

# Biological Monitoring of Exposure to Benzene in Petrol Pump Workers and Dry Cleaners

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**Abstract:** Exposure to benzene has been monitored in petrol-pump workers and dry cleaners of Meerut City (India) by measuring phenol content of their urine samples. Average values for phenol in urine were higher in petrol-pump workers than dry cleaners. Alcoholic subjects excreted more phenol than smokers and non-vegetarians. It is concluded that alcohol can alter the susceptibility of man to benzene toxicity by affecting its metabolism.

**Key words:** Benzene, Phenol, Cigarette smoke and food

## Introduction

Benzene is a major monocyclic aromatic hydrocarbon largely used as solvent in a variety of industrial and commercial processes<sup>1</sup>. Benzene is used as a feeder chemical in the manufacture of lubricants, detergents, rubber, dyes and pesticides. Benzene is often found in automobiles and solvent gasoline<sup>2</sup>. A large section of population is occupationally exposed to benzene through work environment<sup>3</sup>. Several reports available suggest that exposure to benzene is a serious health problem. About 238,000 people may be occupationally exposed to benzene in USA<sup>4</sup>. A causal relationship between benzene exposure and lung cancer has also been suggested<sup>5, 6</sup>.

Biological monitoring of human exposure to benzene has been performed as a component of health surveillance programs in several countries<sup>7–10</sup>. However, no attempt has so far been made in India. Since percentage of benzene in automobile gasoline in India is known to be about 3%<sup>11</sup>, petrol-pump workers and dry cleaners that too use benzene as a solvent, suffer a serious health risk. Therefore, a study on biomonitoring of exposure to benzene in petrol pump workers and dry cleaners was made. Results on the influence of alcohol, cigarette smoke and food habits on benzene exposure are also reported in this communication.

## Materials and Methods

Volunteers from local petrol pumps and dry cleaning factories of Meerut city (India) were registered for this study. Their occupational histories were prepared along with their food habits, smoking status and consumption of alcohol etc. The conditions of their work environment, working time and work shift were also recorded.

Urine samples were collected from volunteers after the workshift. Five samples each from nonalcoholics, vegetarians and non smokers and occupationally unexposed persons were also collected for comparison and those were treated as controls.

Samples were collected in white sterile plastic bottles and transported in an ice-box to the laboratory and stored frozen uptill analyzed.

Specific gravity of urine samples was determined by an urinometer (Atago Company Limited, Tokyo, Japan).

Creatinine in the samples was determined using alkaline picrate method suggested by Toro and Ackerman<sup>12</sup>.

Phenol was determined using aminoantipyrine method<sup>13</sup>. Pure liquid phenol (Central Drug House (P). Ltd., Mumbai, India) was used as the standard.

Statistical data was evaluated by Student's "t" test<sup>14</sup>.

## Results

Influence of three factors viz: alcohol, cigarette smoke

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**Table 1. Benzene exposure in alcoholic workers**

Group	Location	Work exposure (years)	Specific gravity	Creatinine (mg/l)	Phenol (mg/l)	Phenol corrected to S.G. (mg/l)	Phenol corrected to creatinine (mg/g creatinine)
Petrol pump workers	A	3 ± 0.8	1.017 ± 0.002*	1358 ± 2.5*	13.4 ± 0.40*	9.2 ± 0.3*	11.4 ± 1.9*
	B	6 ± 0.7	1.022 ± 0.001*	1089 ± 3.8*	17 ± 0.36*	19.8 ± 1.0*	16.5 ± 2.4*
	C	11 ± 0.5	1.035 ± 0.001*	1326 ± 2.2*	17.5 ± 0.36*	29.5 ± 1.0*	15.8 ± 2.3*
Dry-cleaners	A	5 ± 3.1	1.020 ± 0.001 <sup>NS</sup>	1086 ± 3.7*	9.2 ± 0.31*	8.8 ± 0.8*	8.9 ± 0.7*
	B	20 ± 0.5	1.020 ± 0.001 <sup>NS</sup>	1225 ± 6.5*	9.2 ± 0.31*	8.8 ± 0.8*	7.5 ± 0.4 <sup>NS</sup>
	C	25 ± 0.6	1.024 ± 0.002*	1360 ± 3.1*	8.3 ± 0.33*	12.3 ± 1.6*	6.9 ± 0.9*
Control		NIL	1.011 ± 0.001	794 ± 10.8	6.2 ± 0.24	3.46 ± 0.31	7.8 ± 0.31

