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Occupational Exposure to Pesticides and Its Effects on Health Status of Workers in Swat, Khyber Pakhtunkhwa, Pakistan

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Abstract

Pesticides are a large and diverse group of chemicals used to kill and eradicate rodents, fungi, insects, and weeds. The present study was designed to check the effect of pesticides on liver as well as kidney function of the workers engaged in occupations in which there is persistent exposure to pesticides, (dealers, gardeners and owners of gardens), and to check the prevalence of hepatitis in these workers indistrict Swat, Khyber Pakhtunkhwa, Pakistan. Blood samples

were collected and history was taken from different groups of individuals exposed to pesticides. Four groups were made, owners, gardeners, dealers and control, which had approximately same age and were engaged in this field for an average of 8 years. A significant decrease in hemoglobin concentration was noticed in all the exposed groups. The level of glutamate pyruvate transaminase, uric acid, bilirubin (direct and total) and calcium was high among exposed groups compared to control. The prevalence of both hepatitis B and C was also high in exposed groups. Pesticides significantly affected the hemoglobin level, and altered liver and kidney functions. The same study may be preceded to other biochemical and hematological parameters considering a large number of exposed persons.

Keywords: Pesticides, Liver Function, Kidney Function, Hepatitis

1. Introduction

The use of pesticides has increased food production with increasing population in many parts of the world (AL-Shinnawy, 2008). In USA a total of about 890 active ingredients are registered as pesticides (Bolognesi, 2003). Pesticides are a large and diverse group of chemicals (Kamel et al., 2004)that are used to kill and eradicate rodents, fungi, insects, and weeds (Mnif et al., 2011) as well as an important cause of morbidity and mortality in developing countries (Saxena, 2010). It covers a wide range of compounds like insecticides, fungicides, herbicides, rodenticides, molluscicides, nematicides, plant growth regulators (Aktar et al., 2009). The extensive use of insecticides has caused great concern because of the possible effects of these compounds on human beings as well as wild and domestic animals (Alpalan et al., 2006). Its exposure may affect spermatogenesis leading to poor semen quality and reduced male fertility (Falck et al.,1992), as well as reproduction, nervous, immune, endocrine, blood coagulation, hematology, cardiovascular, respiration, metabolisms and fluid and electrolyte balance. It affects several organs of human beings, but liver is most susceptible and have carcinogenic (Patil et al., 2012) and mutagenic potential (Kumar, 2008). Pesticides uptake occurs mainly through the skin and eyes, by inhalation or by ingestion (Patil et al., 2012). Occupational exposures occur in the mixing and loading of equipment as well as in the spraying and application of insecticides (Wolfe et al., 1967).

The present study was designed to focus the effect of pesticides on liver as well as kidney function of the workers engaged in occupations where persistent exposure to these types of chemicals were present and to check the prevalence of hepatitis among the workers.

2. Materials and Methods

2.1 Data Collection:

For the present study; villages (Matta, Khwazakhela, and Bandai) of district Swat, Khyber Pakhtunkhwa; were selected, where peach plants are commonly grown and sprayed with pesticides to protect fruits and plants from various diseases as well as pests. A total of 55 workers were randomly selected from dealers, gardeners and owners of the gardens, exposed to pesticides. Control people were also selected from the same area where the other groups were selected. The exposed groups were engaged in this field for an average of 8 years. A questionnaire was formulated to collect the specific information regarding the age,

socioeconomic status, and health status and exposure time. Same questions were also asked from the control group.

2.2 Blood collection:

An equal amount (5 ml) of blood samples were taken randomly from the people of different regions of district Swat that were engaged in distribution of pesticides (dealers), the gardeners and the owners of the gardens. Also same amount of blood was taken from the people that were living in the same locality but were not exposed to pesticides and were kept as control. Plasma was separated, and Fully Automated Blood Chemistry Analyzer 4000 (Italy) and Shimadzu UV- Visible Double Beam Spectrophotometer 1700 Pharma (Japan) were used for analysis of different biochemical parameters.

2.3 Biochemical analysis

The following biochemical parameters were measured in order to study the effect of pesticides on the health status of people engaged in the use and distribution of pesticides as well as of control group.

