Pakistan J. Zool., vol. 41(1), pp. 61-65, 2009.

Changes in Selected Blood Biochemical Components of Industrial Workers Occupationally Exposed to Textile Dyes: A Preliminary Study

Iram Liaqat, Mohammad Arshad and Najma Arshad
Department of Zoology, University of the Punjab, Lahore-54590, Pakistan (IL, NA), and Government College University Lahore, Pakistan (MA).

Abstract.- Present study was designed to evaluate the effects of chemicals used in textile dyes on the health of occupationally exposed workers. The various blood biochemical parameters of a total of 62 male textile workers (20-45 years of age) involved in the dyeing processes for a period of six months to 20 years and 50 non-industrial workers were compared to assess the health of industrial workers. The levels of acid phosphatase (AP), alkaline phosphatase (ALP) and lactate dehydrogenase (LDH) were found to be low while those of aspartate aminotransferase (AST) and albumin were higher in textile industry workers. The changes observed in the blood component did not correlate with the age and job duration. A significant ($p \leq 0.05$) depletion in ALP and elevation in ALT was recorded in most of the age groups along with alterations in AP, LDH, AST and globulin. On the other hand significant decrease in AP, ALP, LDH and increase in AST was observed in workers involved in the dying processes for 6-10 years. The present study suggests that occupational exposure to textile dyes causes adverse effects on the health of industrial workers, though these effects are not related to the age or duration of exposure.

Key words: Textile dyes, textile industry workers, liver function tests, serum protein subsets.

INTRODUCTION

Dyeing is one of the critical procedures in textile industry in which the workers get exposed to a number of hazardous chemicals including acids, bases and caustics, bleaching agents, chromophores and organic solvents like formaldehyde and benzene (Wernli *et al.,* 2006). These chemicals gain entry into the system through inhalation or dermal contact. Systemic effects may occur beyond the site of contact if the dye is absorbed into the bloodstream and distributed throughout the body (Singhi *et al.,* 2005).

Liver is the major organ involved in detoxification process and is the first target of chemical induced tissue injury. Shimizu *et al*. (2002) reported liver dysfunction among workers handling 5-nitro-o-toludine, a raw material for azo dyes. Soyinka *et al*. (2007) documented hepatic malfunctioning in workers occupationally exposed to benzanthrone, an important dye intermediate used in the manufacture of vat dyes.

A substantial amount of work is available regarding effects of textile dyes on lung function, allergies and cancer (Mastrangelo *et al*., 2002; Singhi *et al.,* 2005; Wernli *et al.,* 2006; Astrakianakis *et al*., 2007; Kuzmickiene and Stukonis, 2007), but limited information is available about their influence on liver function (Soyinka *et al*., 2007). Moreover, information about their effects on protein fractions of serum like albumin, globulin, gamma globulin (γ-globulin) and A-gamma-globulin (A-γ globulin) have not been documented so far. All the findings about effects of dyes are based on reports from advanced countries where the concentration of pollutants are kept at recommended low levels (Osunsanya *et al*., 2001; Ustinaviciene *et al*., 2004; Donbak *et al*., 2006; Wernli *et al*., 2006). Despite the fact that textile industry is one of the important manufacturing sectors and prominent occupation of Pakistani population, least information is available regarding the health of the workers involved in different processes. Present study was, therefore, designed to determine the effects of dyes on the liver function tests and serum protein fractions of occupationally exposed workers.

* Address for correspondence: najmaarshad@yahoo.com

0030-9923/2009/0001-0061 $ 8.00/0

MATERIALS AND METHODS

Sixty two subjects, occupationally exposed to textile dyes in two factories at Sheikhupura Road, Lahore were included in this study. They were sex and age matched with fifty control subjects from village Kot Pindidas, Sheikhupura who had no previous exposure to textile dyes. All the subjects gave their informed consent and a semi-structured questionnaire was used to obtain information on age, smoking habit, job duration /exposure time and history of disease or allergy of the subjects.

