

HAEMATO-BIOCHEMICAL EFFECTS OF ORAL SUB-CHRONIC CYPERMETHRIN TOXICOSIS IN BUFFALO CALVES

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ABSTRACT

Cypermethrin, a type II synthetic pyrethroid insecticide, at a dose rate of 0.5 mg/kg/day for 14 consecutive weeks, produced mild signs of toxicity in buffalo calves. Repeated exposure to cypermethrin produced a significant increase in the plasma levels of lactate dehydrogenase (15.4%), gamma-glutamyl transpeptidase (18.7%), aspartate aminotransferase (13.5%), blood urea nitrogen (75%) and plasma creatinine (33.9%). It also produced significant decrease in the levels of total proteins (4.9%), haemoglobin concentration (9.5%), packed cell volume (8.9%) and total erythrocytic count (14.3%), but, there was a significant increase in the erythrocyte sedimentation rate (6.6%).

Keywords: buffalo calves, cypermethrin, oxidative stress, insecticide, toxicity

INTRODUCTION

In the present world scenario, insect pest management has gained impetus, leading to constant evolution of pesticide technology as a result of which newer and safer compounds are being developed for various agricultural and veterinary practices. 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 now being preferentially used in place of organophosphates and organochlorines (El-Tawil and Abdel-Rahman, 2001).

The toxicity of pyrethroid insecticides to mammalian animals has received much attention in recent years because animals exposed to these insecticides exhibit changes in their physiological activities besides other pathological features. Cypermethrin is a synthetic type II pyrethroid. It is widely used as an insecticide in developing countries for controlling pests and in various agricultural practices (Usmani and Knowles, 2001). Due to the central role played by the liver in the detoxification of cypermethrin, there is a tendency for its accumulation and subsequent toxicity to the liver, disrupting the normal hepatic functioning. Low levels of chronic exposure to agricultural chemicals may not have clinically recognizable symptoms but could produce subtle cumulative effects that eventually affect the health of an organism. The potential hazard due to pesticide residues on the health of livestock is a growing concern.

Although extensive research work is being done on various aspects of synthetic pyrethroids, including their metabolism, pharmacological

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characteristics, ecotoxicity and detection of residues, little attention has been paid to their biochemical effects in nontarget species. Although some work on the toxicity of cypermethrin has been done in different animals, there is limited information available regarding its toxic mechanisms in buffalo species. So, in order to better understand the mechanisms involved in cypermethrin toxicity, it was thought pertinent to investigate its ability to modulate various biochemical and haematological parameters in buffalo calves.

MATERIALS AND METHODS

The experiments were performed on eight healthy male buffalo calves of 6-12 months of age and weighing between 60-120 kg, procured from the University Dairy Farm and local market. The animals were acclimatized in the animal shed of department under uniform conditions for 2 weeks prior to the commencement of study. The animals were dewormed, fed seasonal green fodder and wheat straw and had access to water *ad libitum*. Permission to conduct the experiment was duly obtained from the University Animal Ethics Committee. The animals were randomly divided into two groups of four animals, each. Animals of Group 1 served as healthy control whereas Group 2 animals were orally administered cypermethrin at a dose rate of 0.5 mg/kg/day for 14 consecutive weeks. Blood samples were collected in heparinized vials via jugular venipuncture at weekly intervals during the treatment period and on 2nd week after the withdrawal of treatment. Levels of cypermethrin were analyzed in the plasma of animals by gas chromatography using an electron capture detector (Gill *et al.*, 1996). Various parameters viz. plasma lactate dehydrogenase

(LDH), plasma gamma-glutamyl transpeptidase (GGT), aspartate aminotransferase (AST), alanine aminotransferase (ALT), blood urea nitrogen (BUN), plasma creatinine and total proteins were estimated using Bayer Autopak kits on a Photometer 5010 (Nicholas Piramal). In addition, the haematological parameters like erythrocyte sedimentation rate (ESR), packed cell volume (PCV), haemoglobin concentration, total erythrocyte count (TEC), total leucocyte count (TLC), differential leucocyte count (DLC), mean corpuscular volume (MCV), mean corpuscular haemoglobin concentration (MCHC) and mean corpuscular haemoglobin (MCH) were estimated by the methods described by Benjamin (1985). Statistical analysis was done using an SPSS® 16.0 software package.

