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Detection of Volatile Organic Compounds in Blood of Farmers and Their General Health and Safety Profile

Syeda Amber Fatima, Almas Hamid, Ghazala Yaqub, Anum Javed and Haseeb Akram
Department of Environmental Sciences, Kinnaird College for Women, Lahore, Pakistan
Corresponding author: Syeda Amber Fatima

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ABSTRACT

Worldwide, volatile organic compounds (VOCs) have become concerning issue for public health. The current study was carried out to analyze the health and safety conditions in agricultural fields of a developing country. Moreover, another aim of the study was to determine pesticide (VOCs) residues in farmers working in rice, corn and cotton fields. Collected blood samples were analyzed by gas chromatography for isopropyl alcohol, ethyl acetate, ethanol, toluene, benzene and phenol. Questionnaire and checklist surveys were also carried out to measure the different health impacts. The qualitative analysis of pesticides in blood samples of farmers showed that those working in the cotton fields had high levels of ethanol that was 90.422 ppm, one had high levels of phenol that was 26.986 ppm, one had high levels of toluene that was 1.954 ppm and two had benzene levels that were 8.105 ppm and 5.654 ppm respectively. Isopropyl alcohol was not detected in any farmer. Health issues faced by farmers were skin, eye, nose and throat irritation, headache and fatigue. It is concluded that the working conditions in Pakistan farms are not up to the mark and it is recommended to improve the health and safety conditions of farm fields in Pakistan by government.

INTRODUCTION

Pakistan is an agricultural country and agriculture is the backbone of the national economy. Agriculture is indeed the most undeniably essential field for our country (Jones 2009). Approximately 65% of Pakistani population lives in the rural area and are related to agriculture activity (Hansen & Donohoe 2008). The GDP growth rate in Pakistan, which is mainly dependent on the growth rate in agriculture sector, increased from 4.5 % in 2001-2006 to 5.2 % in 2007-2009 mainly due to increase in the production of the cotton, rice, wheat and sugar in the year 2005-2009 (Rosenbaum & Shin 2010).

Moreover, an increased usage of different chemicals, pesticides and insecticides is to be blamed for the increased amount of pesticides in the blood of the farmers (Von & McCurdy 2013). The levels of the chemical compounds such as the pesticides are also increasing in the body of the farmers which is serious health concern for them (Mitloehner & Calvo 2008).

Such great demand of agricultural output requires a significant amount of labor. Unfortunately, in Pakistan different occupational related accidents, injuries and deaths are increasing day by day. The effects of these activities are becoming a barrier in the life of the farmers in the form of health hazards, substandard living conditions, poverty and cultural barriers. The specific problems, which are related to the life of the farmers in the different rural areas, are the infectious diseases, chemical and pesticides related illness, dermatitis, heat stress, respiratory conditions, musculoskeletal disorders, traumatic injuries, reproductive health problems, dental diseases, cancer, poor health, adequate preventive care, social and mental health problems (Myers & Hendricks 2010).

An estimated 1.3 billion workers are engaged in agricultural production worldwide. This represents half of the total world labor force. Only 9% of agricultural workers are in industrialized countries. Almost 60% of them are in developing countries. A great majority of agricultural workers is found in Asia, which is the most densely populated regions of the world, with more than 40% of the world's agricultural population concentrated in China and more than 20% in India. The farm work is one of the dangerous works counted in all over the world. The issues related to the farmer's health and safety are rising in Pakistan and in all the developing countries. While working in the farms using dangerous chemicals, the ingestion of the chemicals and the pesticides in the body of the farmers takes place. The hazardous areas such as the grain bins, silos and wells are harmful to the farmers' health. The occupational health and safety of the farm workers are necessary. It is the main thing which needs to be more focused on around the world (Rao 2007 and Von & Urdy 2009).