Results are expressed as mean ± SE (N=5). \*All means are significantly different (P<0.05). NS - Means are non-significant.

**Table 2. Benzene exposure in smokers**

Group	Location	Work exposure (years)	Specific gravity	Creatinine (mg/l)	Phenol (mg/l)	Phenol corrected to S.G. (mg/l)	Phenol corrected to creatinine (mg/g creatinine)
Petrol pump workers	A	3 ± 0.8	1.017 ± 0.001*	1430 ± 3.1*	8.2 ± 0.31*	6.0 ± 0.8*	5.4 ± 0.8*
	B	6 ± 0.7	1.017 ± 0.002*	1358 ± 2.5*	13.4 ± 0.40*	9.2 ± 0.3*	11.4 ± 1.9*
	C	11 ± 0.5	1.035 ± 0.001*	1362 ± 2.2*	17.5 ± 0.36*	29.5 ± 1.0*	15.8 ± 2.3*
Dry-cleaners	A	5 ± 3.1	1.021 ± 0.004 <sup>NS</sup>	1150 ± 3.1*	9.7 ± 0.6*	12.4 ± 1.7*	7.4 ± 0.8 <sup>NS</sup>
	B	20 ± 0.5	1.020 ± 0.001 <sup>NS</sup>	1225 ± 6.5*	9.2 ± 0.31*	8.8 ± 0.8*	7.5 ± 0.4 <sup>NS</sup>
	C	25 ± 0.6	1.026 ± 0.001*	1358 ± 2.5*	12.9 ± 0.64*	17.3 ± 1.5*	8.8 ± 0.6*
Control		NIL	1.011 ± 0.001	794 ± 10.8	6.2 ± 0.24	3.46 ± 0.31	7.8 ± 0.31

Results are expressed as mean ± SE (N=5). \*All means are significantly different (P<0.05). NS - Means are non-significant.

**Table 3. Benzene exposure in non-vegetarian subjects**

Group	Location	Work exposure (years)	Specific gravity	Creatinine (mg/l)	Phenol (mg/l)	Phenol corrected to S.G. (mg/l)	Phenol corrected to creatinine (mg/g creatinine)
Petrol pump workers	A	3 ± 0.8	1.017 ± 0.001 <sup>NS</sup>	1430 ± 3.1*	8.2 ± 0.31*	6.0 ± 0.8*	5.4 ± 0.8*
	B	6 ± 0.7	1.017 ± 0.002 <sup>NS</sup>	1630 ± 3.1*	9.2 ± 0.31*	7.2 ± 0.5*	5.0 ± 0.8*
	C	11 ± 0.5	1.017 ± 0.002 <sup>NS</sup>	1225 ± 6.5*	12.4 ± 1.22*	8.4 ± 0.62*	7.0 ± 0.9*
Dry-cleaners	A	5 ± 3.1	1.024 ± 0.002*	1360 ± 3.1*	8.3 ± 0.33*	12.3 ± 1.6*	6.9 ± 0.9*
	B	20 ± 0.5	1.029 ± 0.001*	1705 ± 3.1*	15.0 ± 1.6*	22.5 ± 1.5*	10.2 ± 2.0*
	C	25 ± 0.6	1.038 ± 0.001*	1224 ± 3.7*	15.4 ± 1.1*	25.4 ± 1.3*	13.2 ± 1.2*
Control		NIL	1.011 ± 0.001	794 ± 10.8	6.2 ± 0.24	3.46 ± 0.31	7.8 ± 0.31