RESULTS

Oral administration of cypermethrin at the dose rate of 0.5 mg/kg/day for 14 consecutive weeks resulted in an increase in plasma cypermethrin concentration for the initial four weeks, and thereafter, the cypermethrin concentration declined slowly (Figure 1). The initial incline could be due to continuous exposure of cypermethrin, and thereafter, the decline in cypermethrin concentration may be attributed to the induction of the metabolizing enzymes or decrease of plasma protein levels as observed in the present study.

Cypermethrin exposure produced significant elevation in the enzymatic activity of lactate dehydrogenase and gamma-glutamyl transpeptidase from the 12th week onwards (Table 1). This elevation in LDH and GGT was observed to be 16.3% and 23.6%, respectively, after 14 weeks of insecticide exposure. Similarly, the enzymic activity of aspartate aminotransferase increased

significantly from the 12th week onwards, elevating by 14.9% by the end of treatment period (Table 1). On the other hand, no significant changes were observed in the activity of alanine aminotransferase in cypermethrin exposed animals (Table 1). These findings are consistent with those reported by Aslam *et al.* (2010), Khan *et al.* (2009) and Remya *et al.* (2010) in poultry, goats and rats, respectively.

The increase in plasma LDH activity in present investigation reflects damage to a range of tissues including skeletal, cardiac muscles, kidney and liver. Although the exact cause of increased GGT level in the present study could not be ascertained, yet cholestatic disorders of all species are associated with increased GGT activity (Braun *et al.*, 1987). Aspartate aminotransferase is not an organ specific enzyme; however, as the cardiac and skeletal muscles have high concentrations of aspartate aminotransferase (Brar *et al.*, 2000), its elevation in present investigation suggests marked muscular damage. Alanine aminotransferase is employed as a marker of hepatocellular damage in various species and is usually elevated in disorders of inflammatory, toxic or degenerative origin (Dial 1995). Leakage of this enzyme into the blood occurs when there is damage to hepatocytes, so its level increases in plasma. In large domestic species, the activity of ALT in the liver is low and hence during liver injury, the ALT is not remarkably elevated (Tennant 1997).

Cypermethrin produced significant increase in the levels of blood urea nitrogen and plasma creatinine to the extent of 75% and 33.9%, respectively by the 12th week of insecticide exposure (Table 2). However, chronic cypermethrin exposure resulted in a significant decline in the total plasma proteins, to the extent of 4.9% after the 14th week of cypermethrin exposure (Table 2). The levels however returned to normal within 2

weeks post treatment. These findings are in league with those reported by Padma and Ashok (2010) in rats, Nagarjuna *et al.* (2008) in rabbits and Khan *et al.* (2009) in goats, exposed to pyrethroids.

Diseased or damaged kidneys cause an elevated BUN because the kidneys are less able to clear urea from the bloodstream. Elevated blood urea is correlated with an increased protein catabolism in the mammalian body (Murray *et al.*, 1990). Increase in plasma creatinine and BUN levels probably indicate renal damage, which may be attributed to urinary obstruction, which potentiates decreased secretion of urea from the body. Decrease in protein levels of plasma are usually seen in chronic liver diseases due to impaired synthesis and in renal diseases due to loss of proteins. Hypoproteinemia is seen in inflammations and is due to increased protein catabolism during stress. Leakage of proteins is also observed during glomerulonephritis. The decrease in protein levels of plasma in the present investigation could be attributed to impairment of protein synthesis following chronic exposure to cypermethrin.

Long term oral exposure to cypermethrin (0.5 mg/kg; 14 weeks) resulted in significant changes in the blood profile of exposed animals. This was manifested by a significant decrease in haemoglobin (18.7%) and packed cell volume (11.7%) by the 14th week of treatment, as depicted in Table 3. The levels however returned to normal within 2 weeks post-treatment. Similarly, a significant decline in TEC was observed in insecticide exposed animals from the 10th week onwards, declining by 16.9% by the 14th week of treatment (Table 3). In contrast, there was a significant increase in ESR from the 8th week onwards reaching a maximum of 8.02% by the 14th week of cypermethrin exposure (Table 3). However, the values returned to normal during

Table 1. Effect of repeated oral administration of cypermethrin 0.5 mg/kg/day on plasma lactate dehydrogenase, gamma-glutamyl transpeptidase, aspartate aminotransferase and alanine aminotransferase in buffalo calves.

