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PROENOFOS EFFECTS ON RABBIT PERFORMANCE AND THEIR AMELIORATION BY USING NATURAL CLAY MINERALS

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ABSTRACT : Eighty New Zealand White male rabbits of 35 days of age, were used in the present study. The rabbits were randomly allotted to 8 groups with 10 animals in each. Four groups were fed diets contaminated with 0, 0.658, 1.315, 2.630 mg proenofos/kg diet. The other four groups fed the same diets but supplemented with 5% natural clay (80% betonite). Rabbits fed with diet contaminated with proenofos (an organophosphorus insecticide) decreased feed intake, final live body weight (-22% for the highest level), daily gain, heamoglobin, serum total protein, albumin, SGPT and cholinesterase while mortality rate, SGOT, urea-N and creatinine increased. Feed conversion impaired with increasing pesticide level in rabbit diets. Proenofos residues in liver (3 to 7 ppm), kidney and muscle (0.4 to 0.7 ppm) significantly (P<0.001) increased with increasing pesticide level in rabbit diets. Proenofos residue in liver and kidney tissues and muscle decreased with 54.8, 50.3 and 40.0%, respectively, with clay supplementation in rabbit diets. Final live body weight, daily gain, serum albumin, and cholinesterase significantly increased by the clay supplementation in pesticide contaminated diets, while blood urea-N significantly decreased. Heamoglobin, serum total protein, globulin, creatinine, transaminases (SGOT and SGPT) and carcass and non-carcass components were insignificantly affected by the interaction between proenofos contamination and clay addition. Supplemented natural clay in rabbit diets contaminated with proenofos decreased mortality rate (3.3% vs 16.7%; P=0.097) Feed conversion was improved with clay supplementation in contaminated rabbit diets

RÉSUMÉ : Effets du proenofos sur les performances des lapins et améliorations obtenues par l'inclusion d'agile naturelle dans l'aliment.
Quatre vingt mâles néo-zélandais blancs, âgés de 35 jours, ont été utilisés pour cette étude. Les lapins ont été répartis au hasard en 8 groupes de 10 animaux chacun. Quatre groupes ont reçu un aliment auquel a été ajouté 0 - 0,658 - 1,315 ou 2,630 mg /kg de proenofos, un insecticide organophosphoré. Les quatre autres groupes ont reçu les mêmes aliments additionnés de 5% d'argile naturelle (80% de bentonite). Les lapins nourris avec les aliments contaminés par le proenofos ont eu une nette réduction de la consommation, du poids vif final (-22% pour le taux de proenofos le plus élevé), de la vitesse de croissance, des taux d'hémoglobine et de protéines sériques, d'albumine, de transaminases (SGPT), et de cholinestérase ; par contre le taux de mortalité, SGOT, l'urée et la créatinine sanguines ont augmenté. L'efficacité alimentaire a diminué avec l'accroissement du taux d'incorporation de proenofos. Les résidus de proenofos dans le foie (3 à 7 ppm), les reins et les muscles (0,4 à 0,7 ppm) a augmenté significativement (P<0,001) avec l'accroissement du taux de proenofos dans l'aliment.
L'addition d'argile a diminué les résidus de proenofos dans le foie, les reins et les muscles de 54,8 - 50,3 et 40,0 %, respectivement. L'addition d'argile naturelle dans les aliments contaminés par le proenofos a significativement augmenté le poids vif final, le gain de poids quotidien, les taux d'albumine et de cholinestérase tandis que l'albumine sérique a diminué significativement. Les taux d'hémoglobine, de protéines sériques totales, de globuline, de créatinine, de transaminases (SGOT et SGPT), le poids de la carcasse et des abats n'ont pas été significativement modifiés par l'addition d'argile. L'addition d'argile aux aliments contaminés par le proenofos a diminué le taux de mortalité (3.3% vs 16.7%; P=0.097) et amélioré l'efficacité alimentaire

