Research Journal of Applied Sciences 8 (9): 449-455, 2013
ISSN: 1815-932X


# Study of Heavy Metal Levels in Nails and Hairs among Vegetable Farmers in Malaysia

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**Abstract:** The use of the pesticides and chemical fertilizers in agricultural sector releases plenty types of heavy metals to environment and brings adverse effects to human health. Arsenic (As), Cadmium (Cd), lead (Pb), Nickel (Ni) and Cobalt (Co) are toxic heavy metals to harm human health. Presence of keratin in hairs and nails allows the accumulation of metals elements in longer period. Thus, hairs and nails are suitable to be used as biological marker in the study of human exposure to heavy metal elements. The purpose of this study was to determine As, Cd, Pb, Ni and Co levels in hairs, fingernails and toenails of vegetable farmers. There were 90 Bangladesh farmers participated in this research by using universal sampling. Questionnaires have been carried out to collect the demographic data, working periods of the farmers and blood pressure. As, Cd, Pb, Ni and Co levels were analyzed by using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Result showed that there was significant difference of As, Cd, Pb and Ni levels among hairs, fingernails and toenails, $p<0.05$. The levels of As (90.56±10.19 μg $L^{-1}$) and Cd (34.57±3.44 μg $L^{-1}$) in toenails were found to be highest whereas the levels of Pb (74.73±7.93 μg $L^{-1}$) and Ni (694.12±19.70 μg $L^{-1}$) in fingernails were found to be highest with the mean level. ANOVA test showed that Co levels in toenails were significantly higher in farmers with hypertension (22.51±3.61 μg $L^{-1}$). Kruskal-Wallis test showed that As ($H = 10.64$, $p<0.05$) and Cd ($H = 7.34$, $p<0.05$) levels in toenails were significantly higher in farmers with hypertension. There was a significant weak negative relationship among As ($r = -0.44$, $p<0.05$), Cd ($r = -0.43$, $p<0.05$), Pb ($r = 0.32$, $p<0.05$) and Ni ($r = -0.31$, $p<0.05$) in fingernails together with Pb ($r = -0.29$, $p<0.05$) levels in toenails with working periods of farmers shown by Spearman correlation test. Almost all farmers from different blood pressure groups shower after handling pesticides and fertilizers significantly ($p<0.05$). The 66 famers have good knowledge from different working periods and there was a significant different between individual's knowledge and working periods ($p<0.05$). As a conclusion, As, Cd, Pb, Ni, Co levels among vegetable farmers were lower than earlier studies and remained at a safety level.

**Key words:** Heavy metals, pesticides, fertilizers, toenails, fingernails, hairs

## INTRODUCTION

Heavy metals are defined as metals or metalloid with density higher than 5 g/$cm^3$ or 5 times higher than water density (Hawkes, 1997). Mainly heavy metals exist naturally in the earth crust but those heavy metals can be released into environment through anthropogenic human activities such as mining operations, disposal of drainage and use of pesticides in agricultural sectors (Jing *et al*., 2007). Heavy metals are persistent environmental contaminants since they cannot be degraded or destroyed (Duruibe *et al*., 2007). Examples of heavy metals are lead (Pb), cadmium (Cd), zink (Zn), mercury (Hg), arsenic (As), chromium (Cr), copper (Co) and iron (Fe) (Duruibe *et al*., 2007).

Some metals are extremely toxic to human (Duruibe *et al*., 2007). These heavy metals are incorporated into the organism via different routes and can be stored in different tissues which lead to an internal bioconcentration that can induce different alterations and adverse effects. Human exposure to heavy metals occurs through food, air, industrial products and occupational exposure (Duruibe *et al*., 2007). Heavy metals exposure occurs through three pathways (De Miguel *et al*., 2007) such as oral ingestion, air ingestion and skin absorption due to dermal exposure (Luo *et al*., 2012). The use of pesticides and chemical fertilizers in agricultural sectors will release the heavy metals causing accumulation of heavy metals in human body (Jing *et al*., 2007).