| Time (weeks) | Control | Treatment | Control | Treatment | Control | Treatment | Control | Treatment |
|-----------------------|------------------------------|---------------------------|--------------------------------------|-----------------------|-----------------------------------|-------------------------|---------------------------------|-----------|
| Treatment | Lactate dehydrogenase | | Gamma-glutamyl transpeptidase | | Aspartate aminotransferase | | Alanine aminotransferase | |
| 0 | 1193.4±49.6 | 1215.6 ± 35.1 | 15.0±1.1 | 14.4±0.8 | 119.6±6.3 | 123.2±8.0 | 30.2±1.2 | 31.2±1.6 |
| 2 | 1136.2±47.9 | 1227.0 ± 46.4 | 14.0±0.8 | 15.0±0.8 | 122.6±6.4 | 121.4±6.3 | 29.4±2.6 | 31.0±3.0 |
| 3 | 1174.6±44.6 | 1235.0 ± 48.4 | 12.8±0.8 | 13.8±0.8 | 132.4±4.0 | 121.4±8.3 | 30.0±5.4 | 33.6±3.0 |
| 4 | 1203.4±56.6 | 1256.0 ± 55.6 | 14.0±0.8 | 14.8±0.7 | 131.0±5.9 | 125.0±10.2 | 33.8±4.8 | 39.0±5.1 |
| 5 | 1189.3±56.3 | 1271.0 ±51.6 | 15.7±1.0 | 14.8±0.8 | 133.0±4.9 | 124.0±8.8 | 35.0±4.6 | 39.2±5.1 |
| 6 | 1216.6±44.2 | 1302.4 ± 52.4 | 15.2±0.7 | 16.4±0.7 | 119.8±6.4 | 133.0±9.2 | 33.2±2.6 | 33.0±5.3 |
| 7 | 1235.7±64.6 ^a | 1334.4 ± 53.6 | 15.0±0.7 ^a | 16.6±0.8 | 131.0±6.1 ^a | 131.2±9.1 | 35.8±3.1 ^a | 38.6±3.4 |
| 8 | 1214.0±63.8 ^a | 1344.8 ± 64.1 | 15.1±1.0 ^a | 16.4±0.8 | 125.0±10.7 ^a | 139.2±7.2 | 34.0±6.3 ^a | 41.0±3.4 |
| 9 | 1256.7±48.9 ^a | 1366.4 ± 59.7 | 14.9±1.0 ^a | 16.6±0.8 | 122.7±9.7 ^a | 135.4±7.2 | 37.0±5.7 ^a | 44.6±3.9 |
| 10 | 1236.0±64.5 ^a | 1370.2 ± 55.9 | 15.4±0.8 ^a | 17.0±0.8 | 124.7±8.2 ^a | 137.0±6.1 | 35.3±5.8 ^a | 43.4±6.2 |
| 12 | 1233.0±53.6 ^a | 1423.0±56.5 ^{**} | 15.0±0.7 ^a | 17.4±0.7 [*] | 127.7±6.5 ^a | 145.0±7.6 ^{**} | 34.7±6.0 ^a | 45.2±5.6 |
| 13 | 1224.3±64.3 ^a | 1410.6 ±45.8 [*] | 15.3±0.8 ^a | 17.4±0.7 [*] | 126.3±7.6 ^a | 143.0±6.6 ^{**} | 34.0±4.3 ^a | 42.2±5.2 |
| 14 | 1228.7±57.6 ^a | 1413.6±51.2 ^{**} | 15.0±0.9 ^a | 17.8±0.8 [*] | 127.0±5.8 ^a | 141.6±6.8 ^{**} | 33.0±5.6 ^a | 37.4±5.1 |
| Post treatment | | | | | | | | |
| 2 | 1222.7±49.5 ^a | 1291.4 ± 40.9 | 15.7±0.9 ^a | 15.2±0.7 | 123.7±6.5 ^a | 134.8±4.9 | 35.0±3.1 ^a | 37.2±3.3 |

Values given are expressed as U/L and represent the Mean ± S.E. of 5 animals unless stated.

a= Mean ± S.E. of 4 animals.

Values with superscript in a given row differs significantly from each other. (*P<0.05 and **P<0.01).

