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Furadan SP50 Induced Haematological Responses of Blue-Rock Pigeon, *Columba livia* Gmelin

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Furadan SP50 (2.2-dimethyl 2,3 dihydro-7-benzofuranyl-N-methylcarbamate), commonly known as carbofuran, elicits acute intoxication by virtue of reversible inhibition of acetylcholinesterase and consequent accumulation of acetylcholine at the synapses (Gupta et al. 1994 a). The pesticide is also known to affect the biochemical parameters in liver (Saxena et al. 1998) and serum (Gupta et al. 1994 b). Besides, the compound has also been reported to bring about alterations in cellular and humoral immune responses in animals (Street and Sharma 1975). Although there seems to be minimum health risks to animals when exposed to furadan through judicious use in fields on account of its rapid excretion in urine, in large doses the pesticide can produce a variety of toxicological effects. So far there has been a few reports on the effect of furadan on bodily parameters, the present investigation therefore, was undertaken to determine the effect of acute and sub-chronic treatment of furadan SP50 on certain haematological parameters in pigeon.

MATERIALS AND METHODS

Furadan SP50, the pesticide used in the present study, was procured from Rallis India Ltd., Bombay. The experiments were carried out on 50 pigeons (Columba livia), irrespective of sex, purchased from local animal catcher. The pigeons were weighed and kept in disinfected cages in four sets - one acute of 5 pigeons, one sub-chronic of 20 pigeons and two control of 5 and 20 pigeons for acute and sub-chronic treatment respectively. Sub-chronic set had four sub-sets of 5 pigeons each.

Toxicity of the pesticide i.e. furadan SP50 was determined by introducing required amount of pesticide, dissolved in warm distilled water, through intramuscular injection. Appropriate doses were selected after estimating the LD_{50} (96 hours duration) by the log-probit analysis method (Finney 1971). The sub-lethal doses of 4.6 mg/kg. b.wt and 1.5 mg/kg. b.wt. were selected and administered for acute and sub-chronic treatment respectively. The twenty pigeons of the sub-chronic group were given fractionated doses (1.15 mg/kg. b.wt.). The controls were given vehicle treatment only.

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The blood samples were collected directly from the ventricle of the heart after one day from acutely dosed and on the 7th, 14th, 21 st and 28th day from sub-chronically treated pigeons. Blood samples were collected in glass vials containing anticoagulant, disodium salt of EDTA.

The red blood corpuscles (RBCs) and white blood corpuscles (WBCs) were counted with the standard Neubaur (double improved) haemocytometer (Natt and Herrick 1952). Differential leucocyte count (DLC) was done using Wright's - Giemsa technique suggested by Hamre (Lucas and Jamroz 1974) and haemoglobin (Hb) contents were determined by the standard Sahli's method (Wintrobe et al. 1981). Packed cell volume (PCV) was determined with the aid of a Wintrobe tube (Seiverd 1972).

All the data were analyzed for statistical significance using Student's t-test.

RESULTS AND DISCUSSION

None of the pigeons of the experimental groups exhibited any overt toxicity except mild tremors, distress, excessive salivation and muscular incoordination after acute treatment. The pesticide however, induced certain significant alterations in the haematological parameters in the treated pigeons as compared with those of the control sets (table 1 and 2).

Analysis of the result indicate that the compound adversely affects the haemogrammic values and the leucogram of pigeons. The fall in the erythrocyte number and Hb content is indicative of anaemic condition. Accordingly, the administration of furadan might have caused destruction of erythrocytes directly or the decrease in RBC count might have resulted due to adverse effect of the chemical on the erythropoietic tissue, the bone marrow and gains support by the findings of Rajini et al. (1987). Decrease in the total erythrocyte count may also be attributed to the cytotoxic effect of the pesticide on the bone marrow leading to the disturbances in the progression of cell cycle (Shea 1987). Further, pesticides are also known to cause a decrease in catecholamines level in plasma (Liu et al. 1994) which results in a decreased erythropoietin production (Guyton and Hall 1996) and its release into the blood. The decreased erythropoetin level, in turn, results in a diminished stimulation to bone marrow leading to a decreased rate of erythropoiesis.

Decrease in Hb content (hypohaemoglobinemia) was due to the reduction in the total number of RBCs in blood indicating adverse effect of tiradan SP50 on bone marrow. Furadan induced hypohaemoglobinemia, in the present study, is in accordance to the earlier findings of Khan and Ali (1993) and Sharma and Saxena (1997). The present findings are however, in contradiction to Hussain et al. (1990) who did not find any decrease in the Hb content after pesticide treatment.

Table 1. Erythrocyte values in control (C) and furadan SP50 treated (T) pigeons.

(Values are mean ± S.E. of five determinations; figures in parentheses indicate percentage increase (+) or decrease (-) after treatment)

Parameter (s)	Group	Treatment				
		Acute	Sub-Chronic			
		(1 day)	7 days	14 days	21 days	28 days
Total erythrocyte count (million/cumm)	C	3.822±0.160	4.009±0.167	4.278±0.348	5.041±0.231	4.049±0.104
	T	3.095±0.039[b]	3.109±0.125[b]	3.745±0.084[N.S.]	3.857±0.254[b]	3.665±0.098[c]
		(-19.0)	(-22.4)	(-12.5)	(-23.5)	(-9.5)
Haemoglobin content (g/100ml)	C	14.360±0.512	16.360±0.676	15.320±0.498	15.520±0.167	14.760±0.239
	T	12.200±0.122[b]	15.280±0.397[N.S]	14.280±0.167[N.S]	14.400±0.274[b]	13.600±0.394[c]
		(-15.0)	(-6.6)	(-6.8)	(-7.2)	(-7.9)
Packed cell volume (%)	C	51.6±1.483	50.8±1.387	57.6±1.351	58.8±1.387	55.0±2.291
	T	47.0±0.791[c]	51.2±1.981[N.S]	56.2±1.025[N.S.]	54.6±2.683[N.S.]	54.0±0.612[N.S.]
		(-8.9)	(+0.8)	(-2.4)	(-7.1)	(-1.8)

P values : a= $p < 0.001$; b= $p < 0.01$; c = $p < 0.05$; N.S. = Non-significant

Table 2. Leucocyte values in control (C) and furadan SP50 treated (T) pigeons.

