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FOOD SAFETY PERCEPTIONS VS REALITY: THE CASE OF PERI-URBAN AREAS OF RAWALPINDI, PAKISTAN

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ABSTRACT

This study investigated the differences in people's preferences about food safety vs ground realities in peri-urban areas of Rawalpindi, Pakistan. For this purpose, primary data were collected from 103 residents. Perceptions regarding various aspects of water and food safety were recorded using a well developed questionnaire that incorporated both open and closed ended questions. Samples of drinking water and vegetables from the study areas were collected. A mixed-method research approach was applied to permit qualitative and quantitative investigation. Results showed that the majority of the households perceived that they consume safe drinking water (74%) and food (83%). However, at the same time they contradicted with their perception while reporting the incidence of waterborne diseases. 72% of the respondents reported that one of more household members suffered from water borne diseases during last month (from interview). Chemical tests of water and vegetables confirmed that drinking water and vegetables available in the study area were not suitable for human consumption. It is recommended that the awareness level of households must be improved.

Keywords: *Food safety, Water borne diseases, Heavy metals, Pesticide residues, Chemical food analysis.*

INTRODUCTION

Food safety is an essential part of food utilization component of food security (Bashir and Schilizzi, 2013). Both developed and developing countries are concerned about food safety as it is the important link between food and health (Unnevehr, 2003). Concerns about food safety have increased as a result of increased international trade (Kirezieva *et al*., 2015), urbanization (Chen *et al*. 2016), increased vulnerability to food borne diseases (Lund and O'Brien 2011; and Lund 2015), issues in food handling and consumption (Yapp and Fairman, 2006; and Omari and Frempong, 2015), and emergence of resistant pathogens (Koutsoumanis *et al*., 2014). Consequently, new institutions, standards and regulations are established to control such hazards in developed countries (Unnevehr, 2003).

Vegetables are considered as safe and healthy food (Losio *et al*., 2015). They are a rich source of essential nutrients such as vitamins, minerals, antioxidants and fiber (Dias, 2012). To maintain the production demands and reduce losses owing to insect pests, excessive pesticides are used these days (Halimatunsadiah *et al*., 2016). Toxic material absorbs in the vegetables in the form of pesticide residues and increases the incidences of food poisoning and other food borne illnesses (Snelder *et al*., 2008). Pesticide residues can have bad prolonged effects on body's endocrine, immune and neurological systems (Colborn, 1995; Saal *et al*., 1997; and Porter *et al*., 1999).

On the other hand, heavy metals present in the environment (due to urbanization and industrialization especially in developing countries (Wong *et al*., 2003; Arora *et al*., 2008) can accumulate in vegetables and pose credible threat to human health (Haiyan and Stuanes, 2003). The prevalence of metallic compounds in fertilizers impart extra metal contamination in vegetables (Yusuf *et al*., 2003). Furthermore, application of untreated waste water as irrigation is one of the leading sources of heavy metals in soil (Mapanda *et al*., 2007; and Sharma *et al*., 2014). Heavy metals are the metallic chemical elements that have comparatively high density and noxious even at very small concentration. These enter in human body through different routes like food, drinking water and air resulting in health complications even at very low concentrations. The main reason behind their toxicity is that these are noncompetitive inhibitors for numerous enzymes. Their excessive uptake might result in various health disorders (Arora *et al*., 2008). The prevalence of both pesticide residues and heavy metals in food supply (especially vegetables) is considered the most important problem which is serious in developing countries (Bempah *et al*., 2011) like Pakistan (Zaidi *et al*., 2005).

Pakistan is the 6th most populous country of the world with a population of 195.4 million (GOP, 2016). The proportion of undernourished population is high i.e. 22% (FAO, 2015). Being a transition economy, urbanization is increasing. The urban population has increased to 78 million i.e. 40% (GOP, 2016). Due to the increasing urban population, urban centers are under pressure to create more job and residential facilities. As a results, cities are expanding in a haphazard way (Haq, 2011) increasing the number of peri-urban areas (Shah and Abbas, 2015) which threatens urban food security and creates other social problems in these city centers (Haq, 2011).