INTRODUCTION

Pesticides are widely used to control agricultural pests. This process causes pollution of the soils and crops. Most pesticides are not highly selective, but are generally toxic to many non-target species including farm animals and man. Organophosphorus compounds like proenofos are a powerful stomach poisons for must insects and are used on most crops such as alfalfa, cotton and maize. Growth rate decreased in animals or birds fed diets contaminated with pesticide (REHFELD *et al.*, 1969, CLARK *et al.*, 1979, SALEM *et al.*, 1988, EL-GINDY, 1989, BRAR *et al.*, 1991, MOSTAFA *et al.*, 1994 and SHALABY and AYYAT, 1999). ASGHAR *et al.* (1994) found that blood glucose, cholesterol and urea concentrations were elevated, whereas blood protein decreased gradually in rabbits fed diets contaminated with parathion methyl.

GROBNER *et al.* (1982) reported that inclusion of zeolite in rabbit rations might be beneficial in reducing incidence of enteritis as characterized by diarrhea. The use of natural clays can absorbed toxic products of digestion and decrease accumulation of toxic substance in tissues, thus decreasing the incidence of internal disorders (EL-GENDY, 1989, KUBENA *et al.*, 1992, HARVEY *et al.*, 1993 and SHALABY and AYYAT, 1999).

The present experiment was conducted to study the growth performance of rabbits as affected by feed diets contaminated with pesticide and their amelioration by using natural clay, under Egyptian sub-tropical conditions.

MATERIALS AND METHODS

Eighty New Zealand White male rabbits of 35 days of age, were used in the present study. The rabbits were randomly allotted to 8 groups of nearly equal average weight with 10 animals in each. Four groups were fed diets contaminated with 0, 0.658, 1.315, 2.630 mg proenofos/kg diet. The other four groups fed the same diets but supplemented with 5% clay. The experimental period was 8 weeks; i.e. until marketing

Table 1 : Average live body weight and daily gain in rabbits as affected by proenofos and clay supplementation and their interaction.

Items	Live body weight at			Daily body gain at		
	W4	W8	W12	W4-8	W8-12	W4-12
Proenofos level:						
0 mg	551.5 ± 4.6	1349.1 ± 5.4[a]	2058.0 ± 18.5[a]	28.48 ± 0.55[a]	25.32 ± 0.76[a]	26.90 ± 0.34[a]
0.658 mg	550.8 ± 5.1	1246.1 ± 18.0[b]	1876.1 ± 35.1[b]	24.83 ± 0.70[b]	22.50 ± 1.18[b]	23.67 ± 0.62[b]
1.315 mg	552.6 ± 4.5	1153.8 ± 23.8[c]	1707.1 ± 42.6[c]	21.47 ± 0.84[c]	19.76 ± 1.42[c]	20.62 ± 0.76[c]
2.630 mg	551.9 ± 4.7	1117.5 ± 26.3[c]	1609.4 ± 44.6[d]	20.20 ± 0.93[c]	17.57 ± 0.98[c]	18.88 ± 0.80[d]
Significance	NS	***	***	***	***	***
Clay supplementation:						
0%	553.7 ± 3.3	1171.0 ± 22.2	1694.9 ± 39.2	22.05 ± 0.79	18.71 ± 0.82	20.38 ± 0.70
5%	549.9 ± 3.2	1266.7 ± 16.8	1935.3 ± 25.6	25.60 ± 0.60	23.88 ± 0.77	24.74 ± 0.45
Significance	NS	***	***	***	***	***
Interaction between proenofos and clay supplementation:						
0 mg proenofos:						
0% Clay	552.5 ± 6.5	1318.1 ± 14.5	1994.0 ± 10.4[a]	27.34 ± 0.52[ab]	24.14 ± 0.55	25.74 ± 0.22[b]
5% Clay	550.5 ± 6.7	1380.0 ± 23.9	2122.0 ± 20.6[b]	29.62 ± 0.85[a]	26.50 ± 1.36	28.06 ± 0.38[a]
0.658 mg proenofos:						
0% Clay	552.8 ± 8.9	1202.2 ± 7.0	1742.2 ± 12.5[d]	23.19 ± 0.33[c]	19.29 ± 0.44	21.24 ± 0.13[d]
5% Clay	549.0 ± 6.0	1285.5 ± 28.8	1996.5 ± 34.1[b]	26.30 ± 1.13[b]	25.39 ± 1.78	25.85 ± 0.55[b]
1.315 mg proenofos:						
0% Clay	554.4 ± 6.3	1106.25 ± 39.9	1543.8 ± 27.2[e]	19.71 ± 1.32[d]	15.63 ± 1.54	17.67 ± 0.47[e]
5% Clay	551.1 ± 6.6	1196.10 ± 20.6	1852.2 ± 26.2[c]	23.04 ± 0.82[c]	23.43 ± 1.50	23.23 ± 0.46[c]
2.630 mg proenofos:						
0% Clay	555.6 ± 4.9	1016.9 ± 22.3	1418.8 ± 31.8[f]	16.47 ± 0.80[e]	14.35 ± 1.38	15.41 ± 0.51[f]
5% Clay	549.0 ± 7.5	1198.0 ± 20.5	1762.0 ± 17.7[d]	23.18 ± 0.55[c]	20.14 ± 0.64	21.66 ± 0.27[d]
Significance	NS	NS	***	*	NS	***