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Heavy metals such as arsenic, cadmium and lead has no importance to human body yet toxic in vice versa although in small quantities (Duruibe *et al*., 2007). Besides, heavy metals such as nickel and cobalt are needed in small quantities for human body but they can cause serious effect if exposure at high level. Nickel compounds are known as carcinogen to human body (Denkhaus and Salnikow, 2002) whereas cobalt can cause negative effects to respiratory system, hematopoietic tissue and thyroid gland (De Boeck *et al*., 2003). Toxic effect of heavy metals is related to the release of reactive oxygen species which will lead to oxidative stress in human body (Ercal *et al*., 2001).

Accumulation of heavy metals in human body normally occurs in the tissue which rich in keratin such as hair and nail. This is due to the presence of disulfide covalent bond between the keratin in hair and nail samples and positive metal ions. Thus, nail and hair samples are significant biomarker to determine the heavy metals levels besides blood and urine (Mehra and Juneja, 2005). Besides, collection of hair and nail samples is non-invasive (Slotnick and Nriagu, 2006). According to, human exposure to heavy metal at low level is a condition to cause poisoning and diseases due to non-biodegradable properties of heavy metals whereas accidental exposure at high level can cause serious effect immediately.

In this study, the levels of arsenic, cadmium, lead, nickel and cobalt in nail and hair samples from farmers were determined and those levels were then correlated with demographic factors, blood pressure and working periods. Knowledge, awareness and practices of pesticide use among farmers were determined with working periods and blood pressure.

## MATERIALS AND METHODS

Method of collection and processing of samples was referred to Bass *et al*. (2001), Were *et al*. (2008), Rodushkin and Axelsson (2000), Mortan *et al*. (2002) and Mehra and Juneja (2005).

**Study group:** Subjects chosen for this study were vegetables farmers who were chosen via universal sampling from the list of registered farmer. A cross sectional study was conducted and a total of 90 male Bangladesh farmers took part in this study. Inclusion criteria of subjects for this study consisted of farmers had been working >1 year and have the age between 18-80 years old.

**Questionnaire:** Questionnaires were used to collect the information from farmers such as demographic data and factors that will influence the level of heavy metals. Each subject was interviewed for the each section in the questionnaire which included personal background, disease history, knowledge of pesticides and fertilizers use, practice of pesticides and fertilizers use, attitude of pesticides and fertilizers use, lung function and medical examination.

**Sampling:** Samples were collected from the farmers who used pesticides and fertilizers. Nails were cut from 10 fingernails and toenails using stainless steel scissors whereas approximately 10 hairs were removed from the scalp. Both nails and hairs samples were then sealed in the plastic bags at room temperature.

**Sample analysis:** Samples collected were washed to remove the particles on them. Hair samples were cut into smaller pieces in the length 1 cm and were weighed into 0.0025 g. Samples in test tube were soaked in 10 mL of 0.5% Triton X-100 for 10 min and followed by 10 mL deionized water for 10 min and 8 mL aceton for 10 min. The samples were then rinsed three times with deionized water and one time with aceton. Nail samples were weighed between 0.010-0.013 g followed by soaking in 10 mL of Triton X-100 solution for 2 h and 8 mL of aceton for 1 h. Then, the samples were rinsed with deionized water five times. Subsequently, the samples were placed in incubator at 45°C overnight for drying process.

Both hair and nail samples were digested using nitric acid 65% and hydrogen peroxide 30% in a half closed opened digester. The 2 mL of nitric acid 65% was pipette into the each test tube contained sample and heated at 250°C to obtain a clear solution. Then, 0.2 mL hydrogen peroxide was pipette into the test tube till foam formation obtained. All samples were diluted with deionized water and filtered (6 μm) into centrifuge tube. The samples were stored in cold room at 4°C until the levels of heavy metals were conducted by using ICP-MS.