Table 2. Effect of repeated oral administration of cypermethrin 0.5 mg/kg/day on blood urea nitrogen, creatinine and total proteins in buffalo calves.

| Time (weeks) | Control | | Treatment | | Control | | Treatment | |
|-----------------------|----------------------|-----------------------|------------------------|-------------------------|------------------------|------------------------|------------------------|------------------------|
| | Blood urea nitrogen | | Creatinine | | Total proteins | | Total proteins | |
| 0 | 3.2±0.4 | 3.6±0.7 | 1.14±0.06 | 1.20±0.05 | 7.21±0.18 | 7.17±0.19 | 7.21±0.18 | 7.17±0.19 |
| 2 | 4.2±0.8 | 3.8±0.4 | 1.20±0.07 | 1.13±0.08 | 7.11±0.17 | 7.06±0.17 | 7.11±0.17 | 7.06±0.17 |
| 3 | 3.2±0.7 | 3.2±0.5 | 1.13±0.05 | 1.22±0.09 | 7.11±0.21 | 7.14±0.22 | 7.11±0.21 | 7.14±0.22 |
| 4 | 3.6±0.5 | 3.2±0.4 | 1.18±0.06 | 1.23±0.11 | 7.16±0.18 | 7.09±0.18 | 7.16±0.18 | 7.09±0.18 |
| 5 | 2.8±0.3 | 2.6±0.3 | 1.11±0.06 | 1.27±0.12 | 7.05±0.15 | 7.01±0.17 | 7.05±0.15 | 7.01±0.17 |
| 6 | 3.2±0.4 | 3.8±0.4 | 1.24±0.06 | 1.23±0.08 | 7.07±0.16 | 7.08±0.15 | 7.07±0.16 | 7.08±0.15 |
| 7 | 2.5±0.6 ^a | 3.4±0.9 | 1.16±0.06 ^a | 1.27±0.06 | 7.02±0.22 ^a | 6.98±0.11 | 7.02±0.22 ^a | 6.98±0.11 |
| 8 | 4.3±0.3 ^a | 5.4±1.6 | 1.25±0.08 ^a | 1.30±0.10 | 7.10±0.20 ^a | 6.91±0.13 | 7.10±0.20 ^a | 6.91±0.13 |
| 9 | 4.3±1.5 ^a | 6.7±0.4 ^{**} | 1.15±0.10 ^a | 1.41±0.11 | 7.04±0.19 ^a | 6.90±0.25 | 7.04±0.19 ^a | 6.90±0.25 |
| 10 | 4.7±0.7 ^a | 7.2±0.6 ^{**} | 1.17±0.09 ^a | 1.45±0.10 ^{**} | 7.03±0.17 ^a | 6.81±0.12 | 7.03±0.17 ^a | 6.81±0.12 |
| 12 | 4.0±0.6 ^a | 7.0±0.5 ^{**} | 1.12±0.10 ^a | 1.50±0.12 ^{**} | 7.03±0.15 ^a | 6.76±0.15 | 7.03±0.15 ^a | 6.76±0.15 |
| 13 | 4.3±0.3 ^a | 7.4±0.5 [*] | 1.21±0.08 ^a | 1.49±0.11 ^{**} | 7.08±0.16 ^a | 6.75±0.11 [*] | 7.08±0.16 ^a | 6.75±0.11 [*] |
| 14 | 4.0±0.6 ^a | 7.1±1.0 ^{**} | 1.16±0.10 ^a | 1.50±0.12 ^{**} | 7.08±0.14 ^a | 6.73±0.13 [*] | 7.08±0.14 ^a | 6.73±0.13 [*] |
| Post-treatment | | | | | | | | |
| 2 | 4.0±0.6 ^a | 5.4±0.3 | 1.19±0.08 ^a | 1.27±0.08 | 7.11±0.09 ^a | 7.11±0.10 | 7.11±0.09 ^a | 7.11±0.10 |

Values given are expressed as mg/dl and represent the Mean ± S.E. of 5 animals unless stated.

a= Mean ± S.E. of 4 animals.

Values with superscript in a given row differs significantly from each other. (*P<0.05 and **P<0.01).