W=Week, * P<0.05, *** P<0.001, NS = Not significant. Means in the same column within each classification, bearing the different litters are differ significantly (P<0.05).

Table 2 : Mortality percentages, feed intake and conversion, in rabbit as affected by proenofos and clay supplementation and their interaction.

Items	Mortality %	Feed intake (g/day)	Feed conversion
Proenofos level:			
0 mg	0.0	113.5	4.219
0.658 mg	5.0	108.5	4.584
1.315 mg	15.0	97.5	4.728
2.630 mg	10.0	94.5	5.005
Clay supplementation:			
0%	12.5	104.5	5.128
5%	2.5	102.5	4.143
Interaction between proenofos and clay supplementation:			
0 mg proenofos:			
0% clay	0.0	117.0	4.545
5% clay	0.0	110.0	3.920
0.658 mg proenofos:			
0% clay	10.0	109.0	5.132
5% clay	0.0	108.0	4.178
1.315 mg proenofos:			
0% clay	20.0	98.5	5.574
5% clay	10.0	96.5	4.154
2.630 mg proenofos:			
0% clay	20.0	93.5	6.067
5% clay	0.0	95.5	4.409

age. The soluble cations and anions (Milliequivalent (meq)/100 g dry soil) of clay (which includes 80 % bentonite) were 0.75 Ca^{++}, 0.25 Mg^{++}, 0.05 Na^{+}, 0.10 K^{+}, 0.55 Cl^{-}, 0.30 SO_4^{-} and 0.75 HCO_3^{-}. Exchangeable cations was 2.65 meq/100 g dry soil and available nutrients (mg/100 g dry soil) were 5.0 P, 1.2 K, 2.4Mn, 0.74 Zn and 0.30 Cu, and Fe was 0.55 ppm.

All animals were fed a pelleted diet and watered *ad libitum*. Each kg of the basal diet consisted of 300 g alfalfa hay, 240 g corn, 130 g soybean meal, 280 g wheat bran, 30 g molasses, 14 g limestone, 3 g sodium chloride, 3 g vitamins and minerals premix. The diet contained 16.3% crude protein, 13.2% crude fibre (both were analyzed according to AOAC, 1980) and 11.2 Mj//kg digestible energy (calculated according to NRC, 1977).

All rabbits were kept under similar managerial and hygienic conditions, during the experimental period. The weanlings were raised in individual cages provided with feeders and automatic nipple drinkers and were housed in naturally ventilated and provided with sided electric fans.

The rabbits were individually weighed at the beginning of the experiment, and then at biweekly intervals. Weighing was carried out before offering the morning meal at 8.00 h and live body weight gain was

Table 3 : Some blood components in rabbits as affected by proenofos and clay supplementation and their interaction.