2.4 Hemoglobin (Hb) level

Sahli's method was used for the estimation of hemoglobin. In this test, N/10 HCl is used as a diluting fluid. It hemolysis the RBCs and frees the hemoglobin. This released Hb is stabilized by HCl, by conversion of Hb to acid haematin, which is a stable form of Hband is tan in color. The color of acid haematin is matched with standard.

2.5 Uric Acid Level

Uric acid level was estimated by enzymatic colorimetric test using CRESCENT diagnostic kit (Saudi Arabia) according to the procedure given in the kit protocol.

2.6 Calcium level

The AXIOM Gestllschaft for Dignostica and Biochemicam BH kit (Deutschland) was used to measure the level of Calcium in the serum samples of both workers and control groups.

2.7 Bilirubin (both direct and indirect)

The bilirubin level was estimated using DIALAB diagnostic kit for Bilirubin Direct/Total (Austria) as described by the manufacturer.

2.8 Serum glutamate pyruvate transaminase (SGPT) level

The Crescent diagnostic kits (Saudi Arabia) were used forestimation of serum glutamate pyruvate transaminase (SGPT) by following the procedure given in the kit protocol.

2.9 Screening for hepatitis B virus (HBV) and hepatitis C virus (HCV)

All the samples were screened for HBV and HCV positive persons by using one step test Device package. It is a rapid chromatographic immunoassay for the qualitative detection of antibody to HBV and HCV in serum or plasma.

2.10 Statistical Analysis

The data was statistically analyzed by using online available software, Prism, Demo version 05, downloaded from the site www.graphpad.com.

3. Results

The present study was conducted to evaluate the adverse effects of pesticides on health of human; by determining various biochemical parameters of blood.

3.1 Hemoglobin Level

The maximum value of hemoglobin for the control group was found to be 14.83±0.252 mg/dl and minimum was 9.000±0.500 mg/dl with a range of 9.000 mg/dl to 14.83 mg/dl. The uppermost level of hemoglobin for dealers was 12.10±0.200 mg/dl while the lowest was 7.000±0.0200 mg/dl with a range of 7.000 mg/dl to 12.10 mg/dl. The maximum level in gardeners was 11.77±0.153 mg/dl and minimum 7.600±0.200 mg/dl with a range of 7.600 mg/dl to 11.77 mg/dl. A maximum value for hemoglobin (11.971±0.153 mg/dl) was found in owners group with a minimum value of 6.800±0.300 with a range 6.800 mg/dl to 11.97 mg/dl (Figure 1).

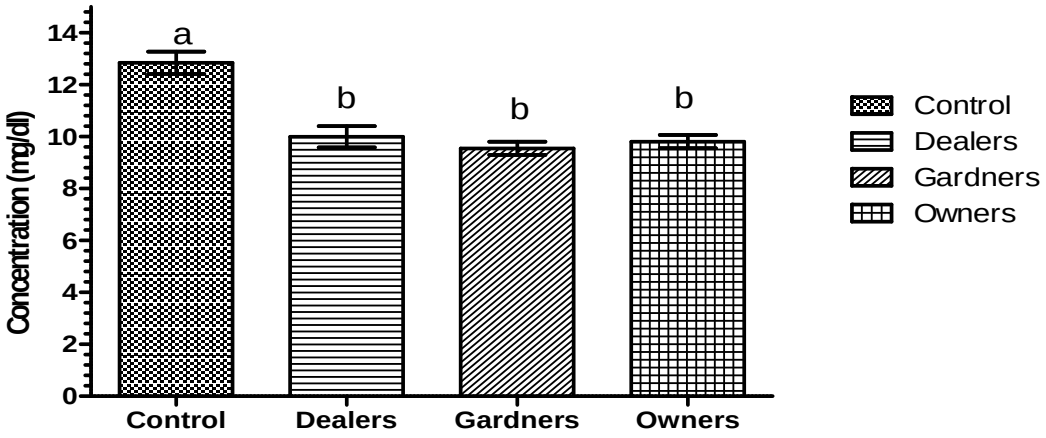

Figure 1. Hemoglobin level of control, dealers, gardeners and owners

Different alphabets show statistical difference among the columns, same alphabets showing no significant difference