**Statistical analysis:** All data obtained analyzed by using Program Statistical for Social Science (SPSS) Version 20. The levels of each heavy metal were shown in mean (μg $L^{-1}$) together with Standard Error of Mean (±SEM). This study employed Kruskal Wallis test and one-way ANOVA to compare the mean level of heavy metals among hairs, fingernails and toenails and to compare the mean level of heavy metals with blood pressure. To find out the correlation of level of heavy metals with working period, Spearman correlation and Pearson correlation tests were carried out. On the other hand to determine the correlation of knowledge, attitude and practice of pesticides and fertilizers use with working period and blood pressure, Chi-square correlation were used in this study.

## RESULTS AND DISCUSSION

In the findings, the mean value of each heavy metal level among hair, fingernail and toenail samples from farmers are presented in Table 1. There were a significant different shown in arsenic ($H = 17.95$, $p<0.05$), cadmium ($H = 63.56$, $p<0.05$), lead ($H = 25.87$, $p<0.05$) and nickel ($H = 157.01$, $p<0.05$) among hair, fingernail and toenail samples. Table 2 shows comparison of heavy metals levels between two each samples. There were a significant difference shown in cadmium, lead and nickel levels between hair and fingernail between hair and toenail and fingernail and toenail. Arsenic level is only shown significant in between hair and fingernail samples ($U = 1768.00$, $p<0.05$).

Table 1: Comparison of means of heavy metals levels among hair, fingernail and toenail samples

| | Mean±SEM | | | |
|---|---|---|---|---|
| Parameters | Sample size (n) | Heavy metals level (μg $L^{-1}$ (ppb)) | H-value | p-value |
| **Arsenic** | | | | |
| Hair | 83 | 75.27±9.350 | | |
| Fingernail | 80 | 1.76±0.230 | 17.95 | 0.00* |
| Toenail | 80 | 90.56±10.19 | | |
| **Cadmium** | | | | |
| Hair | 83 | 23.21±2.960 | | |
| Fingernail | 80 | 1.29±0.380 | 63.56 | 0.00* |
| Toenail | 80 | 34.57±3.440 | | |
| **Lead** | | | | |
| Hair | 83 | 37.59±1.520 | | |
| Fingernail | 80 | 74.73±7.930 | 25.87 | 0.00* |
| Toenail | 80 | 66.74±17.63 | | |
| **Nickel** | | | | |
| Hair | 83 | 36.21±3.230 | | |
| Fingernail | 80 | 694.12±19.70 | 157.01 | 0.00* |
| Toenail | 80 | 95.21±10.66 | | |
| **Cobalt** | | | | |
| Hair | 83 | 12.11±1.580 | | |
| Fingernail | 80 | 17.62±0.380 | 4.61 | 0.10 |
| Toenail | 80 | 14.91±1.640 | | |

Table 2: Comparison of mean of heavy metals levels between two each samples

| Parameters | U-value | p-value |
|---|---|---|
| **Arsenic** | | |
| Hair with fingernail | 1768.00 | 0.00[a*] |
| Hair with toenail | 3241.50 | 0.79[a] |
| Fingernail with toenail | 2673.00 | 0.06[a] |
| **Cadmium** | | |
| Hair with fingernail | 1633.50 | 0.00[a*] |
| Hair with toenail | 2629.00 | 0.02[a*] |
| Fingernail with toenail | 1137.00 | 0.00[a*] |
| **Lead** | | |
| Hair with fingernail | 1842.50 | 0.00[a*] |
| Hair with toenail | 2438.50 | 0.00[a*] |
| Fingernail with toenail | 2478.50 | 0.01[a*] |
| **Nickel** | | |
| Hair with fingernail | 161.000 | 0.00[a*] |
| Hair with toenail | 1731.00 | 0.00[a*] |
| Fingernail with toenail | 174.000 | 0.00[a*] |

*Significant ($p<0.05$)

