrin.

Treatment	Mean (U/l)	S.D. ±	S.E. ±	Range at 95% Confidence limit	Inhibition %
Control	8.28	2.76	1.595	5.153 - 11.406	00
5%	5.52	2.76	1.595	2.393 - 8.646	33.33
10%	4.60	3.186	1.842	0.989 - 8.210	44.44

$F_{2,6} = 22.99$, $P = 0.002$

The liver and kidney enzymes showed higher sensitivity to the inhibition by L-homoarginine than by L-phenylalanine. The intestinal enzymes in higher vertebrates were more sensitive to the inhibition by L-phenylalanine than by L-homoarginine, whereas the intestinal ones in lower vertebrates showed quite similar sensitivities to both amino acids. Goseki *et al.* (1990) examined the enzymatic and immunological properties of

Table 7. Activity of alkaline phosphatase in liver of *E. cyanophlyctis* treated with Sandaphos.

Treatment	Mean (U/l)	S.D. ±	S.E. ±	Range at 95% Confidence limit	Inhibition %
Control	7.36	3.186	1.842	3.749 - 10.970	00
5%	3.68	1.593	0.921	1.874 - 5.485	50.0
10%	2.76	00	00	-	62.5

$F_{2, 6} = 91.00$, P= 0.001

Table 8. Activity of alkaline phosphatase in kidney of *E. cyanophlyctis* treated with Sandaphos.

Treatment	Mean (U/l)	S.D. ±	S.E. ±	Range at 95% Confidence limit	Inhibition %
Control	5.52	2.76	1.595	2.393 - 8.646	00
5%	4.6	3.1869	1.842	0.989 - 8.210	16.66
10%	3.68	1.593	0.921	1.874 - 5.485	33.33

$F_{2, 6} = 1.31$, P = 0.337

Table 9. Activity of alkaline phosphatase in brain of *E. cyanophlyctis* treated with Sandaphos.

Treatment	Mean (U/l)	S.D. ±	S.E. ±	Range at 95% Confidence limit	Inhibition %
Control	8.28	7.302	4.220	0.006 - 16.553	00
5%	7.36	5.745	3.321	0.850 - 13.869	11.11
10%	5.52	4.780	2.763	0.1039 - 10.936	33.33

$F_{2, 6} = 2.25$, P = 0.186

Table 10. Activity of alkaline phosphatase in liver of *E. cyanophlyctis* treated with β-Cypermethrin.

Treatment	Mean (U/l)	S.D. ±	S.E. ±	Range at 95% Confidence limit	Inhibition %
Control	7.36	3.186	1.842	3.749 - 10.970	00
5%	6.44	4.215	2.436	1.663 - 11.216	12.50
10%	5.52	2.76	1.595	2.393 - 8.646	25.00

$F_{2, 6} = 1.19$, P = 0.368

Table 11. Activity of alkaline phosphatase in kidney of *E. cyanophlyctis* treated with β-Cypermethrin.

Treatment	Mean (U/l)	S.D. ±	S.E. ±	Range at 95% Confidence limit	Inhibition %
Control	5.52	2.76	1.595	2.393 - 8.646	00
5%	4.6	1.593	0.921	2.794 - 6.405	16.66
10%	3.68	1.593	0.921	1.874 - 5.485	33.33

$F_{2, 6} = 1.66$, P = 0.267

Table 12. Activity of alkaline phosphatase in brain of *E. cyanophlyctis* treated with β-Cypermethrin.

Treatment	Mean (U/l)	S.D. ±	S.E. ±	Range at 95% Confidence limit	Inhibition %
Control	8.28	7.302	4.220	0.006 - 16.553	00
5%	6.44	4.215	2.436	1.663 - 11.216	22.22
10%	3.68	1.593	0.921	1.874 - 5.485	55.55

$F_{2, 6} = 1.92$, P = 0.227

alkaline phosphatase (ALP) in several tissues of bullfrog *Rana catesbeiana*. The inhibition and thermal inactivation studies showed that bullfrog ALP in kidney, liver and intestine had similar enzymatic properties. In addition, mouse antiserum against bullfrog liver ALP cross-reacted with kidney and intestine enzymes as well as with liver enzyme.

Another study, the adverse effect of Chlorpyrifos and Dathrin on ALP activity in the liver, kidney and brain of E. *cyanophlyctis* were reported, under the effect of chlorpyrifos it was decreased upto 25.0 and 50.0% (P<0.027) in liver, 33.33 and 50.0% (P<0.219) in kidney, 22.22 and 44.44% (P<0.231) in the brain, respectively, while under the effect of Dathrin it was decreased upto