3.2 Uric Acid Level

For control group, the maximum level of uric acid was 6.567 ± 0.172 mg/dl and minimum was 5.187 ± 0.173 mg/dl. The peak level of uric acid for dealer group was 13.17 ± 0.222 mg/dl while the lowest level was 6.103 ± 0.270 mg/dl. The range was from 6.103 mg/dl to 13.17 mg/dl. The maximum level of uric acid in gardeners was 14.26± 0.272 mg/dl and minimum level was 6.230 ± 0.252 mg/dl with a range of 6.230 mg/dl to 14.26 mg/dl. A higher level for uric acid was determined in owner group; the uppermost uric acid level was 20.17 ± 0.163

mg/dl while the lowest was 5.183±0.176 mg/dl. The range was from 5.183 mg/dl to 20.17 mg/dl (Figure 2).

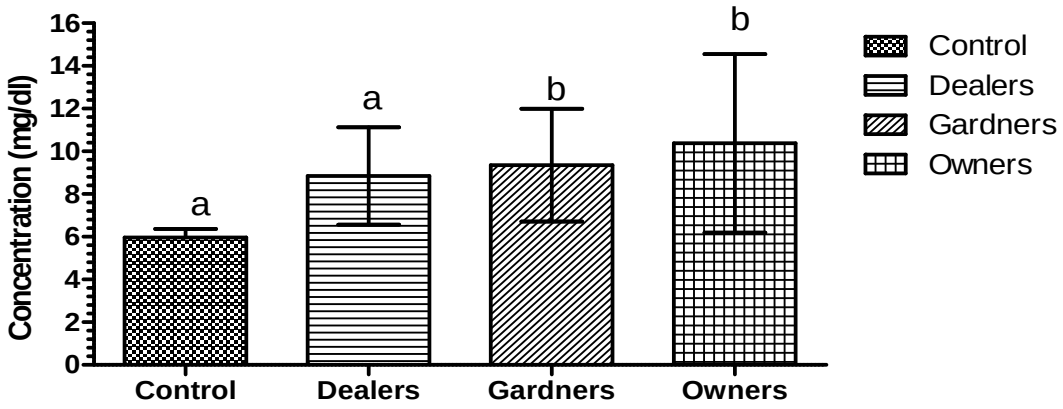

Figure 2. Blood uric acid level of control, dealers, gardeners and owners

Different alphabets show statistical difference among the columns, same alphabets showing no significant difference

3.3 Calcium Level

The groups exposed to pesticides showed high level of blood calcium. The calcium level was lowest in control group as compared to exposed groups. The maximum level for calcium in control was 10.81 ± 0.100 mg/dl and lowest was 8.670 ± 0.100 mg/dl with a range of 8.670 mg/dl to 10.81 mg/dl. An increase was observed in calcium level of dealers group, the maximum level was 20.09 ± 0.241 mg/dl while the minimum was 8.640 ± 0.366 mg/dl and the range was from 8.640 mg/dl to 20.09 mg/dl. Gardeners showed a significant increase in calcium level. The uppermost level was 22.75±0.140 mg/dl and the lowest was 8.803 ± 0.221 mg/dl with a range of 8.803-22.75 mg/dl. A significant increase was also observed in owner group. The highest level was 20.26 ± 0.085 mg/dl while the lowest was 8.743 ± 0.117 mg/dl. The range of calcium level was from 8.743-20.26 mg/dl (Figure 3).