(Values are mean ± S.E. of five determinations; figures in parentheses indicate percentage increase (+) or decrease (-) after treatment)

Parameter		Experimental Group	Treatment				
			Acute	sub-chronic			
			(1 day)	7 days	14 days	21 days	28 days
Total leucocyte count (TLC) ($x10^3$ / cumm)		C	15.4±0.872	12.63±0.539	15.52±0.790	13.28±0.263	13.81±0.445
		T	22.245±1.332[b]	16.85±0.637[a]	16.96±0.737[N.S.]	17.612±1.182[b]	17.78±1.334[c]
			(+44.4)	(+33.4)	(+9.3)	(+32.6)	(+28.7)
Differential leucocyte count (DLC) (%)	H	C	33.0±1.225	24.6±1.789	26.4±1.151	22.4±0.837	21.8±1.294
		T	40.6±1.924[c]	30.0±0.791[c]	24.2±1.294[N.S.]	26.2±1.140[c]	23.6±1.891[N.S.]
			(+7.6)	(+5.4)	(-2.2)	(+3.8)	(+1.8)
	E	C	4.2±0.822	1.8±0.548	4.0±1.275	4.6±0.447	2.6±0.447
		T	8.8±0.548[b]	3.2±0.548[N.S.]	5.8±1.140[N.S.]	5.0±0.500[b]	5.6±0.570[b]
			(+4.6)	(+1.4)	(+1.8)	(+0.4)	(+3.0)
	B	C	4.0±0.354	2.8±0.822	3.4±0.274	2.4±0.274	3.6±0.570
		T	2.6±0.570[N.S.]	2.6±0.570[N.S.]	2.6±0.758[N.S.]	2.2±0.742[N.S.]	3.6±1.151[N.S.]
			(-1.4)	(-0.2)	(-0.8)	(-0.2)	(-0.0)
	L	C	53.8±1.432	65.8±0.894	61.2±1.557	65.6±0.758	65.4±0.837
		T	41.0±2.031[a]	58.2±1.673[b]	63.8±0.548[N.S.]	61.0±1.000[b]	60.4±1.304[C]
			(-12.8)	(-7.6)	(+2.6)	(-4.6)	(-5.0)
	M	C	5.0±0.354	5.0±1.000	5.0±0.791	5.0±0.500	6.6±0.570
		T	7.0±0.866[N.S.]	6.0±1.696[N.S.]	5.6±0.908[N.S.]	5.6±1.151[N.S.]	6.8±0.894[N.S.]
			(+2.0)	(+1.0)	(+0.6)	(+0.6)	(+0.2)

H= Heterophils; E=Eosinophils; L= Lymphocytes; B=Basophils; M= Monocytes

P - values: a = $p<0.001$; b = $p<0.01$; c=$p<0.05$; N.S = Non-significant

The fall in haemoglobin content in the present investigation may be as a result of either an elevation of the rate at which haemoglobin is destroyed or a decreased rate of its synthesis in bone marrow.

The decrease in the total erythrocyte count and Hb concentration is often accompanied with decrease in the packed cell volume (PCV) which again may be attributed to the physiological dysfunction of the haemopoietic system. Thus the decline in **the** rate of erythropoiesis may well be attributed to the pesticide induced hypoplasia of bone marrow resulting in a fall in the PCV.

Leucogrammic picture of pigeons reveals a significant rise in the total leucocyte count (table 2) which may be a pathological leucocytosis condition associated with inflammatory state produced by pesticidal intoxication. It may be presumed that furadan SP50, by some way, is capable to stimulate WBC precursors in the bone marrow, the site of granulopoiesis, resulting in an increased formation of WBCs. The increase in WBC production after pesticide treatment is in accordance to Khan and Ali (1993).

Further, the stress condition, caused by pesticidal intoxication slows down leucocyte infiltration in inflamed area (Guyton and Hall 1996). This decreased migration of leucocytes from the blood vessels into inflamed area, probably may account for higher leucocyte count in the blood of treated pigeons.

The leucogram oftreated pigeons is further characterized with heterophil leucocytosis (heterophilia), eosinophilia and lymphopaenia associated with a non-significant change in the number of basophils and monocytes (table 2) and is in affirmation to Khan and Ali (1993). The present findings however, are in contradiction to Gross and Siegel (1983) who have made leucogrammic studies in chickens.

It is also evident that in spite of a marked lymphopaenia pigeons did not develop leucopaenic condition which suggests apparent reversal of lymphoid-myeloid ratio induced by pesticide in pigeons. The observed alterations may be attributed to the possible cytotoxic effect of furadan SP50 as became evident by the highly disorganized cellular morphology of heterophils (*Sharma, 2996*).

Further, the decline in the number of lymphocytes may be an outcome of the possible immunosuppression by pesticide treatment associated with impaired splenic function (Mandal and Lahiri 1985)

However, the precise cellular and molecular mechanisms involved in the discriminatory effect of furadan SP50 on different sub-populations of WBCs is a matter of further investigation.

The overall toxic effect of furadan SP50 shows that significant alterations in the blood parameters have taken place in the acutely treated pigeons.

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