Blood samples were collected into lithium heparin specimen tubes. Plasma was separated from cells by centrifugation at 3380 x g for 15 min. Plasma was stored at -20°C until analyzed. Estimation of acid phosphatase (AP) (Andersch and Szayphinskhi, 1947), alkaline phasphatase (ALP) (Haussament, 1977), lactate dehydrogenase (LDH) (Weisshaar *et al*., 1975), aspartate and alanine aminotransferase (AST and ALT) (Reitman and Frankel., 1957), total serum protein (Henry *et al*., 1974), and serum albumin (Doumes *et al*., 1971) were performed using commercial kits from RANDOX (RANDOX Laboratory Ltd., UK). Gamma globulin (γ-globulin) was determined following the procedure of Wolfson *et al.* (1948). Serum globulin level was determined by substracting the serum albumin value from total protein (Varley, 1975) while A-gamma globulin (A-γ-globulin) was calculated by substracting the serum γ-globulin levels from globulin levels. Albumin/globulin (A/G) ratio was determined by dividing albumin contents from globulin and taking its percentage.

Statistical analysis

Comparison between exposed and unexposed groups was carried out using Student's t-test in the SPSS computer statistical package (Version 12, SPSS Inc, Chicago). To investigate the influence of age on the work related changes, the factory and non factory workers were divided into 5 age groups (21-25; 26-30; 31-35; 36-40 and 40-45 years). On the other hand, the exposure time specific changes were evaluated by dividing factory workers into five groups on the basis of their job duration in the dyeing process (≥ 1; 1-5; 6-10; 11-15 and 16-20 years). All parameters were expressed as mean ± standard error and the comparison was made with respective control groups of non factory workers. P values ≤ 0.05 were considered significant.

RESULTS AND DISCUSSION

Various chemicals are used in dyeing process, which have hazardous effects on workers involved in this process (Wernli *et al*., 2006; Singh *et al*., 2005). Donbak *et al*. (2006) have also reported the genotoxic potential of dyes and their solvents on the liver and serum. A correlation between adverse changes in liver structure and biochemical constituent has been shown in different mammals exposed to various xenobiotics (Kazmi *et al.,* 2003).

Table I shows the comparison of various biochemical components of blood parameters of industrial workers with unexposed control group. A significant ($p<0.05$) decrease in AP, ALP and LDH was recorded in textile industry workers, whereas AST and albumin were found to be elevated. However, other parameters remained unchanged. Table II shows age specific changes in liver function tests of industrial workers, whereas Table III shows age specifics changes in various protein fractions of industrial workers. A decrease in AP, ALP and LDH and increase in AST, ALT and globulin was recorded in some age groups of textile workers. Table IV shows effect of duration of exposure to textile dyes on enzymes and proteins levels. The

Table I.- Effect of textile dyes on various blood components of textile industry workers.

Parameters[a]	Control (n=50)	Exposed (n=62)	Reference values
AP	23.29±0.69	21.07±0.61*	1-35 IU/L
ALP	43.48±1.74	37.25±1.09*	19-69 IU/L
LDH	195.71±9.90	166.83±3.15*	160-320 IU/L
AST	23.44±1.12	28.25±0.87*	upto 25 IU/L
ALT	25.62±1.02	27.89±1.40	up to 29 IU/L
Protein	6.91±1.10	6.95±0.12	6-8.7 g/dl
Albumin	4.14±0.11	4.52±0.10*	3.8-4.4 g/dl
Globulin	2.59±0.18	2.66±0.11	1.13-2.17 g/dl
γ-globulin	1.21±0.06	1.35±0.09	0.9-1.5 g/dl
A-gamma globulin	1.38±0.89	1.35±0.12	1.4-2.4 g/dl
Albumin/ globulin ratio	1.87±0.14	2.02±0.15	1.2-2.5 g/dl

[a]Abbreviations used: ALP, alkaline phosphatase; ALT, alanine

aminotransferase; AP, acid phosphatase; AST, aspartate aminotransferase; LDH, lactate dehydrogenase.