Results are expressed as mean ± SE (N=5). \* All means are significantly different (P<0.05). NS - Means are non-significant.

and food habits was determined on the urinary excretion of phenol, a metabolite of benzene in human subjects. Effect of work experience has also been studied. In petrol pump workers, excretion of phenol in urine increased with the increase of exposure period. However, in dry cleaners, the excretion of phenol decreased with the increase in period of exposure. In smokers, a reverse trend was observed where urinary phenol increased with the exposure period. No such trend was observed in petrol pump workers. In nonvegetarian

subjects, urinary phenol increased with duration of exposure in petrol pump workers as well as in dry cleaners.

Nevertheless, average values for phenol were higher in alcoholics than smokers and non vegetarians. Among alcoholics average values for creatinine were higher in petrol pump workers than the dry cleaners. Similar observations show that exposure to benzene is higher in petrol pump workers than the dry cleaners.

## Discussion

Under conditions prevailing at the work place, benzene is absorbed by inhalation, however, skin absorption of liquid benzene is also significant<sup>15</sup>. Approximately one-third of retained benzene is excreted rapidly in urine as conjugate phenol and dihydroxy phenols<sup>16,17</sup>. The remainder is further degraded to be incorporated in tissues or exhaled as CO<sub>2</sub><sup>18</sup>.

Traces of benzene (less than 1.5%) are present in gasoline used in USA. In India, gasoline contains 3% benzene. The percentage of benzene may be as high as 30% in gasoline used in some other countries. Therefore, petrol pump workers are very likely to be exposed to benzene. Similarly, the dry cleaners use petrol to remove stains and generally wash woolen clothes with petrol. Thus they also face benzene exposure through their skin and inhalation.

Phenol excretion as a marker of benzene exposure was established by Docter and Zielhuis<sup>19</sup>. Various methods exist for the analysis of phenol in biological media. Gas liquid chromatographic (GLC) method is supposed to be the best method. Van Haaften *et al.*<sup>20</sup> and Menard<sup>21</sup> used this method for various phenols and cresols. Teisinger *et al.*<sup>16</sup> used the colorimetric method of Gibbs using a specific reagent 2,6-dichloroquinon chlorimide. Walkley *et al.*<sup>9</sup> used diazotised p-nitroanilin (colorimetric method of Theis-Benedict). A modified Theis-Benedict method was used by Buchwald<sup>22</sup>. However, a similarity in results was recorded by Docter and Zielhuis<sup>19</sup> and by Bardodej<sup>23</sup> amongst GLC method, Gibbs method and 4-amino antipyrine method. Therefore amino antipyrine method can be treated as a reliable process for the determination of urinary phenol.

However, excretion of phenol in urine may depend on the diet consumed and other factors like smoking and consumption of alcohol. Individual differences in phenol concentration in urine are large. Sex differences in benzene intoxication have also been reported in man and laboratory animals<sup>24, 25</sup>.

Although the activities of liver drug metabolizing enzymes is increased by chronic alcohol administration<sup>26</sup>, it was not known whether the consumption of alcohol can affect the susceptibility of workers to the toxic effects of solvents in their work environment. Present results show that urinary phenol was highest in alcoholic petrol pump workers and dry cleaners. Smoking and non-vegetarian diet did not accelerate the metabolism of benzene. Concerning nutritional modification of metabolism and toxicity of chemical substances, it has been suggested that it is a nutrient protein which regulates the metabolism<sup>27</sup>. Food habits, in general, do not appear to influence benzene metabolism in man.

However, on the basis of present results, it would be reasonable to assume that excessive alcohol intake may alter the susceptibility of man to benzene by affecting its metabolism in the body. Workers who are occupationally exposed to benzene should be advised to avoid alcohol ingestion. Present results are supported by a recent study made on risk assessment of benzene in petroleum workers<sup>28</sup>. Development of suitable biomarkers can be of great help in the molecular epidemiology of benzene exposed workers<sup>29</sup>.

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