Items	Heamoglobin (g/l)	Total protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	Urea-N (mg/dl)	Creatinine (mg/dl)
Proenofos level:						
0 mg	119.5 ± 1.03[a]	7.87 ± 0.11[a]	4.19 ± 0.04[a]	3.68 ± 0.07[a]	15.10 ± 0.19[a]	1.07 ± 0.01[a]
0.658 mg	114.9 ± 1.09[b]	7.27 ± 0.14[b]	3.87 ± 0.10[b]	3.40 ± 0.11[ab]	17.13 ± 0.40[b]	1.14 ± 0.02[b]
1.315 mg	108.8 ± 1.29[c]	6.96 ± 0.19[bc]	3.75 ± 0.14[bc]	3.21 ± 0.15[b]	18.08 ± 0.59[c]	1.19 ± 0.04[b]
2.630 mg	106.6 ± 1.96[c]	6.72 ± 0.25[c]	3.69 ± 0.12[c]	3.03 ± 0.15[b]	18.30 ± 0.78[c]	1.19 ± 0.04[b]
Significance	***	***	***	**	***	*
Clay supplementation:						
0%	110.3 ± 1.96	6.91 ± 0.19	3.68 ± 0.09	3.23 ± 0.13	18.00 ± 0.59	1.18 ± 0.03
5%	114.5 ± 1.35	7.50 ± 0.11	4.07 ± 0.04	3.43 ± 0.07	16.31 ± 0.27	1.11 ± 0.02
Significance	***	***	***	NS	***	*
Interaction between proenofos and clay supplementation:						
0 mg proenofos:						
0% Clay	118.6 ± 1.76	7.76 ± 0.17	4.13 ± 0.05[ab]	3.63 ± 0.13	14.97 ± 0.35[e]	1.07 ± 0.02
5% Clay	120.4 ± 1.21	7.98 ± 0.12	4.25 ± 0.06[a]	3.73 ± 0.06	15.23 ± 0.18[de]	1.07 ± 0.02
0.658 mg proenofos:						
0% Clay	113.0 ± 1.44	7.00 ± 0.14	3.68 ± 0.11[c]	3.32 ± 0.23	17.97 ± 0.18[b]	1.19 ± 0.01
5% Clay	116.7 ± 0.70	7.54 ± 0.09	4.06 ± 0.05[ab]	3.48 ± 0.05	16.30 ± 0.27[cd]	1.10 ± 0.03
1.315 mg proenofos:						
0% Clay	106.6 ± 1.79	6.62 ± 0.18	3.45 ± 0.12[c]	3.17 ± 0.29	19.27 ± 0.35[a]	1.24 ± 0.06
5% Clay	110.8 ± 0.83	7.30 ± 0.19	4.04 ± 0.03[ab]	3.25 ± 0.16	16.90 ± 0.49[bc]	1.14 ± 0.03
2.630 mg proenofos:						
0% Clay	102.9 ± 2.09	6.25 ± 0.22	3.45 ± 0.09[c]	2.80 ± 0.20	19.80 ± 0.62[a]	1.23 ± 0.03
5% Clay	110.2 ± 1.27	7.19 ± 0.17	3.93 ± 0.06[b]	3.26 ± 0.12	16.80 ± 0.52[bc]	1.14 ± 0.06
Significance	NS	NS	*	NS	**	NS

* P<0.05, ** P<0.01, *** P<0.001 and NS = Not significant.
Means in the same column within each classification, bearing the different litters are differ significantly (P<0.05).

calculated biweekly, but only averages of body weights at 0, 4 and 8 weeks were recorded in the results. Absolute daily gain weight between 0-4, 4-8 and 0-8 weeks of the experimental period were studied.

At the end of the experimental period, 3 male rabbits from each group were randomly taken for slaughter. Blood samples were collected during slaughter. Blood heamoglobin was estimated directly according to Titetz (1982). The blood samples were centrifuged at 3000 RBM for 20 minutes to separate the serum. The collected serum was stored at -20 °C until assay. Plasma total protein, albumin, urea-N, creatinine and serum transaminases (SGOT and SGPT) were determined by using commercial kits. Acetylcholinesterase was determined using the method of ELLMN *et al.* (1961). After complete bleeding, pelt, viscera and tail were removed and the carcass and some carcass components were weighed. Meat samples were taken from the intermediate part to the analysis for the pesticide residues. Rabbit tissue samples were extracted according to TINDLE (1972). The extract of proenofos residue was subjected to clean-up procedures suggested by ZWIEG (1963) a further clean-up with a florisil column was made. The residue of proenofos was determined using High Performance Liquid Chromatography (HPLC). The wavelength, retention time and detection limit for proenofos were 254 nm, 3.19 min and 15 ng, respectively. Suitable aliquots (20 µl) from extracts and standard were injected.