There is no consensus over the common definition of peri-urban areas (Optiz *et al.*, 2016). The available definitions are situational and case specific (Iaquinta and Drescher, 1999). This study follows the definition given by UNICEF i.e. "*peri-urban areas refer to the areas between consolidated urban and rural regions*" (UNICEF, 2012). The agriculture of peri-urban areas is the source of fresh vegetables not only for their own residents but for urban markets too (Optiz *et al.*, 2016). Peri-urban farmers in Pakistan, apply sewage water to irrigate vegetables (Buechler *et al.*, 2006) and use heavy doses of pesticides to avoid insect / pest attacks. The residues of pesticides and sewage water assimilate into the plant tissues that may cause serious health issues after consumption (Kumari *et al*., 2004). On the other hand, ground water is used for drinking purposes. In many cases, the ground water is also contaminated with to sewage water (Aziz, 2007). Due to which people are suffering from various waterborne diseases (Kausar *et al*., 2011). People usually do not have knowledge about the adverse health impacts of pesticide (Bhandari, 2014) and sewage water residues in vegetables or water. They consider vegetables and water safe for consumption. This study aims to improve food security and safety policies in peri-urban areas. The objectives are to:

1. Identify the perceptions of peri-urban residents about food and drinking water safety in Rawalpindi.
2. Test the selected vegetables and drinking water samples of the study area to compare with the perceptions of residents.
3. Suggest policy implications.

MATERIALS AND METHODS

Study Area: Rawalpindi, the fourth largest city of the Punjab province (GOP, 1998) was selected as the study area for this study. The population density is 636 persons per square kilometer and almost 65% of the population is urban (GOP, 2014). The district was marked as food secure based on food availability, but had a high food insecure proportion (29%) of population (SDPI, 2009). A stratified random sampling technique was used to collect data. Three peri-urban areas (strata) around the city were selected (based on three homogeneous characters i.e. 1. location adjacent to the cities, 2. residential areas with mostly landless (no agricultural land) households, and 3. number of households in the study area between 150 - 200 households. Table 1 shows the sample and strata selection.

Table 1. Sample selection.

City	Stratum	Total households*	Sample Size
Rawalpindi	Bajnial	150	35
	Khasala Khurd	160	35
	Bara Meera	150	35
Total		**460**	**105**

* The total number of households in the study area were confirmed from local government representatives' offices

From each strata 35 households were randomly selected. This made the total sample size of 105. Data were collected using a structured interview schedule regarding the food and water safety knowledge and perceptions.

Samples of seasonal vegetables (Cauliflower, carrots, reddish, cucumber, tomato, potato, onion, brinjal, turnip, ladyfinger, bottle gourd and tinda) were purchased from the study area, randomly. These samples were purchased in three different quarters of the years. Maximum variety of locally grown vegetables during a year was covered in these three quarters. To avoid losses to the collected samples due to the perishable nature of vegetable, they were kept in polyethylene air tight bags and stored at -40^{o}C in cold storage before transporting to Food and Nutrition Laboratory of the National Institute of Food Science and Technology, University of Agriculture, Faisalabad for immediate processing. However, some samples, which were not immediately processed due to any reason, were stored at -40^{o}C until further processing so that any degradation of residues could be avoided occurring during ordinary storage.

Similarly, drinking water samples were also collected from the different households and water sources in the study area, randomly.

Data Analysis: A mixed-method research approach (Sarantakos, 2005) was applied to permit qualitative and quantitative investigation.

Perceptions about Food Safety: Qualitative information was collected regarding different aspects of food safety. Following open and closed ended questions were asked:

1. How would you describe safe food? (open ended question)
2. Is the food, especially vegetables, which you consume safe for consumption? (closed ended -- safe (yes), unsafe (no))
3. What is the source of your drinking water?
4. Water is fit for consumption?
5. Have you ever get your drinking water tested?