*Mean±SEM; Student's `t' test, *p<0.05

Table II. Age specific comparison of various enzyme levels of textile industry workers.

Age (years)	Groups (n) [a]	AP (IU/L)	ALP (IU/L)	LDH (IU/L)	AST (IU/L)	ALT (IU/L)
21-25	Control (10)	23.36±0.53	34.51±3.67	193.0±15.31	24.53±2.37	22.49±2.05
	Exposed (19)	19.27±0.94*	41.37±1.68	168.59±8.80	32.22±4.04	33.22±2.09*
26-30	Control (10)	22.83±1.40	44.87±3.67	218.51±19.09	26.39±1.82	24.94±2.44
	Exposed (21)	20.19±1.14	34.93±1.70*	167.06±3.77*	26.39±1.35	25.83±0.87*
31-35	Control (10)	20.39±2.78	48.14±2.49	204.22±23.03	28.23±2.97	22.27±2.67
	Exposed (07)	25.97±0.88	39.97±1.88*	167.13±5.87	25.97±2.17	23.60±1.11
36-40	Control (10)	24.96±0.93	49.16±2.10	184.61±18.97	25.83±2.69	26.07±2.87
	Exposed (06)	20.11±1.46*	23.43±1.20*	161.05±4.67	27.23±2.50*	26.99±1.32
40-45	Control (10)	25.77±0.62	43.15±2.10	152.39±36.47	22.27±1.22	19.93±2.28
	Exposed (09)	23.32±1.61	39.87±2.83	165.59±6.12	26.94±1.18	27.97±1.49*

[a] n = number of samples; * $p < 0.05$

Table III. Age specific comparison of various protein fractions of textile industry workers.

Age (years)	Groups (n) [a]	Protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	γ-globulin (g/dl)	A-γ globulin (g/dl)	A/G ratio [b] (g/dl)
21-25	Control (10)	6.42±0.30	4.29±0.28	2.13±0.28	0.91±0.16	1.22±0.28	2.25±0.36
	Exposed (19)	7.34±0.25	4.65±1.15	2.80±0.25	1.25±0.18	1.39±0.25	2.14±0.38
26-30	Control (10)	6.88±0.42	3.95±0.26	2.94±0.31	1.37±0.07	1.56±0.29	1.51±0.20
	Exposed (21)	6.75±0.16	4.49±0.17	2.33±0.18	1.35±0.17	1.20±0.19	2.24±0.22
31-35	Control (10)	6.99±0.52	3.95±0.13	1.84±0.26	1.15±0.15	0.69±0.22	2.29±0.29
	Exposed (07)	6.51±0.17	4.58±0.37	3.04±0.28*	1.64±0.35	1.41±0.37	1.56±0.20
36-40	Control (10)	6.98±0.59	4.22±0.09	2.74±0.53	1.38±0.12	1.36±0.46	1.82±0.32
	Exposed (06)	6.64±0.35	3.80±0.17	2.84±0.27	1.55±0.20	1.28±0.42	1.38±0.13
40-45	Control (10)	7.60±0.72	4.42±0.68	2.82±0.58	1.22±0.08	2.15±0.53	1.49±0.36
	Exposed (09)	7.14±0.33	4.66±1.07	3.37±0.27	1.24±0.21	1.84±0.23	1.91±0.35

[a] n = number of samples; [b]Albumin to globulin ratio; * $p < 0.05$

textile industry workers with up to 10 years of exposure were found to be most affected in which significant variations were recorded in AP, ALP, LDH and AST. ALP was significantly reduced and AST significantly increased in industrial workers exposed during 20 years of job. The albumin level was however increased in all groups (Table IV).