Statistical analyses of live body weight, body gain weight, blood components and pesticide residues were carried out by 2 X 4 factorial design (SNEDECOR and COCHRAN, 1982) according the following model :

$$Y_{ijk} = \mu + C_i + P_j + CP_{ii} + e_{ijk} \quad \text{(Eqn 1)},$$

where μ is the overall mean, C_i is the fixed effect of i^{th} clay supplementation (1, 2), P_j is the fixed j^{th} effect pesticide level (1,......4), CP_{ij} is the interaction between clay supplementation and pesticide level and e_{ijk} is the random error.

Significant differences were determined by Duncan's Multiple Range test (DUNCAN, 1955). Data obtained at slaughter were analysed using the following model :

$$Y_{ijk} = \mu + C_i + P_j + CP_{ii} + b(X\text{-}x) + e_{ijk} \quad \text{(Eqn 2)},$$

where b is the partial linear regression coefficient of Y_{ijk} on pre-slaughter live body weight, X is the value of pre-slaughter live body weight and x is the overall average of pre-slaughter live body weight.

Table 4 : Some blood enzymes in rabbits as affected by proenofos and clay supplementation and their interaction

Items	SGOT (u/l)	SGPT (u/l)	Cholinesterase (u/l)
Proenofos level:			
0 mg	26.33 ± 0.07[a]	20.05 ± 0.35[a]	983.5 ± 3.4[a]
0.658 mg	31.15 ± 1.06[b]	19.02 ± 0.35[b]	884.3 ± 22.1[b]
1.315 mg	32.78 ± 1.08[b]	18.62 ± 0.55[c]	830.2 ± 40.7[b]
2.630 mg	35.57 ± 1.06[c]	16.85 ± 0.73[d]	753.5 ± 41.3[c]
Significance	***	***	***
Clay supplementation:			
0%	33.05 ± 1.24	17.76 ± 0.50	814.1 ± 37.0
5%	29.87 ± 0.96	19.51 ± 0.32	911.7 ± 18.8
Significance	***	***	***
Interaction between proenofos and clay supplementation:			
0 mg Pesticide:			
0% Clay	27.06 ± 0.83	19.60 ± 0.38	987.0 ± 5.5[a]
5% Clay	25.60 ± 1.00	20.50 ± 0.51	979.9 ± 3.9[ab]
0.658 mg proenofos:			
0% Clay	32.83 ± 1.45	18.40 ± 0.31	838.7 ± 16.3[cd]
5% Clay	29.47 ± 0.85	19.63 ± 0.37	929.9 ± 9.9[ab]
1.315 mg proenofos:			
0% Clay	34.73 ± 0.94	17.63 ± 0.64	760.3 ± 45.5[d]
5% Clay	30.83 ± 1.07	19.60 ± 0.40	900.2 ± 36.0[bc]
2.630 mg proenofos:			
0% Clay	37.57 ± 0.71	15.40 ± 0.32	670.3 ± 25.7[e]
5% Clay	33.57 ± 1.05	18.30 ± 0.66	836.7 ± 30.9[cd]
Significance	NS	NS	*

* P<0.05, *** P<0.001 and NS = Not significant.
Means in the same column within each classification, bearing the different litters are differ significantly (P<0.05).

RESULTS

Proenofos effect:

Live body weight and daily body gain decreased significantly (P<0.001) in rabbits fed diets contaminated with proenofos (Table 1). Final body weight decreased with 8.24, 17.05, 21.80% in rabbits fed diets contaminated with 0.658, 1.315 or 2.630 mg proenofos/kg diet, respectively, when compared with those fed diets without pesticide, while the same figures for daily body gain were 12.01, 23.35 and 29.81%, respectively. On the other hand, mortality rate increased, while fed intake, decreased with increasing proenofos level in rabbit diets. Feed conversion impaired (Table 2).