Table 3. Effect of repeated oral administration of cypermethrin 0.5 mg/kg/day on haemoglobin, packed cell volume, erythrocyte sedimentation rate and total erythrocytic count in buffalo calves.

| Time (weeks) | Control | Treatment | Control | Treatment | Control | Treatment | Control | Treatment | Control | Treatment |
|-----------------------|------------------------|-------------------------|-------------------------|--------------------------|--------------------------------|-------------------------|--------------------------|-------------------------|---------|-----------|
| Treatment | Haemoglobin | | Packed cell volume | | Erythrocyte sedimentation rate | | Total erythrocytic count | | | |
| 0 | 8.96±0.29 | 9.10±0.31 | 38.46±1.19 | 38.55±0.56 | 130.2±1.8 | 129.6±1.2 | 5.08±0.29 | 5.21±0.12 | | |
| 2 | 8.94±0.40 | 9.12±0.21 | 38.29±0.78 | 38.21±1.12 | 131.0±1.4 | 131.2±1.9 | 5.08±0.13 | 5.18±0.29 | | |
| 3 | 8.75±0.31 | 9.03±0.32 | 37.82±0.34 | 37.87±0.46 | 131.8±2.7 | 129.6±2.9 | 5.05±0.21 | 5.22±0.25 | | |
| 4 | 8.84±0.21 | 9.01±0.24 | 37.69±0.42 | 37.54±0.43 | 130.0±1.6 | 132.2±1.7 | 5.06±0.23 | 5.14±0.22 | | |
| 5 | 8.90±0.28 | 8.84±0.35 | 36.66±0.81 | 36.56±0.68 | 131.6±1.4 | 133.2±1.8 | 5.03±0.16 | 5.24±0.25 | | |
| 6 | 8.90±0.34 | 8.71±0.31 | 37.49±0.45 | 36.72±0.60 | 132.2±1.6 | 135.6±2.1 | 5.10±0.22 | 5.03±0.27 | | |
| 7 | 8.99±0.30 ^a | 8.83±0.30 | 37.03±0.83 ^a | 35.86±0.54 | 131.0±2.3 ^a | 134.2±1.6 | 5.11±0.20 ^a | 4.91±0.26 | | |
| 8 | 9.15±0.26 ^a | 8.36±0.27 | 36.83±0.51 ^a | 34.82±0.79 ^{**} | 133.0±2.1 ^a | 135.2±1.4 | 5.09±0.17 ^a | 4.74±0.24 | | |
| 9 | 8.86±0.28 ^a | 8.24±0.31 | 37.40±0.85 ^a | 34.38±0.95 ^{**} | 131.3±1.8 ^a | 137.4±1.7 ^{**} | 5.05±0.21 ^a | 4.67±0.23 | | |
| 10 | 8.88±0.25 ^a | 8.15±0.30 ^{**} | 37.10±0.62 ^a | 34.31±1.0 ^{**} | 133.0±1.7 ^a | 139.0±1.7 ^{**} | 5.13±0.18 ^a | 4.67±0.18 [*] | | |
| 12 | 8.87±0.23 ^a | 8.07±0.22 ^{**} | 37.87±1.07 ^a | 34.33±0.87 ^{**} | 131.7±2.6 ^a | 139.8±2.3 ^{**} | 5.00±0.22 ^a | 4.49±0.25 [*] | | |
| 13 | 8.65±0.28 ^a | 7.94±0.25 ^{**} | 37.37±1.20 ^a | 34.04±0.95 ^{**} | 132.0±2.6 ^a | 139.0±2.2 ^{**} | 5.03±0.19 ^a | 4.31±0.19 ^{**} | | |
| 14 | 8.73±0.23 ^a | 7.90±0.31 ^{**} | 37.58±0.95 ^a | 34.51±1.03 [*] | 131.3±2.9 ^a | 140.0±2.5 [*] | 5.03±0.21 ^a | 4.38±0.21 ^{**} | | |
| Post-treatment | | | | | | | | | | |
| 2 | 8.79±0.25 ^a | 8.85±0.27 | 38.05±1.08 ^a | 37.62±0.64 | 131.7±1.5 ^a | 133.8±1.4 | 5.05±0.24 ^a | 5.11±0.26 | | |

Values given are expressed as g/dl and represent the Mean ± S.E. of 5 animals unless stated.

a= Mean ± S.E. of 4 animals.

Values with superscript in a given row differs significantly from each other. (*P<0.05 and **P<0.01).