The AP, ALP and LDH were noted to be highly sensitive parameters in relation to exposure to dyes in textile workers. In present study, depletion in the levels of these parameters was observed which the depletion of ALP due to toxicity of xenobiotics has also been reported recently. Their depleted levels may either be due to impairment in their synthesis or its retention in the cells (Soyinka *et al*., 2007). In contrast to the findings of Soyinka *et al*. (2007), an increase in albumin and globulin levels was observed at various instances in this study. These observations point towards work, age and exposure time related shift in hepatocyte functioning. The activity of LDH is a good indicator of anaerobic capacity of the tissues and is inducible by oxygen stress. The decreased level of LDH observed in present study is in accordance with

Wade *et al*. (2002) who reported similar findings in male rats following exposure to low levels of other environmental contaminants (dieldrin, endosulfan, methoxychlor, hexachlorobenzene, and other

Table IV.- Experience specific comparison of various serological parameters of textile industry workers.

Parameters	Control (n =50)[a]	Job duration of exposed groups (Years)[a]				
		≥ 1 year (n=15)	1-5 years (n =15)	6-10 years (n =12)	11-15 years (n =10)	16-20 years (n =10)
AP (IU/L)	23.24±0.69	21.80±2.11	20.34±1.02*	19.94±1.30*	23.87±1.03	22.19±1.48
ALP (IU/L)	43.48±1.74	42.50±4.70	40.41±1.53	33.25±2.06*	37.45±2.32	35.22±3.14*
LDH (IU/L)	195.71±9.91	142.15±9.77	177.04±6.68	161.00±4.41*	162.14±7.56	168.47±3.26
AST (IU/L)	25.62±1.02	22.00±1.55	30.18±2.98*	27.00±2.83*	26.88±1.04	27.42±2.27*
ALT (IU/L)	23.44±1.12	25.28±1.41	30.20±1.85	27.38±1.56	24.98±1.14	29.30±1.49
Protein (g/dl)	6.90±0.21	6.77±0.20	7.16±0.24	6.78±0.18	6.72±0.28	7.06±0.30
Albumin (g/dl)	4.14±0.11	4.86±0.40*	4.77±0.15*	4.21±0.15	4.56±0.38	4.48±0.23
Globulin (g/dl)	2.59±0.18	2.47±0.21	2.62±0.23	2.67±0.23	2.66±0.28	2.84±0.21
γ-globulin (g/dl)	1.21±0.01	1.52±0.40	1.34±0.16	1.24±0.17	1.55±0.45	1.35±0.13
A-γ globulin (g/dl)	1.38±0.16	0.95±0.32	1.09±0.23	1.39±0.24	1.81±0.32	1.59±0.21
A/G ratio[b] (g/dl)	1.86±0.14	2.03±0.27	2.31±0.34	1.86±0.25	1.99±0.38	1.72±0.20

[a] n = number of samples; [b]Albumin to globulin ratio; * $p < 0.05$

chlorinated benzenes etc.).

The analysis of data with different prospects indicated an increase in the levels of AST and ALT in industry workers. The higher levels of AST and ALT have already been associated with liver toxicity by various authors (Kazmi *et al*., 2003; Soyinka *et al*., 2007). The significant elevation can be attributed to the impairment in their synthesis under the influence of xenobiotics (Kazmi *et al*., 2003). Another possibility might be the disturbance of membrane integrity by dying chemicals with a concomitant increase in lipid peroxidative damage leading to leakage of the amino transferases located within the cells (Soyinka *et al*., 2007), however, the significant depletion observed in other enzyme parameters (AP, ALP, LDH) do not support this scenario.