Heamoglobin, serum total protein, albumin, globulin, SGPT and cholinesterase decreased significantly (P<0.01 or 0.001) in rabbits fed diets contaminated with proenofos, while SGOT, urea-N (P<0.001) and creatinine (P<0.05) increased (Tables 3 and 4).

Pre-slaughter body weight significantly (P<0.001) decreased in rabbits fed diets contaminated with proenofos, while adjusted carcass and non-carcass components were insignificant affected (Table 5). Adjusted kidney weight increased while kidney fat weight decreased in rabbits fed diets contaminated with proenofos. Proenofos residues in liver, kidney and muscle are indicated in Table 6. They significantly (P<0.001) increased with increasing pesticide level in rabbit diets. Proenofos residue in liver increased by 45.98 and 96.78% in rabbits fed diets contaminated with 1.315 or 2.630 mg proenofos/kg diet, respectively, when compared with those fed diets contaminated with 0.658 mg. The same figure in kidney tissue were 37.74 and 77.80%, respectively, and in muscle were 20.55 and 54.27%, respectively.

Clay effect:

Supplementation of natural clay in rabbit diets significantly (P<0.001) increased live body weight and daily body gain (Table 1). Final live body weight and daily gain increased by 14.18 and 21.39%, respectively, in rabbit fed diets supplemented with 5% clay than those fed the same diet without clay addition. Mortality rate decreased with clay supplementation (Table 2). Feed conversion improved by clay supplementation.

Heamoglobin, serum total protein, albumin, SGPT and cholinesterase increased significantly (P<0.001) in rabbits fed diets supplemented with clay, while SGOT, serum urea-N (P<0.001) and creatinine (P<0.05) decreased. On the other hand, blood globulin was not significantly affected by clay addition in rabbit diets (Tables 3 and 4).

Pre-slaughter body weight significantly increased (P<0.001) in rabbits fed diets supplemented with clay, while adjusted carcass and non-carcass components were insignificant affected (Table 5). Pesticide residues in liver, kidney and muscle significant (P<0.001) decreased with supplemented clay minerals in rabbit diets (Table 6). Pesticide residue in liver and kidney tissues and muscle decreased with 54.79, 50.31 and 40.03%, respectively, with clay supplementation in rabbit diets.

Interaction between pesticide and clay supplementation:

Final live body and daily gain were significantly affected (P<0.001) by the interaction between proenofos and clay supplementation (Table 1). Supplementation of natural clay in rabbit diets contaminated with 0.656, 1.315 and 2.630 mg proenofos/kg diets significantly (P<0.05) increased live daily body gain by 20.76, 31.47 and 40.56%, respectively, than those fed contaminated diets without

Table 5 : Actual pre-slaughter live body and adjusted carcass and non-carcass component weights in rabbit as affected by proenofos and clay supplementation and their interaction.