Table 3 shows comparison of heavy metals levels in samples of farmers with the blood pressure groups. There were significant difference shown in the arsenic ($H = 10.64$, $p<0.05$), cadmium ($H = 7.34$, $p<0.05$) and cobalt ($F = 3.33$, $p<0.05$) levels in toenail among the blood pressure groups. From the Table 4, arsenic and cadmium levels in toenail were significant difference in between normal with pre-hypertension group and normal with

Table 3: Comparison of heavy metals levels in hairs and nails of farmers among the blood pressure group

| | | Mean±SEM | | |
|---|---|---|---|---|
| Parameters | Blood pressure (mmHg) | Heavy metals level (μg $L^{-1}$ (ppb)) | F/H value | p-value |
| **Hair** | | | | |
| Arsenic | Normal | 59.31±16.99 | 1.28 | 0.28[a] |
| | Pre-hypertension | 74.84±12.29 | | |
| | Hypertension | 107.58±26.11 | | |
| Cadmium | Normal | 17.48±5.420 | 1.27 | 0.28[a] |
| | Pre-hypertension | 23.58±3.900 | | |
| | Hypertension | 32.70±8.110 | | |
| Lead | Normal | 33.29±1.960 | 4.40 | 0.11[b] |
| | Pre-hypertension | 40.13±2.250 | | |
| | Hypertension | 35.69±3.460 | | |
| Nickel | Normal | 31.22±5.650 | 0.72 | 0.32[a] |
| | Pre-hypertension | 36.74±4.290 | | |
| | Hypertension | 43.69±9.560 | | |
| Cobalt | Normal | 9.49±2.900 | 1.16 | 0.32[a] |
| | Pre-hypertension | 12.08±2.070 | | |
| | Hypertension | 17.25±4.340 | | |
| **Fingernail** | | | | |
| Arsenic | Normal | 1.46±0.310 | 1.13 | 0.57[b] |
| | Pre-hypertension | 2.00±0.360 | | |
| | Hypertension | 1.41±0.350 | | |
| Cadmium | Normal | 1.28±0.870 | 0.98 | 0.61[b] |
| | Pre-hypertension | 1.18±0.440 | | |
| | Hypertension | 1.87±1.060 | | |
| Lead | Normal | 67.35±15.89 | 1.55 | 0.46[b] |
| | Pre-hypertension | 78.87±10.71 | | |
| | Hypertension | 72.46±16.74 | | |
| Nickel | Normal | 679.79±36.95 | 0.25 | 0.88[b] |
| | Pre-hypertension | 698.41±27.99 | | |
| | Hypertension | 706.32±34.68 | | |
| Cobalt | Normal | 17.76±0.910 | 1.92 | 0.38[b] |
| | Pre-hypertension | 17.37±0.460 | | |
| | Hypertension | 18.35±0.730 | | |
| **Toenail** | | | | |
| Arsenic | Normal | 64.87±18.72 | 10.64 | 0.00[b*] |
| | Pre-hypertension | 88.63±13.66 | | |
| | Hypertension | 140.69±22.26 | | |
| Cadmium | Normal | 24.73±5.810 | 7.34 | 0.03[b*] |
| | Pre-hypertension | 35.45±4.870 | | |
| | Hypertension | 48.15±7.130 | | |
| Lead | Normal | 42.27±3.560 | 3.28 | 0.19[b] |
| | Pre-hypertension | 77.81±30.89 | | |
| | Hypertension | 69.79±17.93 | | |
| Nickel | Normal | 81.27±13.33 | 0.33 | 0.85[b] |
| | Pre-hypertension | 105.32±16.88 | | |
| | Hypertension | 83.84±19.70 | | |
| Cobalt | Normal | 9.68±2.760 | 3.33 | 0.04[a*] |
| | Pre-hypertension | 15.27±2.270 | | |
| | Hypertension | 22.51±3.610 | | |

[a]One-way ANOVA; Normal = <120/80 mmHg, [b]Kruskal Wallis test; Pre-hipertensi = 120/80-139/89 mmHg, *Significant ($p<0.05$); Hipertensi = 140/90 mmHg

hypertension group. Post hoc Bonferroni test shows cobalt level in toenail was significant difference in between normal and hypertension group (Table 5).