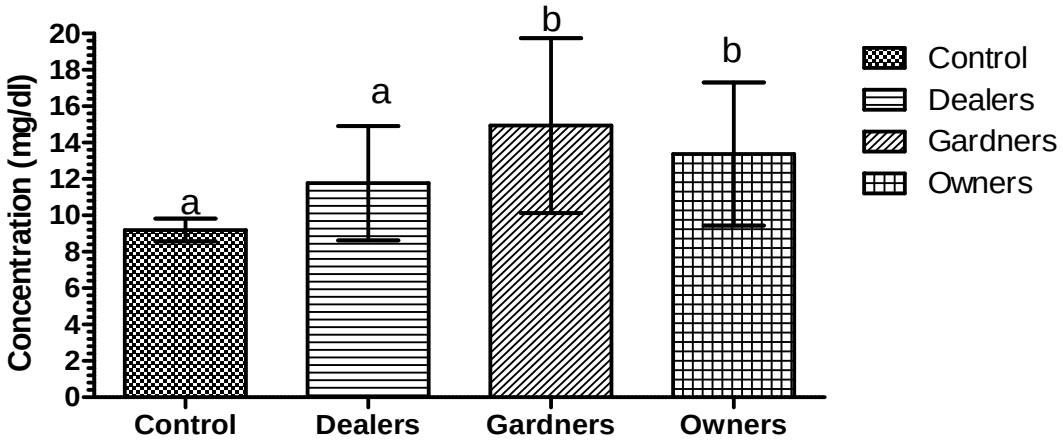

Figure 3. Blood calcium level of control, dealers, gardeners and owners

Different alphabets show statistical difference among the columns, same alphabets showing no significant difference

3.4 Level of Bilirubin (Direct)

The level of bilirubin direct was determined in control as well as exposed groups. A low level of bilirubin (Direct) was determined in control group when compared with the rest of the groups. The highest level was 0.680 ± 0.046 mg/dl while lowest was 0.330 ± 0.036 mg/dl with a range of 0.330 mg/dl to 0.680 mg/dl (control).The dealers had an increase in bilirubin (Direct) level. The highest value obtained was 0.8533 ±0.015 mg/dl; while the lowest was 0.5667 ± 0.015 mg/dl. The range was from 0.5667 mg/dl to 0.8533 mg/dl. There was an increase in bilirubin level (Direct) in gardeners, the uppermost level was 1.340 ± 0.036 mg/dl and lowest value was 0.5167±0.021 mg/dl with a range of 0.5167 mg/dl to 1.340 mg/dl. A significant increase ($P<0.05$) was recorded in bilirubin level (Direct) in owner group. The maximum value was 1.217±0.031 mg/dl and minimum 0.5233 ± 0.025 mg/dl with a range 0.5233 mg/dl to 1.217 mg/dl (Figure 4).

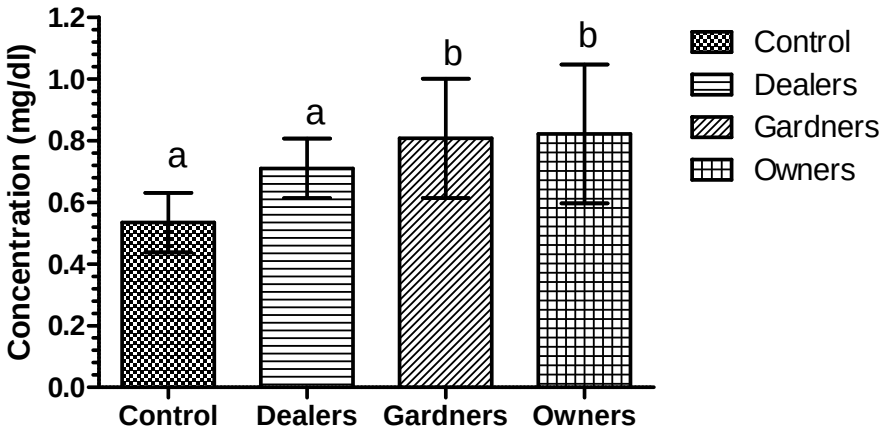

Figure 4. Blood bilirubin (direct) level of control, dealers, gardeners and owners

Different alphabets show statistical difference among the columns, same alphabets showing no significant difference

3.5 Level of Bilirubin (Indirect)

There was an increase in bilirubin level (Indirect) in the groups exposed to pesticides when compared to control. The bilirubin level (Indirect) was almost normal in control group having the maximum value of 0.707 ± 0.040 mg/dl and a minimum value of 0.583 ± 0.021 mg/dl with a range of 0.583 mg/dl to 0.707 mg/dl. The highest value of bilirubin (Indirect) in dealers was 1.333 ± 0.045 mg/dl while the lowest value was 0.673 ± 0.025 mg/dl with a range 0.673 mg/dl to 1.333 mg/dl. The uppermost level of bilirubin (Indirect) was 1.613 ± 0.035 mg/dl while the lowest was0.517± 0.015 mg/dl and the range was 0.517-1.613 mg/dl. There was a significant increase ($P<0.05$) in bilirubin level (Indirect) in owners. The maximum level was 1.653 ± 0.040 mg/dl and minimum level was 0.650 ± 0.026 mg/dl with a range 0.650 mg/dl to 1.653 mg/dl (Figure 5).