6. Have you or any family member experienced water borne illness (diarrhea) during the past 30 days?

Chemical composition analysis of vegetables and drinking water: Quantitative analysis was carried out to test the quality of vegetables and drinking water from the study area. Vegetable samples were analyzed for heavy meals and pesticide residues whereas water samples were assessed for heavy meals only. After size reduction, fresh vegetables samples were oven drying at 70º C for 24 hours and ground to fine powder (Figure 1) for heavy metal analysis following method described in AOAC (2006). After wet digestion, digested samples were transferred to 100mL volumetric flask and volume was made with de-ionized (Figure 2). Afterwards, filtered sample solutions were run through atomic absorption spectrophotometer (AA240 Varian K, Australia) for the determination of metals like Fe, Zn, Mn, Cu, Pb, Cd, Hg, Ni and Cr. Likewise water samples were analyzed for the same elements following the stated method (Figure 3). To probe the pesticide residues in vegetables, after homogenization, residues of pesticides were extracted following modified method of Kadenezki *et al*. (1992), Kumari *et al*. (2004) and Khan *et al*. (2009). For the determination of pesticide residues, the re-dissolved samples were subjected to the GC-ECD and HPLC (Perkin Elmer Series 200 HPLC Systems, USA) analysis following procedures described by Asi (2005), Chandra *et al*. (2010) and Randhawa *et al*. (2007).

Figure 1. Oven drided powdered vegetable samples for determination of heavy metal.

Figure 2. Vegetable samples after wet digestion for determination of heavy metal.

Figure 3. Water samples for determination of heavy metal

RESULTS AND DISCUSSION

Perceptions about safe drinking water: In response to the first question i.e. description of safe food, almost all the respondents reported that a safe food is one that looks fresh, without any odor (bad /pungent), and its taste is not altered. Regarding the second question (food safety), majority of people (more than 80%) reported that what they are eating, especially vegetables, are safe for human consumption (Figure 4).

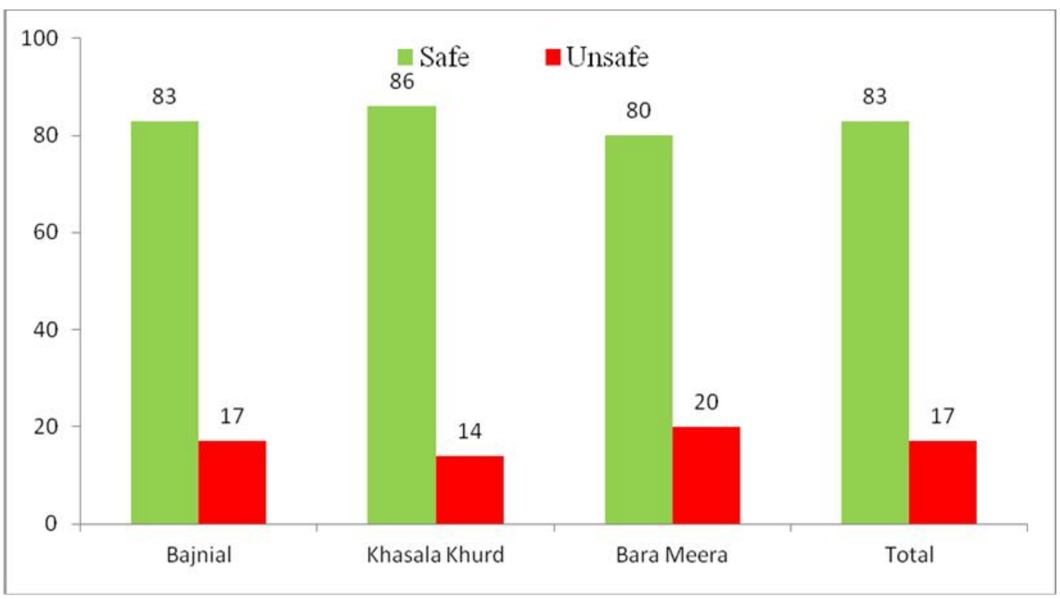

Figure 4. Perceptions about food safety (%)

Access to safe drinking water is an important component of food utilization (SDPI, 2003; 2009). Three sources of drinking water were reported by respondents:

1. Ground water (home), people used to pump ground water by installing water pumps in their homes.
2. Ground water (others), people took water from others' installed pumps. This is usually free of cost.