Table 6 shows the relationship between working periods as farmers and the level of heavy metals in hair and nails samples. There were a weak negative relationship between arsenic (r = -0.44), cadmium (r = -0.43), lead (r = -0.32) and nickel (r = -0.31) levels in fingernail and also lead level (r = -0.29) in toenail with working periods as farmer ($p<0.05$).

In this finding, awareness and practice of pesticides and fertilizers use among farmers by blood pressure groups shown in Table 7. Almost all farmers from different

Table 4: Comparison of arsenic and cadmium levels in toenail between two each group of blood pressure

| Parameters | U-value | p-value |
|---|---|---|
| **Arsenic in toenail** | | |
| Normal with pre-hypertension | 397.00 | 0.16[a] |
| Normal with hypertension | 52.00 | 0.00[a*] |
| Pre-hypertension with hypertension | 169.00 | 0.02[a*] |
| **Cadmium in toenail** | | |
| Normal with pre-hypertension | 400.00 | 0.20[a] |
| Normal with hypertension | 65.50 | 0.01[a*] |
| Pre-hypertension with hypertension | 188.00 | 0.05[a*] |

[a]Mann-Whitney test; [*]Significant ($p<0.05$)

Table 5: Comparison of cobalt level in toenail between two each group of blood pressure

| Parameters | Mean±SEM | p-value |
|---|---|---|
| **Cobalt in toenail** | | |
| Normal with pre-hypertension | -5.59±3.72 | 0.29[a] |
| Normal with hypertension | -12.83±5.00 | 0.03[a*] |
| Pre- hypertension with hypertension | -7.24±4.50 | 0.24[a] |

[a]Post Hoc Bonferroni test; [*]Significant ($p<0.05$)

Table 6: Correlation of heavy metals levels in nail and hair with working periods of farmers

| Parameters | Correlation coefficient | p-value |
|---|---|---|
| **Hair** | | |
| Cadmium | -0.20 | 0.08[a] |
| Lead | -0.01 | 0.96[b] |
| Nickel | -0.16 | 0.15[a] |
| **Fingernail** | | |
| Arsenic | -0.44 | 0.00[b*] |
| Cadmium | -0.43 | 0.00[b*] |
| Lead | -0.32 | 0.00[b*] |
| Nickel | -0.31 | 0.00[b*] |
| Cobalt | 0.18 | 0.11[b] |
| **Toenail** | | |
| Arsenic | -0.04 | 0.76[a] |
| Cadmium | 0.02 | 0.89[a] |
| Lead | -0.29 | 0.01[b*] |
| Nickel | 0.17 | 0.15[b] |
| Cobalt | -0.02 | 0.85[a] |

[a]Pearson correlation; [b]Spearman correlation; [*]Significant ($p<0.05$)

Table 7: Awareness and practice of pesticides and fertilizers use by blood pressure group