In February 2009, the agency for the toxic substances and diseases registry published a study and found that children who lived in places where pesticides are used are more likely to develop brain cancer than those who are not exposed to these pesticides (Myers & John 2015). The studies by the National Cancer Institution found that farmers around the world, who are exposed to the pesticides, have weak endocrine system and complex regulation of hormones, reproductive system, and embryonic development. Endocrine disruption, which can cause infertility and birth defects, includes hormonal imbalance, incomplete sexual development, impaired brain development and behavior disorders. The pesticides are stored in the colon of the human body. After countless studies, it is been proved that pesticides are related to the cancer, Alzheimer's disease and ADHD (Myers & John 2015).

MATERIALS AND METHODS

Data collection: Secondary data were gathered to develop questionnaire, methodology and literature review. The helpful research techniques, methodologies used in the studied literature were thoroughly comprehended to meet the aims and objectives of this study in a most efficient manner. Health and safety standards from OSHA were used to make a suitable and relevant checklist and questionnaire to gather information. Primary data were collected in the following steps:

Walkthrough survey: Walkthrough survey was conducted to check type of solvents or pesticides being used by agriculture/farmers and to analyze environmental/working conditions of farmers. And meeting with farmers was done to design the methodology of data collection.

Questionnaires survey: Interviews were taken from farmers who work continuously with sprays and solvents including pesticides. A questionnaire was developed to collect data about health conditions of farmers. The questions were regarding the physical hazards, chemical hazards, biological hazards and ergonomic hazards faced by farmers.

Detection of Pesticides in Blood

Consent form: Ethical guidelines and protocols were completely followed/adopted during the whole research. According to international ethical guidelines for biomedical research, consent should be obtained from those workers who are voluntarily participating in the research. In the present research, participation of all workers was voluntary. After the farmers' verbal commitment to participate in the present research they were formally requested to sign a consent form as well.

Selection of VOCs for blood analysis: VOCs like isopropyl alcohol, phenol, benzene, dichloromethane, ethanol and ethyl acetate were selected to be analyzed in blood samples based on literature and information gathered during primary data collection.

Blood collection method: For the collection of blood samples from worker, a trained paramedical staff member was hired. Samples were collected after 15-20 minutes of 8 hr work shift. For VOCs analysis in blood, gray top vacutainers of 5 mL were selected depending on the need of sample. These vacutainers already contained sodium fluoride and potassium oxalate as preservative and anticoagulant. The blood samples of workers were obtained by venipuncture (using BD 5 mL syringe) as described by Blount et al. (2006). After blood collection, the vial was shaken well 2-3 times to prevent blood from clotting. Blood samples were then immediately placed in a container containing ice cubes. Finally, the samples were transferred to laboratory and stored at 4°C. The collected blood samples were analyzed within the same day.

Preparation of blood samples and standards: After collection, blood samples were quickly transferred to laboratory and analyzed by handspace method for gas chromatography. 2 mL of blood sample was transferred from vacutainers to 16 mL handspace vail which already contain 1 mL of sodium chloride and it was sealed immediately with a silicone/PTFE septum. Blood sample was gently stirred for 5-10 min and was then incubated at 60°C for about 35-40 min. After partial pressure has been achieved 0.5 mL of hand space air was injected into the gas chromatograph for further analysis. This technique was previously used for identification of variety of solvents and was successfully employed in the laboratory as well. A discard box was prepared to put all the used syringes, vacutainers, microfilters, gloves, vials and other hazardous wastes. Every time after sample preparation, the discard box was immediately sent to the nearest hospital waste bin with great care. For preparation of standards of selected volatile organic compounds, method quoted by EI-Haj et al. was followed with few modifications according to laboratory conditions (Jousha et al. 2008). The chromatographic co-elution of selected VOCs was also evaluated by direct injection of these compounds into the GC.

Analytical analysis: Gas chromatography with flame ionization detector (GC-FID) was used for qualitative and quantitative determination of VOCs in blood samples. GC was equipped with both split/splitless capillary injectors. Temperature of both detector and injection were kept at 200°C, while column temperature was programmed between 50-100°C. N_2 flow and H_2 flow, both were kept at 40 µL/min, while air flow was 400 µL/min. Total run time was 15 min.