Items	Pre-slaughter body weight	Carcass[1] weight	Liver weight	Kidney weight	Kidney fat weight
Proenofos level:					
0 mg	2055.8 ± 31.1[a]	1062.5 ± 41.8	67.2 ± 8.8	12.6 ± 1.6	24.7 ± 6.5
0.658 mg	1941.7 ± 70.7[b]	1048.0 ± 22.8	67.0 ± 4.8	13.7 ± 0.9	18.3 ± 3.6
1.315 mg	1779.3 ± 75.1[c]	1060.9 ± 23.3	67.9 ± 4.9	17.5 ± 0.9	15.4 ± 3.6
2.630 mg	1671.7 ± 72.2[d]	1081.1 ± 41.2	74.8 ± 8.7	17.2 ± 1.6	11.2 ± 6.4
Significance	***	NS	NS	NS	NS
Clay supplementation:					
0%	1729.7 ± 56.3	1076.8 ± 28.7	72.5 ± 6.1	17.4 ± 1.1	13.9 ± 4.5
5%	1994.6 ± 37.6	1049.4 ± 28.7	65.9 ± 6.1	13.1 ± 1.1	20.9 ± 4.5
Significance	***	NS	NS	NS	NS
Interaction between proenofos and clay supplementation:					
0 mg proenofos:					
0% clay	1995.0 ± 20.2[b]	1067.9 ± 35.2	64.7 ± 7.5	13.7 ± 1.3	22.3 ± 5.5
5% clay	2116.7 ± 26.8[a]	1057.0 ± 55.5	69.6 ± 11.7	11.5 ± 2.1	27.1 ± 8.7
0.658 mg proenofos:					
0% clay	1791.7 ± 31.1[c]	1069.7 ± 27.2	66.7 ± 5.8	15.0 ± 1.0	16.3 ± 4.3
5% clay	2091.7 ± 39.2[a]	1026.4 ± 51.1	67.3 ± 10.8	12.4 ± 1.9	20.4 ± 8.0
1.315 mg proenofos:					
0% clay	1618.7 ± 34.6[d]	1065.1 ± 53.6	76.9 ± 11.3	21.1 ± 2.0	10.4 ± 8.4
5% clay	1940.0 ± 34.0[b]	1056.7 ± 28.0	58.9 ± 5.9	13.9 ± 1.1	20.5 ± 4.4
2.630 mg proenofos:					
0% clay	1513.3 ± 21.9[e]	1104.5 ± 72.9	81.8 ± 15.4	19.8 ± 2.8	6.5 ± 5.4
5% clay	1830.0 ± 22.9[c]	1057.7 ± 24.3	67.8 ± 5.1	14.7 ± 0.9	15.9 ± 3.8
Significance	**	NS	NS	NS	NS

1 Linear regression on live pre-slaughter body weight was significantly ($P<0.01$),** $P<0.01$, *** $P<0.001$ and NS = No significance. Means in the same column within each classification, bearing the different litters are differ significantly ($P<0.05$).

contaminated with 0.656, 1.315 and 2.630 mg proenofos/kg diets significantly ($P<0.05$) increased live daily body gain by 20.76, 31.47 and 40.56%, respectively, than those fed contaminated diets without clay addition. Also, supplemented natural clay in rabbit diets contaminated with proenofos decreased mortality rate. Feed conversion improved with clay supplementation in contaminated rabbit diets (Table 2).

Heamoglobin, serum total protein, globulin, creatinine, transaminases (SGOT and SGPT) were insignificantly affected by the interaction between proenofos contamination and clay addition (Tables 3 and 4). Within each pesticide level, supplemented clay minerals significantly ($P<0.05$) increased albumin and cholinesterase, while urea-N decreased significantly ($P<0.05$).

Pre-slaughter body weight were affected significantly ($P<0.001$) by the interaction between proenofos and clay supplementation, while carcass and non-carcass components were insignificantly affected (Table 5). Pesticide residue in liver tissue were significantly ($P<0.001$) affected by the interaction between proenofos and clay supplementation, while kidney tissue and muscle was insignificantly affected (Table 6). Within each proenofos level, supplemented rabbit diets with clay decreased the pesticide residue in liver and kidney tissues and muscle.

DISCUSSION

The observed decline in growth rate and feed efficiency in growing New Zealand White rabbits as a result of fed diets contaminated with pesticide is similar to that reported in sheep and poultry (EL-GENDY, 1989, KUBENA *et al.*, 1992, HARVEY et al., 1993 and SHALABY and AYYAT, 1999). Impairment of feed intake and the decrease in feed utilization may be responsible for the depression in growth rate in rabbits fed diet contaminated with pesticide (proenofos). On the other hand, the decline in concentration of heamoglobin, serum total protein and albumin may be due to a disturbance in protein metabolism. SHAKOORI *et al.* (1990 a and b) reported that the total erythrocytic count, total leukocytic count, packed cell volume and haemoglobin content decreased after bifenthrin (TALSTAR) administration in rabbits. Also, HASSAN *et al.* (1988) reported that the pesticide contaminated in rabbit diets decreased blood heamoglobin red blood cell counts. The poisoning by the organophosphorus

Table 6 : Proenofos residues (ppm) in some organs of rabbit as affected by pesticide and clay supplementation and their interaction.