Table 4. Effect of repeated oral administration of cypermethrin 0.5 mg/kg/day on total leukocytic count, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration in buffalo calves.

| Time (weeks) | Control | Treatment | Control | Treatment | Control | Treatment | Control | Treatment |
|-----------------------|-------------------------------|-------------|--------------------------------|------------|-------------------------------------|------------|---|-------------|
| Treatment | Total leukocytic count | | Mean corpuscular volume | | Mean corpuscular haemoglobin | | Mean corpuscular haemoglobin concentration | |
| 0 | 10590±613.8 | 10420±671.1 | 76.15±2.23 | 74.34±4.55 | 17.63±0.90 | 17.29±1.94 | 23.15±0.85 | 23.25±1.074 |
| 2 | 11000±528.0 | 10820±674.1 | 75.31±3.00 | 73.71±5.02 | 17.59±0.58 | 17.59±0.85 | 23.35±1.63 | 23.86±1.52 |
| 3 | 10700±637.3 | 9944±752.3 | 74.83±3.27 | 72.52±6.59 | 17.32±1.56 | 17.59±0.44 | 23.14±2.35 | 23.86±2.13 |
| 4 | 10760±568.7 | 11680±687.0 | 74.45±3.03 | 73.01±3.14 | 17.66±1.33 | 17.27±0.57 | 23.72±1.08 | 23.56±1.83 |
| 5 | 10920±862.0 | 10560±933.1 | 72.82±3.10 | 71.63±2.56 | 17.68±0.93 | 17.33±0.57 | 24.28±0.61 | 24.19±0.66 |
| 6 | 10600±911.7 | 10320±772.9 | 73.46±2.12 | 72.60±3.49 | 17.44±1.12 | 17.21±0.62 | 23.74±1.14 | 23.71±1.15 |
| 7 | 11700±810.7 ^a | 10760±855.9 | 72.52±1.81 ^a | 71.82±3.84 | 17.92±0.56 ^a | 17.42±0.95 | 24.72±1.14 ^a | 24.25±0.80 |
| 8 | 11733±712.7 ^a | 10560±605.5 | 72.36±0.79 ^a | 70.71±1.88 | 17.36±0.59 ^a | 16.98±0.43 | 23.9±0.81 ^a | 24.02±1.18 |
| 9 | 8850±859.8 ^a | 9240±640.8 | 74.11±1.51 ^a | 71.53±2.20 | 17.55±1.08 ^a | 17.15±1.00 | 23.68±1.07 ^a | 23.97±1.25 |
| 10 | 8953±535.6 ^a | 9080±336.8 | 72.38±2.63 ^a | 71.55±0.72 | 17.33±0.62 ^a | 17.14±1.21 | 23.94±0.02 ^a | 23.95±1.58 |
| 12 | 12366±856.8 ^a | 10930±913.5 | 75.68±2.10 ^a | 74.05±3.34 | 17.74±0.87 ^a | 17.41±0.59 | 23.44±1.09 ^a | 23.51±1.23 |
| 13 | 11666±529.2 ^a | 11170±592.5 | 74.25±2.55 ^a | 73.92±8.17 | 17.19±0.66 ^a | 17.39±1.78 | 23.15±0.19 ^a | 23.53±0.37 |
| 14 | 9266±581.2 ^a | 9560±613.8 | 74.93±3.16 ^a | 74.29±3.29 | 17.34±0.53 ^a | 17.01±0.41 | 23.28±0.67 ^a | 22.90±1.20 |
| Post-treatment | | | | | | | | |
| 2 | 10625±632.5 ^a | 10580±852.3 | 75.93±4.74 ^a | 75.53±7.26 | 17.67±1.47 ^a | 17.61±0.89 | 23.22±0.53 ^a | 23.59±1.65 |

Values given are expressed as 10⁶/mm³ for total erythrocytic count and as mm³ and represent the Mean ± S.E. of 5 animals unless stated.

a= Mean ± S.E. of 4 animals.

Values with superscript in a given row differs significantly from each other. (*P<0.05 and **P<0.01).