Qualitative and quantitative analysis: Qualitative analysis on the basis of peak height and retention time was done

to determine the presence of different VOCs in the prepared blood samples.

Quantitative analysis of results was done by calculating response factor and relative response factor (RRF) by formulas given below.

Response factors: From results of analytes, peak area and concentration were taken to calculate the response factor. Following equations (A) and (B) were used to calculate response factor of samples and standards.

Equation (A)

$$Responcefactor = \frac{\text{Peak area of Standard}}{\text{Concentration}}$$

Equation (B)

$$\text{Response Factors} = \frac{\text{Peak Area of Sample}}{\text{Concentration}}$$

Equation (C)

The calculated response factor of standard (Eq. A) and sample (Eq. B) were then used to calculate relative response factor (RRF) between two analysts. Equation (C) was used to calculate relative response factor (Alavanja et al. 2013).

$$\text{Relative Response Factor (RRF)} = \frac{\text{Response Factor B}}{\text{Response Factor A}}$$

Equation (D)

Relative response factor was further used in order to calculate the unknown concentration of analyte (VOC selected).

$$Concentrationof Analyte = \frac{Peak\ Area\ of A}{Peak\ area\ of\ B} \times \frac{1}{RRF} \times \text{Concentration of Standard}$$

RESULTS

Profile of participants: In the present study, 31 farmers were chosen for questionnaire survey on occupational health hazards. From these, 17 farmers agreed to give the blood samples to be analyzed to check the presence of VOCs in their blood, which may be due to the use of pesticides. Six farmers from rice, six from corn fields and five farmers were from cotton fields. All these farmers were involved in spraying pesticides.

RESULTS OF QUESTIONNIRE SURVEY

Results of questionnaire survey revealed that most reported health effects by farmers were irritation to skin, eyes, nose, throat, headache, nausea, fatigue and weakness during working hours and posture issues. Results of the questionnaire survey for health and safety issues show that coughing, allergies, diabetes, cancer, migraine, irritation in eyes, sleep disturbance, difficult in breathing, arthritis, backbone ache problems, skin rashes, dryness of skin, releasing of heat from skin and black scars on skin were faced by 29.03%, 35.48%, 35.48%, 0%, 32.25%, 9.68%, 29.03%, 22.58%, 29.03%, 32.25%, 22.58%, 25.81%, 25.81% and 22.58% of farmers respectively.

Many of the farmers also complained about nose irritation. Literature supports some of these health impacts. According to the hazardous fact sheet prepared by New Jersery Department of Health, exposure to phenol can cause throat, skin and eye irritation. Sometimes, it may also lead to skin burns and eye damage. Its high exposure may reduce the blood ability to transport oxygen causing fatigue, head-

Table 1: Results of the blood analysis of farmers.

Sr No	Participants	Sample Code	Isopropyl Alcohol	Phenol	Benzene	Ethanol	Ethyl acetate	Toluene
1.	Rice field	00216647	x	x	x	x	x	x
		00216691	x	x	x	x	x	x
		00216640	x	x	x	x	x	x
		00216655	x	x	x	x	x	x
		00216667	x	x	x	x	x	x
		00216644	x	x	x	x	x	x
2.	Corn Field	002166441	x	x	x	x	x	x
		002‘16650	x	x	x	x	x	x
		00216695	x	x	x	x	x	x
		00216685	x	x	x	x	x	x
		00216690	x	x	x	x	x	x
		00216645	x	x	x	x	x	x
3.	Cotton Field	00216618	x	x	x	x	x	x
		00216699	x	x	x	90.422	x	x
		00216665	x	26.9866364	x	x	x	x
		00216646	x	x	8.10599421	x	x	1.9542971
		00216626	x	x	5.65485521	x	x	x

ache, dizziness and blueness of lips and skin (Kamel & Hoppin 2009).