| | | Blood pressure group | | | | |
|---|---|---|---|---|---|---|
| Questions | Answer | Normal | Pre-hypertension | Hypertension | $\chi^2$-value | p-value |
| Have you been involve in talk about the proper | Yes | 23 | 35 | 10 | 1.68 | 0.46 |
| way to use Personal Protective Equipment (PPE)? | No | 3 | 11 | 3 | | |
| Do you aware about Personal Protective Equipment (PPE)? | Yes | 23 | 37 | 11 | 0.79 | 0.79 |
| | No | 3 | 9 | 2 | | |
| Wear hats while spraying pesticides and handling fertilizers | Yes | 16 | 33 | 9 | 1.23 | 0.57 |
| | No | 11 | 13 | 4 | | |
| Had longed-sleeved clothes while spraying pesticides and handling fertilizers | Yes | 21 | 42 | 12 | 3.15 | 0.22 |
| | No | 6 | 4 | 1 | | |
| Had longed-sleeved pant while spraying and handling fertilizers | Yes | 23 | 42 | 12 | 0.81 | 0.64 |
| | No | 4 | 4 | 1 | | |
| Wear goggle while handling pesticides and fertilizers | Yes | 14 | 31 | 8 | 1.74 | 0.41 |
| | No | 13 | 15 | 5 | | |
| Wear mask while handling pesticides and fertilizers | Yes | 21 | 33 | 12 | 2.43 | 0.28 |
| | No | 6 | 13 | 1 | | |
| Wear cotton glove when handling pesticides and fertilizers | Yes | 3 | 5 | 3 | 1.40 | 0.55 |
| | No | 24 | 40 | 10 | | |
| Wear rubber glove when handling pesticides and fertilizers | Yes | 17 | 26 | 7 | 0.41 | 0.84 |
| | No | 10 | 20 | 6 | | |
| Wear long boots when handling pesticides and fertilizers | Yes | 24 | 41 | 11 | 0.63 | 0.73 |
| | No | 2 | 6 | 2 | | |
| Drink while handling pesticides and fertilizers | Yes | 1 | 1 | 0 | 0.63 | 1.00 |
| | No | 21 | 42 | 11 | | |
| Eat while handling pesticides and fertilizers | Yes | 1 | 1 | 0 | 0.63 | 1.00 |
| | No | 21 | 42 | 11 | | |
| Smoking while handling pesticides and fertilizers | Yes | 0 | 3 | 0 | 2.40 | 0.28 |
| | No | 22 | 40 | 11 | | |
| Change cloths after handling pesticides and fertilizers | Yes | 15 | 32 | 10 | 2.08 | 0.34 |
| | No | 7 | 10 | 1 | | |
| Wash hand and face after handling pesticides and fertilizers | Yes | 19 | 35 | 11 | 2.46 | 0.33 |
| | No | 3 | 8 | 0 | | |
| Shower after handling pesticides and fertilizers | Yes | 12 | 33 | 10 | 7.86 | 0.02[*] |
| | No | 10 | 10 | 0 | | |

[*]Significant ($p<0.05$)

Table 8: Awareness and practices of pesticide and fertilizers use by working period as farmer

| Questions | Answer | Working period As farmer (years) Short (<2) | Average (2-7) | Long (≥8) | $\chi^2$-value | p-value |
|---|---|---|---|---|---|---|
| Have you been involve in talk about the proper | Yes | 18 | 28 | 20 | 1.79 | 0.44 |
| way to use Personal Protective Equipment (PPE)? | No | 2 | 9 | 6 | | |
| Do you aware about Personal Protective Equipment (PPE)? | Yes | 17 | 30 | 22 | 0.20 | 0.87 |
| | No | 3 | 7 | 4 | | |
| Wear hats while spraying pesticides and handling fertilizers | Yes | 16 | 22 | 19 | 1.54 | 0.49 |
| | No | 7 | 14 | 6 | | |
| Had longed-sleeved clothes while spraying pesticides and handling fertilizers | Yes | 21 | 30 | 22 | 0.82 | 0.72 |
| | No | 2 | 6 | 3 | | |
| Had longed-sleeved pant while spraying and handling fertilizers | Yes | 22 | 31 | 22 | 1.40 | 0.60 |
| | No | 1 | 5 | 3 | | |
| Wear goggle while handling pesticides and fertilizers | Yes | 14 | 21 | 17 | 0.60 | 0.78 |
| | No | 9 | 15 | 8 | | |
| Wear mask while handling pesticides and fertilizers | Yes | 18 | 27 | 19 | 0.08 | 1.00 |
| | No | 5 | 9 | 6 | | |
| Wear cotton glove when handling pesticides and fertilizers | Yes | 4 | 4 | 2 | 0.96 | 0.69 |
| | No | 19 | 32 | 22 | | |
| Wear rubber glove when handling pesticides and fertilizers | Yes | 9 | 24 | 17 | 5.68 | 0.06 |
| | No | 14 | 13 | 7 | | |
| Wear long boots when handling pesticides and fertilizers | Yes | 21 | 32 | 21 | 0.64 | 0.77 |
| | No | 2 | 4 | 4 | | |
| Drink while handling pesticides and fertilizers | Yes | 0 | 2 | 0 | 2.76 | 0.34 |
| | No | 19 | 30 | 24 | | |
| Eat while handling pesticides and fertilizers | Yes | 0 | 2 | 0 | 2.76 | 0.34 |
| | No | 19 | 30 | 24 | | |
| Smoking while handling pesticides and fertilizers | Yes | 1 | 1 | 1 | 0.14 | 1.00 |
| | No | 18 | 31 | 23 | | |
| Change cloths after handling pesticides and fertilizers | Yes | 15 | 24 | 17 | 0.88 | 0.70 |
| | No | 3 | 8 | 7 | | |
| Wash hand and face after handling pesticides and fertilizers | Yes | 17 | 27 | 20 | 0.36 | 0.84 |
| | No | 2 | 5 | 4 | | |
| Shower after handling pesticides and fertilizers | Yes | 15 | 23 | 16 | 1.48 | 0.54 |
| | No | 3 | 9 | 8 | | |