Table 5. Effect of repeated oral administration of cypermethrin 0.5 mg/kg/day on differential leukocyte count in buffalo calves.

| Time (weeks) | Control | | | | | Treatment | | | | |
|-----------------------|-----------------------|-----------------------|----------------------|----------------------|----------------------|-----------|----------|---------|---------|---------|
| | N | L | M | E | B | N | L | M | E | B |
| Treatment | | | | | | | | | | |
| 0 | 22.2±7.5 | 69.4±7.9 | 5.2±0.7 | 2.2±0.6 | 1.0±0.3 | 23.2±6.1 | 68.6±6.0 | 4.8±0.6 | 2.8±0.4 | 0.6±0.2 |
| 2 | 28.2±5.8 | 63.2±5.8 | 4.8±0.5 | 3.0±0.4 | 0.8±0.2 | 20±2.6 | 70.6±1.9 | 4.8±0.4 | 3.6±0.5 | 1.0±0.4 |
| 3 | 28.0±7.1 | 63.4±7.1 | 4.6±0.4 | 2.8±0.6 | 1.2±0.4 | 21.8±2.8 | 71.4±1.8 | 3.8±0.6 | 2.6±0.7 | 0.4±0.2 |
| 4 | 27.8±3.2 | 66.0±2.4 | 3.8±0.4 | 1.8±0.4 | 0.6±0.24 | 22.8±3.7 | 70.4±3.4 | 4.2±0.4 | 2.0±0.3 | 0.6±0.2 |
| 5 | 34.2±6.1 | 59.8±6.2 | 3.8±1.0 | 1.8±0.8 | 0.4±0.24 | 24.8±3.4 | 68.8±3.9 | 4.0±0.3 | 2.0±0.5 | 0.4±0.2 |
| 6 | 31.6±3.9 | 62.2±4.1 | 3.8±0.7 | 1.8±0.6 | 0.6±0.24 | 26.4±2.3 | 66.6±2.7 | 4.4±0.6 | 2.0±0.4 | 0.6±0.4 |
| 7 | 32.7±3.2 ^a | 61.5±3.3 ^a | 3.5±0.6 ^a | 1.8±0.3 ^a | 0.5±0.3 ^a | 24.8±1.7 | 68.4±2.4 | 4.2±0.6 | 2.2±0.4 | 0.4±0.2 |
| 8 | 30.0±2.2 ^a | 64.5±2.3 ^a | 3.5±0.3 ^a | 1.5±0.3 ^a | 0.5±0.5 ^a | 27.2±1.6 | 65.8±1.9 | 4.2±0.4 | 2.0±0.3 | 0.8±0.4 |
| 9 | 32.0±2.1 ^a | 62.7±3.2 ^a | 3.7±0.9 ^a | 1.7±0.3 ^a | 0.0±0.0 ^a | 23.8±4.4 | 69.8±4.7 | 4.6±0.7 | 1.4±0.2 | 0.4±0.2 |
| 10 | 30.0±1.0 ^a | 64.3±1.9 ^a | 3.3±0.3 ^a | 1.7±0.3 ^a | 0.7±0.3 ^a | 25.4±2.9 | 67.8±2.9 | 4.6±.2 | 2.0±0.3 | 0.2±0.2 |
| 12 | 26.3±9.7 ^a | 65.0±13 ^a | 6.3±0.9 ^a | 2.3±0.0 ^a | 0.0±0.0 ^a | 23.2±6.1 | 69.2±5.9 | 4.4±0.5 | 2.6±0.4 | 0.6±0.2 |
| 13 | 22.7±3.6 ^a | 72.7±4.3 ^a | 4.0±1.0 ^a | 0.0±0.3 ^a | 0.0±0.0 ^a | 27.4±1.3 | 68.0±1.4 | 2.8±0.5 | 1.4±0.2 | 0.4±0.2 |
| 14 | 25.7±1.6 ^a | 67.0±2.1 ^a | 5±0.6 ^a | 2.0 ±0.3 | 0.0±0.0 ^a | 22.6±1.8 | 71.0±1.8 | 4.2±0.6 | 2.0±0.3 | 0.2±0.2 |
| Post-treatment | | | | | | | | | | |
| 2 | 27.7±2.1 ^a | 65.7±2.4 ^a | 4.3±0.9 ^a | 1. ±0.3 ^a | 0.7±0.3 ^a | 26.6±1.1 | 67.2±1.5 | 4.6±0.4 | 1.6±0.2 | 0.0±0.0 |

Values given are expressed as % and represent the Mean ± S.E. of 5 animals unless stated, N, L, M, E, and B stands for neutrophils, lymphocytes, monocytes, eosinophils and basophils respectively.

a= Mean ± S.E. of 4 animals.