Analysis results of blood samples: Concentration of VOCs in blood samples i.e., phenol, benzene, dichloromethane, ethyl acetate, ethanol, xylene and toluene were determined by GC/FID both qualitatively and quantitatively.

Results of qualitative analysis of blood samples showed that concentration of phenol i.e., 26.986 ppm was present in one blood sample of a farmer who has been continuously spraying for 3 years in the cotton fields. Benzene was detected in two blood samples of cotton field farmers out of five blood samples i.e., 8.1059 ppm and 5.654 ppm. Ethanol and toluene were detected in one blood sample of farmer of cotton field and their concentrations were 90.422 ppm, 1.954 ppm respectively (Table 1). No VOC was detected in blood of corn and rice field.

During survey, the most reported health effects by the exposed farmers was irritation to skin, eye and to throat, headache, weakness and fatigue according to the report prepared by agency for toxic substances and diseases registry (ATSDR). A very small exposure (5 -10 min) to a very high level of benzene in air (10,000 to 20,000 ppm) can result in death. Lower level (700 to 3,000 ppm) can cause headache, unconsciousness, dizziness, drowsiness and confusion. It also acts as moderate skin and eye irritant (Donohoe 2009).

Results of questionnaire survey and blood analysis are related to each other. Many of the workers, especially cotton field farmers said that they have skin irritation and other respiratory problems, which are due to inhalation of pesticides. Checklist survey shows that farmers did not use any kind of protective equipment.

REFERENCES

Alavanja, M.C.R., Hoppin, J.A. and Kamel, F. 2013. Health effects of chronic pesticide exposure: cancer and neurotoxicity. Annu. Rev. Public Health, 25(87): 155-197.

Alliance, F.C.W. 2012. The hands that feed us: Challenges and opportunities for workers along the food chain. Food Chain Workers Alliance.

Blount, B.C., Kobelski, R.J., McElprang, D.O., Ashley, D.L., Morrow, J.C., Chambers, D.M. and Cardinali, F.L., 2006. Quantification of 31 volatile organic compounds in whole blood using solid-phase microextraction and gas chromatography-mass spectrometry. Journal of Chromatography B, 832(2): 292-301.

Donohoe, M. 2009. Rural populations. USDA, pp. 11.

Hansen, E. and Donohoe, M. 2008. Health issues of migrant and seasonal farm workers. JHCPU, 4(2): 153-164.

Jones, C.A. 2009. Health status and health care access of farm and rural populations. USDA, 5(57): 12-15.

Jousha, J.R., Layne, L.A. and Marsh, S.M. 2008. Injuries and fatalities to US farmers and farm workers 55 years and older. West J. Med., 52(3): 185-194.

Kamel, F. and Hoppin, J.A. 2009. Association of pesticide exposure with neurologic dysfunction and disease. Environmental Health Perspectives, 112(9): 950.

Mitloehner, F.M. and Calvo, M.S. 2008. Worker health and safety in concentrated animal feeding operations. Journal of Agricultural Safety and Health, 14(2): 163-187.

Myers, J.R. and Hendricks, K.J. 2010. Agricultural tractor overturn deaths: assessment of trends and risk factors. Am. J. Ind. Med., 53(7): 662-672.

Myers, J.A. and John, K.J. 2015. Agricultural health and safety of farmers overturn deaths: Assessment of Trends and Risk Factors of farmers health. West. J. Med., 3(72): 11-18.

Rao, P. 2007. Heat related illnesses an occupational health concern for farm workers. Washington, DC: Farmworker Justice and Migrant Clinicians Network, 4(86): 22-39.

Rosenbaum, S. and Shin, P. 2010. Migrant and seasonal farm workers health insurance KCMU, 7(12): 67-78.

Von, E. and Urdy, M. 2009. Centers for disease control and prevention. heat-related deaths among crop workers-United States, 1992-2006. Morbidity and mortality weekly report, 57(24): 649-653.

Von Essen, S. G., and McCurdy, S. A. 1998. Health and safety risks in production agriculture. Western Journal of Medicine, 169(4): 214.