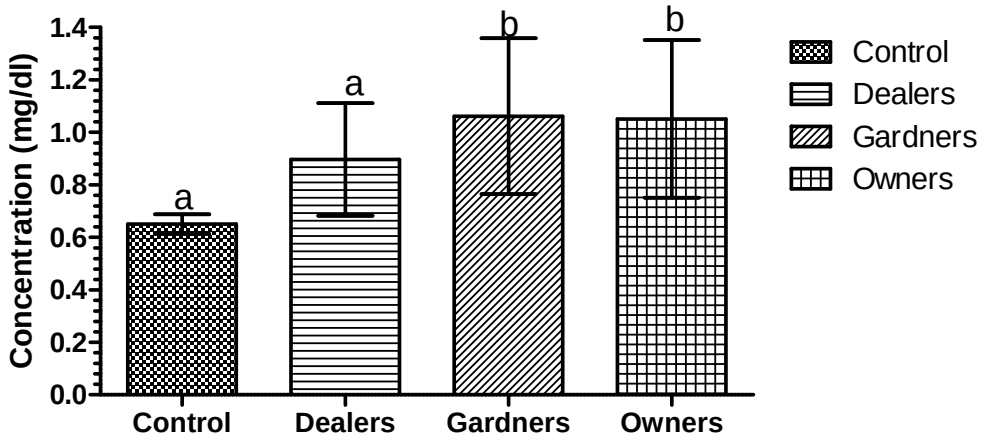

Figure 5. Blood bilirubin (indirect) level of control, dealers, gardeners and owners

Different alphabets show statistical difference among the columns, same alphabets showing no significant difference

3.6 Glutamate Pyruvate Transaminase (GPT) Level

The level of GPT was analyzed for all the groups in order to assess the adverse effect of pesticides on liver. The GPT level in control group was almost normal with a range of 20.121 ± 0.002 units/L to 56.069 ± 0.002 units/L. The value of GPT was higher in the dealers. The maximum value of GPT was 425.60 ± 0.002 units/L, while minimum value was 45.55 ± 0.001 units/L. Gardeners had high level of GPT, the uppermost value being 429.7 ± 0.003 units/L, while the lowest was 70.78± 0.004 units/L. GPT level was highest in the owners, with a maximum level of 432.2 ± 0.003 units/Land minimum was 59.61 ± 0.001 units/L (Figure 6).

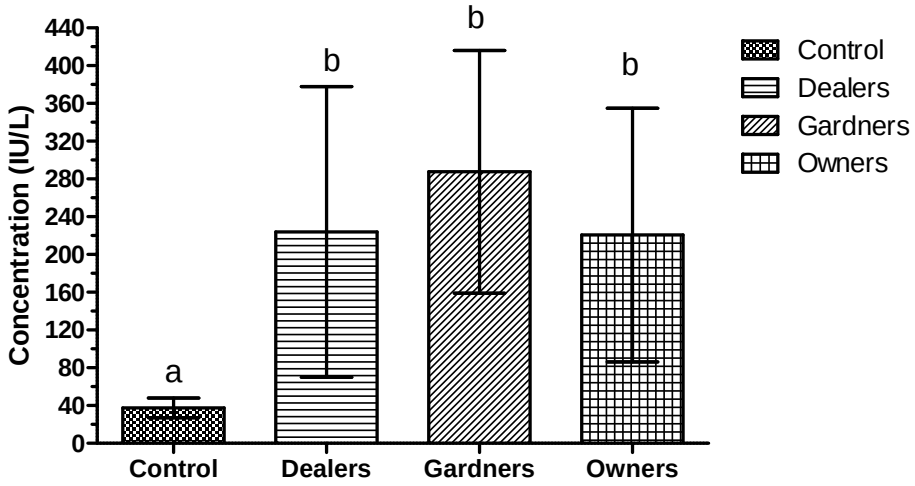

Figure 6. Serum glutamate pyruvate transaminase level of control, dealers, gardeners and owners