Albumin level showed an overall increase in workers involved in dying process. A similar shift in the albumin has been reported in rats by Wade *et al.* (2002) in response to exposure to persistent contaminants like aromatic hydrocarbons. The author related it with hypertrophic changes in liver. Serum protein fractions seemed to be insensitive parameters in relation to dyeing chemicals. This observed trend may also be explained by the large functional capacity of the liver. The significant decreases in plasma proteins may not become apparent except in severe or long standing hepatic disease. The relatively long half-life of these proteins is also a factor (Keith *et al*., 1999). Also, symptoms are not apparent until concentrations are quite low. It has also been observed that in some conditions of liver diseases e.g., cirrhosis, and chronic hepatitis, liver function test can remain normal. Chronic liver disease has been reported as one of the various disorders of occupational exposure. In such case there is no clinical evidence until after years of exposure. The effect of occupational exposure on the synthetic function of the liver can therefore said to be at the sub-clinical level (Soyinka *et al*., 2007). It has been said that one of the limitations of these tests is that normal results of these variables are over valued as ruling out the possibility of present and future health effects related to exposure (Kale *et al*., 2001).

It is interesting to note that significant differences were observed for various parameters between exposed and their respective controls, however the values were in the normal reference range, indicating that the industry workers have their enzyme values at the border line, a form of sub clinical hepatocellular damage. These findings suggest that there is the possibility of liver involvement among even asymptomatic textile workers, and that periodic liver screening may be

useful; furthermore, use of these tests (especially the ratio of ALT, AST, LDH) for workers who are exposed to dyeing chemicals, is advisable even when environmental monitoring indicates levels below the threshold limit values.

REFERENCES

ANDERSCH, M.A. AND SZCYPINSKI, A.J., 1947. Use of p-nitrophenyl phosphate as the substrate in determination of serum acid phosphatase. *Am. J. clin. Pathol*., **17**: 571-574.

ASTRAKIANAKIS, G., SEIXAS, N.S., RAY, R., CAMP, J.E., GAO, D.L., FENG, Z., LI, W., WERNLI, K.J., FITZGIBBONS, E.D., THOMAS, D.B. AND CHECKOWAY, H., 2007. Lung cancer risk among female textile workers exposed to endotoxin. *J. Natl. Cancer. Inst.*, **99:** 357-364.

BESSEY, O.A., LOWLY, O.H. AND BROCK, M.J., 1946. A method for the rapid determination of alkaline phosphatase with 5cc of serum. *J. biol. Chem*., **164:** 321-329.

DONBAK, L., RENCUZOGULLARI, E., TOPAKTAS, M. AND SAHIN, G., 2006. A biomonitoring study on the workers from textile dyeing plants. *Genetika*, **42:** 757-762.

DOUMES, B.T., WATSON, W.A., AND BIGGS, H.C., 1971. Albumin standards and the measurement of serum albumin with bromocresol green. *Clin. Chim. Acta*, **31:** 87-96.

EDOZIEN, J.C., KHAN, R.M.A. AND WASLIEN, C.I., 1976. Human protein deficiency: results of a nigerian village study. *J. Nutr*., **106:** 312-328.

HAUSSAMENT, T.U., 1977. Quantitative determination of serum alkaline phosphatase. *Clin. Chem. Acta*., **35:** 271-273.

HENRY, R.J., CANNON, D.C. AND WINKELMAN, J.W., 1974. *Clinical chemistry*, Harper and Row, New York.

KALE, S.N., POLYHRONOPOULOS, J.M., ALDRICH, P.J., MENDOSA, J.H., SUH, J.H. AND CHRISTIANI, D.C., 2001. Prospective study of hepatic, renal, and haematological surveillance in hazardous materials firefighters. *Occup. environ. Med*., **58:** 87-94.

KAZMI, M.P., SHAKOORI, A.R., HAFEEZ, M.A., AND ALI, S.S., 2003. Short term effects of chlorpyrifos on hematology and biochemical components of blood of the Sprague-Dawley rat. *Pakistan J. Zool*., **35:** 237-243.

KEITH, G., TOLMAN, M.D. AND ROBERT, R. 1999. Liver function. In: *Tietz Textbook of clinical chemistry* (eds. C.A. Burtis, E.R. Ashwood E.R), 3rd ed. WB Saunders Company; Philadelphia; Page 1125-1177.