Values with superscript in a given row differs significantly from each other. (*P<0.05 and **P<0.01).

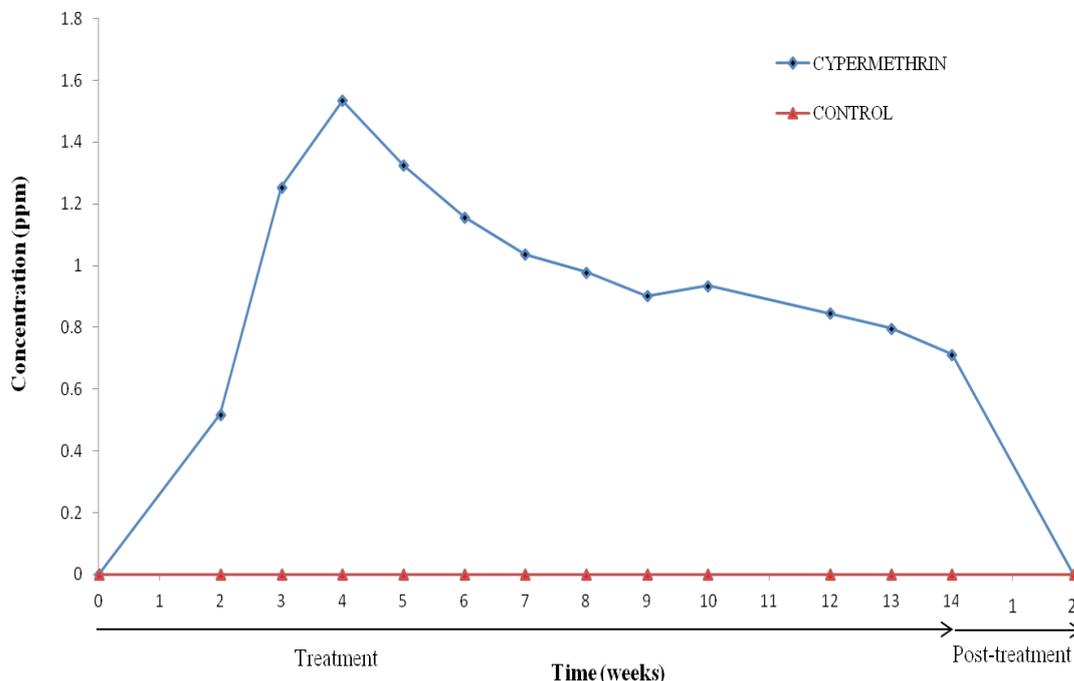


Figure 1. Serum cypermethrin concentration in buffalo calves after oral administration of cypermethrin 0.5 mg/kg/day.

two weeks post-treatment. However, cypermethrin exposure failed to produce any significant changes in total leukocytic count (TLC) and differential leukocytic count (DLC) (Table 4 and Table 5). Table 4 further illustrates that cypermethrin produced no significant changes in any of the erythrocytic indices i.e. mean corpuscular haemoglobin, mean corpuscular volume and mean corpuscular haemoglobin concentration. These observations are in agreement with those reported by Remya *et al.* (2010) in rats, Summaira *et al.* (2010) in broiler chicks, Khan *et al.* (2009) in goats and Yousef *et al.* (2003) in rabbits intoxicated with cypermethrin.

Significant reduction of haemoglobin content during the later period of the investigation could be related to decreased synthesis of red blood cells in bone marrow (Mandal *et al.*, 1986), or reduced biosynthesis of heme in bone marrow (Khan *et al.*, 2009) or as a result of increased rate

of erythrocyte destruction. This could probably be explained by the effect of cypermethrin on erythropoiesis. The subsequent recovery of haemoglobin after termination of cypermethrin treatment indicates that the damage produced was of reversible nature. Consonantly, the decrease in PCV could be attributed to the decrease in TEC. The decrease in TEC, Hb concentration and PCV observed in this study could be the result of disruptive action of cypermethrin on the erythropoietic tissue as a result of which the viability of the cells might have been affected.

Therefore, on the basis of the observations of the present investigation, it can be concluded that chronic exposure to cypermethrin induces significant biochemical and haematological alterations in buffalo calves.

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