Different alphabets show statistical difference among the columns, same alphabets showing no significant difference

3.7 Percentage of Occurrence of Hepatitis B and C among the Exposed As Well As Control Group

The percentage of occurrence of hepatitis was checked by using the following formula.

$$\text{Percentage of Occurrence} \quad \frac{\text{Number of infected persons}}{\text{Number of total samples}} \quad 100$$

In control group, both the hepatitis B and C were 0%. In dealers, the hepatitis B was 6.66% and hepatitis C was 0%. In gardeners, 10% were affected with hepatitis B and 10 % with hepatitis C. In owners, no one was positive for hepatitis B while 10 % were affected with hepatitis C(Table 1).

Table 1. Occurrence of Hepatitis B and C among control, gardeners and owners

S. No	Groups	Occurrence of Hepatitis B		Occurrence of Hepatitis C	
		HBsAG Positive	Percentage	HCVRNA Positive	Percentage
1	Control	0	00%	0	00%
2	Dealers	1	6.66%	0	00%
3	Gardeners	2	10%	2	10%
4	Owners	0	00%	2	10%

HBsA= Hepatitis B surface antigen, HCV RNA= Hepatitis C Virus

4. Discussion

The role of pesticides in the development of diseases in humans is still controversial, despite their important use and their widespread diffusion. There is no such study that provide enough information about the effect of pesticides on vital organs like kidney, liver, lungs, heart and skin of the locality. In the present study, detailed information of adverse health effects from pesticides was provided.

In the present study, control group had high level of hemoglobin than dealers, gardeners and owners. Reenaet al., 1989, Parronet al., 1996 and Jyotsnaet al., 2003 also reported same results. Salih1995 evaluated the hepatotoxic, and nephrotoxic effects of Dimethoate and Diazinon, and showed that hematological factors including hemoglobin were reduced in the treated rabbits. Significant decrease was observed by Patil et al., 2007 in serum cholinesterase, serum total proteins, albumin and hematological parameters viz. Hb, HCT and RBC in a total of 85 healthy male pesticide sprayers in grape garden exposed to different class of pesticides for 3 to 10 years were compared with 75 controls. Patil et al., 2009 compared hematologic parameters and liver and kidney function tests in occupationally exposed pesticide sprayers of grape gardens and normal healthy participants, 20-45 years of age, in Western Maharashtra (India) and found significantly decreased hemoglobin, hematocrit, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, and red blood cell count, whereas the white blood cell count increased in sprayers. Rastogi et al., 2008 also observed same results and indicated a significant decrease in the mean value of hemoglobin. Younger workers were

more affected and leukocyte and platelet counts were increased and hemoglobin decreased significantly, reflecting an acute poisoning after evaluating the health impact of insecticides on Palestinian farm workers in the Gaza Strip by Abu Mouradin 2005.It was concluded that pesticides lead to alteration in hematological parameters. Furthermore, the people involved in selling of the pesticides have no strict rules to sell the chemicals in sealed container. These dealers used to sell the chemicals in sealed containers as well as in open bottles; therefore, there may be the chances of having an exposure with the toxicants.

Control group had normal level of uric acid. Dealers have high level of uric acid but there was no significant difference ($P<0.05$) between control and dealers. Gardeners and owners had significantly high level of blood uric acid. Muthuviveganandavel et al., used methyl 2-benzimidazole carbamate (carbendazim, a fungicide), intradermally to male albino rats and analyzed biochemical and hematological parameters and found an increase in cholesterol, uric acid, and glucose and creatinine level in rats. Khan et al., 2008 determined the frequency of plasma pesticide residues and its correlation with biochemical markers in the tobacco farmers (total 109 adult males; 55 tobacco farmers exposed to pesticides and 54 controls) at district Sawabi, Pakistan. Excessive exposure to pesticide caused cytotoxic changes in the hepatic and renal biochemical markers which were positively correlated with pesticide residue.Salih1995 evaluated the hepatotoxic, and nephrotoxic effects of Dimethoate and Diazinon, and showed that the levels of the ALT and AST as well as ALP, uric acid, creatinin, and blood glucose in the serum of treated rabbits significantly ($P<0.01$) increased compared to control animals. It has been found that pesticides elevate blood uric acid level by altering kidney function.