Table 9: Individual's knowledge on pesticides handling by blood pressure group

| Category/Score | Blood pressure Normal | Pre-hypertension | Hypertension | $\chi^2$-value | p-value |
|---|---|---|---|---|---|
| Low (<10) | 8 | 12 | 3 | 2.10 | 0.72 |
| Medium (10-11) | 12 | 19 | 7 | | |
| High (>11) | 7 | 19 | 3 | | |

Table 10: Individual's knowledge on pesticides handling by working period as farmer

| Category/Score | Working period as farmer Short | Average | Long | $\chi^2$-value | p-value |
|---|---|---|---|---|---|
| Low (<10) | 6 | 13 | 3 | 11.58 | 0.02* |
| Medium (10-11) | 14 | 10 | 13 | | |
| High (>11) | 3 | 16 | 10 | | |

*Significant ($p<0.05$)

Table 11: Individual's attitude on pesticides handling by blood pressure group

| Category/ Score | Blood pressure Normal | Pre-hypertension | Hypertension | $\chi^2$-value | p-value |
|---|---|---|---|---|---|
| Not good (<24) | 3 | 12 | 3 | 5.35 | 0.25 |
| Good (24-26) | 16 | 17 | 5 | | |
| Very good (>26) | 4 | 13 | 2 | | |

blood pressure groups shower after handling pesticides and fertilizers significantly ($p<0.05$). Most of the farmers aware about the Personal Protection Equipments (PPE) and possess good awareness and practice.

Table 8 shows awareness and practice of pesticides and fertilizers use among farmers by working period as farmer. Almost all farmers from different working periods have good awareness and practice against pesticides and fertilizers use. Most of them wore hat, mask, long-sleeve shirt and pant, wash hands and faces and shower after handling pesticides and fertilizers and did not smoke, drink and eat while handling pesticides and fertilizers.

Individual's knowledge on pesticides handling by blood pressure group is shown in Table 9. The 67 farmers posses high score in understanding the use of pesticides and personal protection equipments (≥10 scores). Table 10 shows individual's knowledge on pesticides handling by working period as farmer. The 66 famers have good knowledge from different working periods and there was a significant different between individual's knowledge and working periods ($p<0.05$).

Table 11 shows individual's attitude on pesticides handling by blood pressure groups. The 57 farmers have good attitude in protecting themselves from the exposure of pesticides although, there was no significant difference

Table 12: Individual's attitude on pesticides handling by working period as farmer

| | Working period as farmer | | | | |
|---|---|---|---|---|---|
| Category/Score | Short | Average | Long | $\chi^2$-value | p-value |
| Not good (<24) | 5 | 9 | 4 | 4.15 | 0.38 |
| Good (24-26) | 10 | 17 | 11 | | |
| Very good (>26) | 12 | 7 | 9 | | |

shown. The 66 farmers from different working periods have good attitude on pesticides handling shown in Table 12.