KUZMICKIENE, I AND STUKONIS, M, 2007. Lung cancer risk among textile workers in Lithuania. *J. Occup. Med. Toxico*l., **2:** 14-20.

MASTRANGELO, G.F., FADDA, E., MILAN, G. AND LANGE, J.H., 2002. Epidemiologic evidence of cancer risk in textile industry workers: a review and update. *Toxicol. Ind. Health*., **18:** 171-181.

OSUNSANYA, T., ADEJORO, B. AND KING, B., 2001. Biological monitoring of workers exposed to dimethylformamide in a textile polyurethane unit. *Occup. Med. (Lond).*, **51:** 374-379.

REITMAN, S AND FRANKEL, S., 1957. A calorimetric method for the determination of serum glutamate oxaloacetate and glutamate pyruvate transaminase. *Am. J. Clin. Pathol*., **28**: 56-63.

SHIMIZU, H., KUMADA, T., NAKANO, S., KIRIYAMA, S., SONE, Y., HONDA, T., WATANABE, K., NAKANO, I., FUKUDA, Y. AND HAYAKAWA, T., 2002. Liver dysfunction among workers handling 5-nitro-o-toluidine. *Gut*, **50:** 266-270.

SINGHI, M.K., MENGHANI, P.R., GUPTA, L.K., KACHHAWA, D AND BANSAL, M., 2005. Occupational contact dermatitis among the traditional 'tie and dye' cottage industry in Western Rajasthan. *Ind. J. Dermatol. Venerol. Leprol.*, **71:** 329-332.

SOYINKA, O.O., ADENIYI, F.A. AND AJOSE, O.A., 2007. Biochemical parameters of liver function in artisans occupationally exposed to "vat dyes". *Indian. J. occup. environ. Med*., **11:** 76-79.

THEFELD, W., HOFFMEISTER, H., BUSCH, E.W., KOLLER, P.U. AND VOLLMAR, J., 1974. Referenzwerte für die Bestimmungen der Transaminasen GOT und GPT sowie der alkalischen Phosphatase im Serum mit optimierten Standardmethoden. *Dtsch. Med. Wsch*., **99:** 343-351.

USTINAVICIENE, R., OBELENIS, V. AND EREMINAS, D., 2004. Occupational health problems in modern work environment. *Medicina (Kaunas)*, **40:** 897-904.

VARLEY, H., 1975. *Practical clinical chemistry*, 4th ed. Arnold-Heinemann (Publishers India) Private Ltd, India.

WADE, M.G., FOSTER, W.G., YOUNGLAI, E.V., MCMAHON, A., LEINGARTNER, K., YAGMINAS, A., BLAKEY, D., FOURNIER, M., DESAULNIERS, D. AND HUGHES, C.L., 2002. Effects of subchronic exposure to a complex mixture of persistent contaminants in male rats: systemic, immune, and reproductive effects. *Toxicol. Sci*., **67:** 131-143.

WEISSHAAR, D., GOSSRAU, E. AND FADERL, B., 1975. Normal ranges of alpha-HBDH, LDH, AP, and LAP as measured with substrate-optimated test charges. *Med. Welt*, **26:** 387-392.

WERNLI, K.J., ASTRAKIANAKIS, G., CAMP, J.E., RAY, R.M., CHANG, C.K., LI, G.D., THOMAS, D.B., CHECKOWAY, H. AND SEIXAS, N.S., 2006. Development of a job exposure matrix (JEM) for the textile industry in Shanghai, China. *J. occup. environ. Hyg*., **3:** 521-529.

WOLFSON, W.Q., COHN, A., CALVARY, E. AND ICHIBA, F., 1948. Clinical Practical Biochemistry, Studies in serum proteins V. A rapid procedure for the estimation

of total protein, true albumin, total globulin, alpha globulin, beta globulin and gamma globulin in 1.0 ml of serum. *Am. J. clin Pathol*., **18**: 723-730

(Received 29 July 2008, revised 15 November 2008)