The results of present study revealed that exposure to pesticides increase the blood calcium level in the blood of dealers, gardeners and owners as compared to control. Mishra et al., (2005) and Logaswamyet al.,(2007)also noticed an increase in calcium level. It has been concluded that pesticides have significant effect on calcium level and lead to an elevation in blood.

In the study, bilirubin level (both Direct and Indirect) of persons exposed to pesticides was determined with the aim of evaluating the effect of these pesticides on liver function. The control group showed normal values of both direct and indirect bilirubin in blood. There was no significant difference in direct and indirect bilirubin level indealers with that of control. A significant increase was observed in direct and indirect bilirubin levels of gardeners and owners. Reenaet al., (1989), Brouweretal., (1991), Boogardet al., (1993) and Yousefet al.,(2006) have mentioned same results.Patil et al., 2009 compared hematologic parameters and liver and kidney function tests in occupationally exposed pesticide sprayers of grape gardens and found an increase in serum bilirubin, creatinine, blood glucose, and urea. There are no proper protection measures in the fields and also the people are unaware of these toxicants, also there is difference in exposure period because most workers accomplished their duty as full time.

The level of GPT was normal for control group. There was significant increase ($P<0.05$) in the GPT level of dealers, gardeners and owners. There was no significant difference in elevation of GPT between these three groups. All the three groups were affected equally. Kamal et

al.,(1990), Jyotsnaet al.,(2003), Azmiet al.,(2006), Yousefet al.,(2006) and Ameret al., (2002) observed similar results. Ejigu & Mekonnen 2005 assessed the health status, attitude and level of awareness of safe pesticide handling practices of farm workers engaged in the application of pesticides on agricultural farms and liver function tests showed elevated values. The ALP value in the sprayers, glutamate pyruvate transaminase (GPT) in the assessors and glutamate oxaloacetate transaminase (GOT) in the sprayers and mechanics were significantly higher than the controls ($p < 0.05$).Khan et al., 2008 also found significantly raised plasma biochemical markers including ALT, AST, CK, LDH and phosphate in the pesticides exposed farmers as compared to control ($P<0.001$). Patilet al., 2009 compared hematologic parameters and liver and kidney function tests in occupationally exposed pesticide sprayers of grape gardens and observed significantly increased liver function marker enzymes-serum aspartate transaminase, alanine transaminase, and alkaline phosphatase. The present results showed that pesticide exposure causes an increase in the level of GPT. It may be concluded that pesticides can alter the liver function.

The prevalence of hepatitis B and C among control as well as exposed groups was determined. The prevalence was calculated as percentage of the infected samples in the total samples in each group. Prevalence of hepatitis B was 6.66% in dealers, 10 % in gardeners and 0 % in owners. Hepatitis C was 0% in dealers, 10% in gardeners and 10% in owners. Present results are in correlation with the findings of Azmiet al.,(2006). High percentage of hepatitis in exposed groups may be due to the usual exchange of eating utensils, foodstuffs, body pricking during work etc.

5. Conclusion

From the present study; it has been concluded that pesticides significantly affects the hemoglobin level, affecting calcium level, increases the uric acid level by altering the kidney function, and also affects the liver function by increasing the GPT level as well as bilirubin level in blood.

5.1 Recommendations

Protective measures must be undertaken while dealing pesticides. Sharing of food stuffs during the work should be avoided to prevent the spread of hepatitis and especiallyhepatitis B, whose virus is usually found in saliva. Government agencies must implement strict legislation over selling, purchase and on the use of pesticides.

5.2 Limitations

In the present study, there is the limitation of analysis of the pesticides residues in blood of the people that were exposed to pesticides due to unavailability of facilities. Also the study was restricted to only those areas where the use of pesticides was high; large population size and large area was not undertaken in the present study.

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