The influence of environmental pollution on human health can be determined by metabolically inactive tissues such as nails and hairs due to easy of sample collection, transportation and preparation for analysis. Analysis of heavy metals normally can use alternative biomarkers such as blood and urine but these samples are only meant for short-term exposure (Van Dael *et al*., 2001). In this study, nails and hairs are used to determine the heavy metals levels in human body because evaluation of the biological markers can be used to monitor the elements accumulated over a period such as from a few weeks to a few months (Rodushkin and Axelsson, 2000).

In this study, heavy metals arsenic, cadmium, lead and nickel were significantly higher in nails compared to hairs. Nails contain more α-keratin (22% cystein) compared to hairs (14% cystein) (Mandal *et al*., 2003). Heavy metals levels are different in hair, fingernail and toenail are because of the differences between the growth of samples. Fingernail can grow approximately 3.47 mm per month, toenails grow 1.62 mm per month and hairs grow 1.4 cm per month (Pragst and Balikova, 2006). Arsenic and cadmium levels are higher in toenails because toenail is less exposure and contaminate to exogenous compounds (Barbosa *et al*., 2005). Lead and nickel levels were higher in fingernails because fingernails are more exposed to environment (Sukumar, 2006).

Exposure of heavy metals can injure vascular system causing many types of diseases such as high blood pressure, edema and atherosclerosis (Prozialeck *et al*., 2008). Arsenic, cadmium and cobalt in toenails were significantly higher compared to fingernails and hairs supporting the statement that toenail is a better biological marker. Exposure to arsenic can cause dysfunction of vascular endothelium and inactivate the nitric oxide synthase enzyme (Balakumar and Kaur, 2009). Besides, exposure of cadmium at high level will lead to renal dysfunction leading tubular proteinuria (Jarup *et al*., 1998). High exposure of cobalt can cause myocardial dysfunction and cardiovascular disease too.

In this finding, heavy metals arsenic, cadmium, lead and nickel in fingernails and lead levels in toenails were shown weak negative relationship with working period as farmer. This may be due to most of the farmers posses good attitude and practice on pesticides use to prevent the exposure of heavy metals. This will help to reduce the accumulation of heavy metals inside body. Besides, fertilizers used in are organic fertilizers such as SUKU BUMI fertilizer preventing the release of organic wastes to soil.

From the result of awareness and practices on pesticides use by blood pressure groups and working period most of the farmers have good awareness on the techniques to use pesticides and personal protective equipments when working. This can help them to prevent harm including heavy metals material from entering the body. Besides, most of the farmers have medium scores (10-11 score) in knowledge on pesticides handling. This shows that the farmers are lacking about knowledge in pesticides handling that can lead to careless on the sustainability of pesticide use and ignore the cause of pesticides pollution. However, almost all of the farmers have good attitude on pesticides handling and Personal Protective Equipments (PPE). Protective equipments are a tool to reduce exposure of heavy metals from environment.

## CONCLUSION

There were significantly higher of heavy metals levels in nail compared to hair among farmers. Arsenic, cadmium and cobalt levels in toenail were significantly higher in farmers who have hypertension. Other factors such as nutrition, socioeconomic status and lifestyle have to be considered for a realistic approach. Based on the results of knowledge, attitude and practice on pesticides handling, most of the farmers posses good behavior and responsible in dealing the pesticides use to reduce the exposure of heavy metals. As a conclusion, the levels of heavy metals in nail and hair samples among vegetable farmers are lower compared to previous studies. However, the control of environment levels and human exposure to these metals is still important and other alternatives to control the pesticides and fertilizers use have to be implemented.

## ACKNOWLEDGEMENTS

Special thanks to Malaysian Agricultural Research and Development Institute for the permission to conduct this study on farmers and all the laboratory assistants from departments of Biomedical Science. Researchers wished to thank Ministry of Higher Education Malaysia and Universiti Kebangsaan Malaysia for research grant ERGS/1/2011/SKK/UKM/03/12.

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