Items	Liver	Kidney	Muscle
Proenofos level:			
0.658 mg	3.447 ± 0.552[a]	1.815 ± 0.284[a]	0.433 ± 0.052[a]
1.315 mg	5.032 ± 0.857[b]	2.500 ± 0.415[b]	0.522 ± 0.076[b]
2.630 mg	6.783 ± 1.205[c]	3.227 ± 0.477[c]	0.668 ± 0.065[c]
Significance	***	***	***
Clay supplementation:			
0%	6.994 ± 0.709	3.359 ± 0.283	0.677 ± 0.043
5%	3.180 ± 0.301	1.669 ± 0.158	0.406 ± 0.034
Significance	***	***	***
Interaction between proenofos and clay supplementation:			
0.658 mg proenofos:			
0% clay	4.617 ± 0.289[c]	2.427 ± 0.147	0.543 ± 0.029
5% clay	2.277 ± 0.262[e]	1.203 ± 0.087	0.323 ± 0.020
1.315 mg proenofos:			
0% clay	6.933 ± 0.145[b]	3.383 ± 0.260	0.680 ± 0.057
5% clay	3.130 ± 0.188[d]	1.617 ± 0.120	0.363 ± 0.023
2.630 mg proenofos:			
0% clay	9.433 ± 0.344[a]	4.267 ± 0.148	0.807 ± 0.032
5% clay	4.133 ± 0.216[c]	2.187 ± 0.107	0.530 ± 0.031
Significance	***	NS	NS

* P<0.05, ** P<0.01 and *** P<0.001.
Means in the same column within each classification, bearing the different litters are differ significantly (P<0.05).

Organophosphorus insecticides are inhibits of acetylcholinesterase this result could in accumulation of endogenous acetylcholine in nerve tissue. Acetylcholine is the chemical transmitter of the nerve impulses at endings of postganglionic parasympathetic nerve fibers. HABIBA and ISMAIL (1992), TSATSAKIS *et al.* (1996) and SHALABY and AYYAT, (1999) reported that the organophosphorus insecticides inhibited cholinesterase in rabbit and poultry blood. Pesticide residue in rabbit tissues increased due to the fed on diets contaminated with pesticide. The accumulated residues of pesticide depended on the inner organ and the concentration of the pesticide in rabbit diets. As usually observed, the higher residues were accumulated in liver followed with the kidney tissue and the lowest residues were determined in rabbit muscles. This finding is buzzing since the main biotransformation processes of pesticide molecules occur logical in liver. Several investigators reported that the highest concentrations from variety of toxicants were found in liver and the lowest in skeletal muscles (MOSTAFA *et al.*, 1994 and SHALABY and AYYAT, 1999).

The addition of 5% natural clay (bentonite) to the rabbit diets contaminated with pesticide improved growth rate and feed efficiency. This improvement in growth rate was associated to the increase in blood total protein, albumin and cholinesterase and to decrease in serum GPT. These results paralleled with those obtained by CARSON and SMITH (1983), EL-GENDY *et al.* (1989) and SHALABY and AYYAT (1999). Clay minerals supplementation in contaminated rabbit diets increased liver protein synthesis and serum albumin concentration whereas SGOT decreased to normal level. The role of natural clay in the improvement of protein synthesis in rabbit fed diets contaminated with pesticide may be associated with ion exchange and minerals supplied from natural clay. Natural clay addition in contaminated diets with pesticide clearly reduced the level of pesticide residues in the inner organs and muscles. Bentonite is known to prevent the pesticide toxicity by reducing pesticide absorption in the intestinal tract and increasing fecal excretion.

Finally, blood component changes, and the residue analysis in animal tissues could be used as indicators of the pollution in animals. Also, the addition of natural clay minerals could be recommended to rabbit diets in order to reduce the toxic effects of pollutants like pesticides and therefore to improve animal production.

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