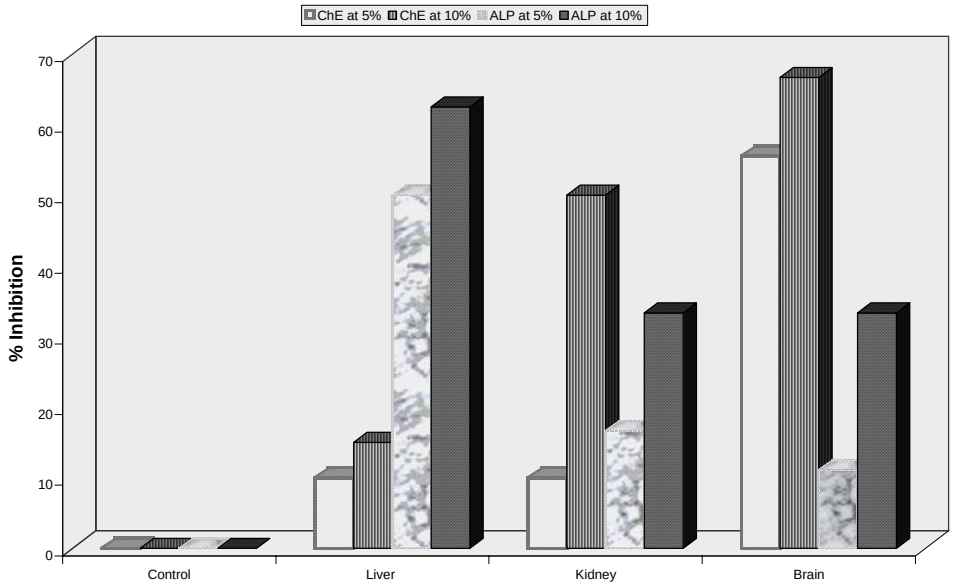

Fig. 1. Activity of ChE & ALP in liver, kidney and brain of *E. cyanophlyctis* treated with Sandaphos.

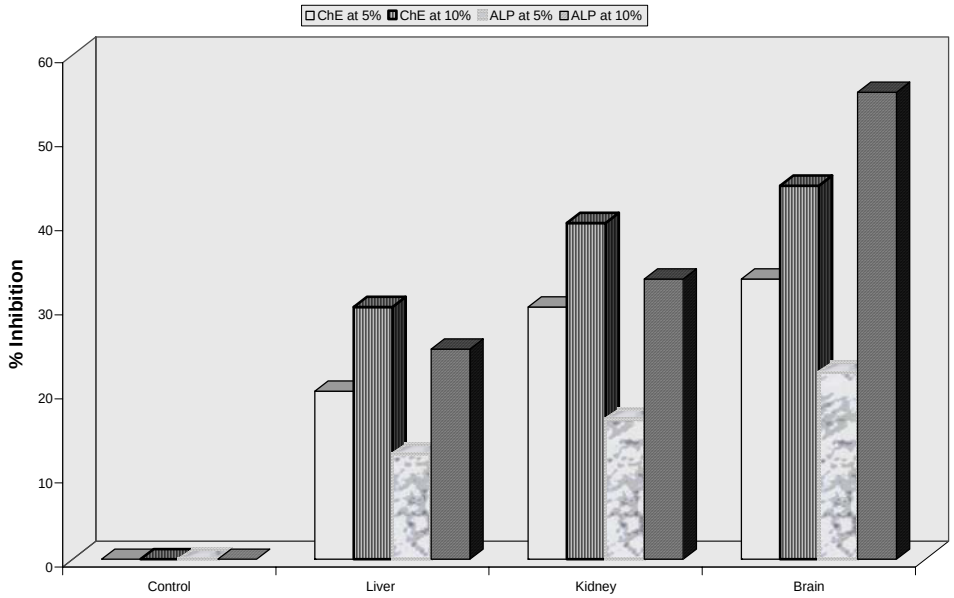

Fig. 2. Activity of ChE & ALP in liver, kidney and brain of *E. cyanophlyctis* treated with β-cypermethrin.

37.50 and 50.0% (P<0.001) in liver, 16.66 and 50.0% (P<0.214) in kidney and 44.44 and 55.55% (P<0.219) in the brain, respectively (Khan *et al.,* 2008).

In the present study, Sandaphos and β-Cypermethrin also decreased the ALP activity in *E. cyanophlyctis.* According to results, Under the effect of 5 and 10% concentration of sandaphos, ALP was found to be decreased upto 50.0 and 62.50% in liver (P<0.001), 16.66 and 33.33% in kidney (P<0.337) and 11.11 and 33.33% (P<0.186) in the brain, respectively, while under the effect of same concentrations of β-cypermethrin exposure, the ALP activity was decreased upto 12.5 and 25.0% in liver (P<0.368), 16.66 and 33.33% in kidney (P<0.267) and 22.22 and 55.55% (P<0.227) in the brain, respectively. In general the present results are in agreement with earlier published results.

During this study, it was also observed that under the effect of Sandaphos the activity of ChE was decreased in the order of brain > kidney > liver (Fig. 1) while the activity of ALP was decreased in the order of liver > kidney > brain (Fig. 1) which shows Sandaphos strongly inhibited the ALP activity in liver. In the case of β-Cypermethrin (Fig. 2) the inhibition of ChE and ALP activity was in the order of brain > kidney > liver.

CONCLUSION

On the basis of present findings it is concluded that the selected pesticides Sandaphos (organophosphate) and β-Cypermethrin (pyrethroid) decreased the cholinesterase and alkaline phosphatase activity in the liver, brain and kidney of *E. cyanophlyctis.* The organophosphate group is more harmful to *E. cyanophlyctis* as compared to pyrethroid group. It is therefore, suggested that pyrethroid group could be a better pesticide if used at lower doses in agriculture fields and other places.

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