INTRODUCTION

An increase in global food demand has resulted in a significant increase in the use of pesticides in agriculture and animal husbandry. Pyrethroid pesticides have gained popularity over other conventional pesticides due to their high efficacy against target species, their relatively low mammalian toxicity and rapid biodegradability. Synthetic pyrethroid pesticides account for over 30% of the global pesticide use and these are preferentially used in place of organophosphates and organochlorines (El-Tawil and Abdel-Rahman 2001). Cyfluthrin is a synthetic type-2 pyrethroid insecticide, which was originally isolated from the flower of chrysanthemum. Due to its versatility it has become a useful ingredient of various formulations used for the control of a wide range of insects including cutworms, cockroaches, ants, termites, grain-beetle, weevil, fleas, flies and mosquitoes (Ecobichon, 2001). Cyfluthrin produces its action through membrane depolarization and loss of electrical excitability in the central and the peripheral nervous system because of its interaction with sodium-ion-gated channels. Cyfluthrin has been reported to exhibit selective toxicity to insects and a sparingly low toxicity in mammals due to rapid liver metabolism and urinary excretion of both the metabolized and intact compound. However, laboratory animals exposed to relatively high doses of cyfluthrin have shown similar toxic effects as those observed in insects; including convulsions, salivation, ataxia, weakness and apathy (Laskowski, 2002). Due to the central role played by the liver in the detoxification of cyfluthrin, there is a ten-
dency for its accumulation and subsequent toxicity to the liver, disrupting the normal hepatic functioning. In addition, certain pyrethroids have been known to produce oxidative stress in animals, but no such data is available regarding cyfluthrin. Low level of chronic exposure to agricultural chemicals may not have clinically recognizable symptoms but could produce subtle cumulative events that eventually affect the health of organism (Bebe and Panemanglore 2003). The potential hazard due to pesticide residues on the health of livestock is a growing concern. Although some work on the toxicity of cyfluthrin has been done in different animals, there is limited information available regarding its toxic mechanisms in buffalo species. In order to better understand the mechanism of toxicity of cyfluthrin, it was thought pertinent to investigate the ability of cyfluthrin to modulate the activities or concentrations of endogenous antioxidants in buffalo calves.

**MATERIALS AND METHODS**

Twelve male buffalo calves (6-12 months), weighing between 70-120 kg, were randomly divided into three groups of four animals. These animals were dewormed and acclimatized to uniform environmental conditions and were provided fodder of season and water *ad libidum*. Group I served as control whereas group II and III animals were orally administered cyfluthrin at the rate of 10 and 20 mg/kg/d for 11 consecutive weeks. Blood samples were collected at weekly intervals via jugular venipuncture in heparinized vials during the period of treatment and two weeks of the post-treatment period whereas that of cyfluthrin withdrawal. Lipid peroxidation is considered to be the main factor for establishing the oxidative stress produced by a particular compound and generally plays a major role in the development and severity of toxicity syndromes.

The corresponding elevation in the activities of antioxidant enzymes especially superoxide dismutase which dismutates the superoxides produced and results in the generation of hydrogen peroxide, which is further decomposed by catalase, however, this increase was not sufficient to overcome the oxidative stress caused to the animals, as is evident by the incline in lipid peroxidation. A similar increase in the erythrocyte fragility has also been observed in in vitro by Sadowska et al. (2010) in humans.

Glutathione plays a pivotal role in the maintenance of intracellular redox status and antioxidant enzyme functions. It acts as a reducing agent and a vital substance in detoxification in the aqueous phase of cellular systems. Its antioxi-dants in biological system (Kelly et al. 1998). In the present investigation, there was a dose dependent increase in the extent of lipid peroxidation (Figure 1). The elevation was degree of 48.5% in low dose group and 64.4% in the high dose group. The enzymic activity of catalase showed a significant decline to the extent of 29.2% and 31.8% in the low-dose and high-dose groups, respectively (Figure 2). A similar trend was observed in the activity of superoxide dismutase (Figure 3). After the withdrawal of cyfluthrin the activity of superoxide dismutase returned to normal within two weeks of the post-treatment period whereas that of catalase remained significantly higher even after two weeks of cyfluthrin withdrawal. Lipid peroxidation is considered by the incline in lipid peroxidation. A similar increase in the erythrocyte fragility has also been observed in in vitro by Sadowska et al. (2010) in humans.

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Glutathione plays a pivotal role in the maintenance of intracellular redox status and antioxidant enzyme functions. It acts as a reducing agent and a vital substance in detoxification in the aqueous phase of cellular systems. Its antioxidant activity is through the thiol group of its cysteine residue (Rana et al. 2002). The blood glutathione levels showed progressive decline with the incremental dosing of cyfluthrin.
Figure 1: Effect of repeated oral administration of cyfluthrin on lipid peroxidation in buffalo calves

Figure 2: Effect of repeated oral administration of cyfluthrin on catalase activity in buffalo calves

Figure 3: Effect of repeated oral administration of cyfluthrin on superoxide dismutase activity in buffalo calves
The levels were reduced by 22.2% and 27.9% in the low-dose and high-dose groups, respectively, by the 11th week of pesticide treatment (Figure 4). A significant inverse relationship exists between the extent of lipid peroxidation and glutathione status. In contrast to the decline in the activities of catalase and superoxide dismutase, there was a significant elevation in GPx activity in cyfluthrin treated animals (Figure 5). This increase was to the extent of 16.9% and 18.8%, in low-dose and high-dose groups, respectively.

The activity of GPx returned to normal during the post-treatment period in both the treatment groups. In the present investigation, the progressive increase in the extent of lipid peroxidation with time, in animals experimentally induced with cyfluthrin toxicity, is suggestive of peroxidative changes imposed by this pesticide on the erythrocytes. The cell has several mechanisms to alleviate the effects of oxidative stress, either by repairing the damage or by directly diminishing the occurrence of oxidative damage by means of enzymatic and nonenzymatic antioxidants. Reduced glutathione is a powerful and known antioxidant in the cells and plays a vital role in protecting cells against radical and oxyradical damage (Verma and Srivastava, 2000). The corresponding elevation in the activity of glutathione peroxidase and the inhibition of enzymes superoxide dismutase and catalase, which are vital in intra-cellular antioxidant defense, were not able to sufficiently neutralize the oxidative stress in terms of increased lipid peroxidation and decreased glutathione content in animals treated with cyfluthrin.

However, the almost normalization of the enzymic system within two weeks of the withdrawal period is suggestive
that cyfluthrin is a moderately toxic insecticide when used in the recommended concentrations.

REFERENCES