3. Filtration plants, in different regions, government or privately installed filtration plants that provide water free of cost.

More than 90% of the respondents reported that they drink their own pumped water (Figure 5).

In response to the third question, whether the water which they are consuming is fit /safe for consumption. More than 70% of the respondents perceived that the water is fit / safe for consumption (Figure 6).

When they were asked about getting their drinking water tested from a laboratory, either of government of private sector, more than 90% of the respondents reported that they had never got their water tested from any sort of laboratory (Figure 7).

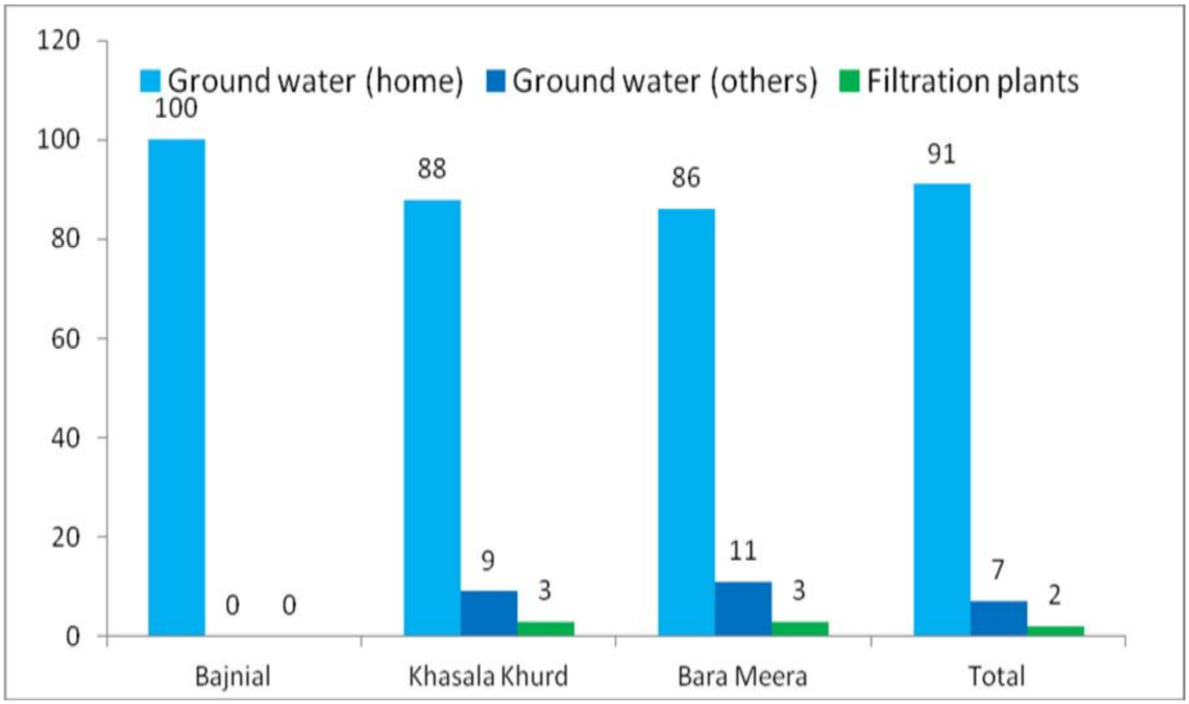

Figure 5. Source of drinking water.

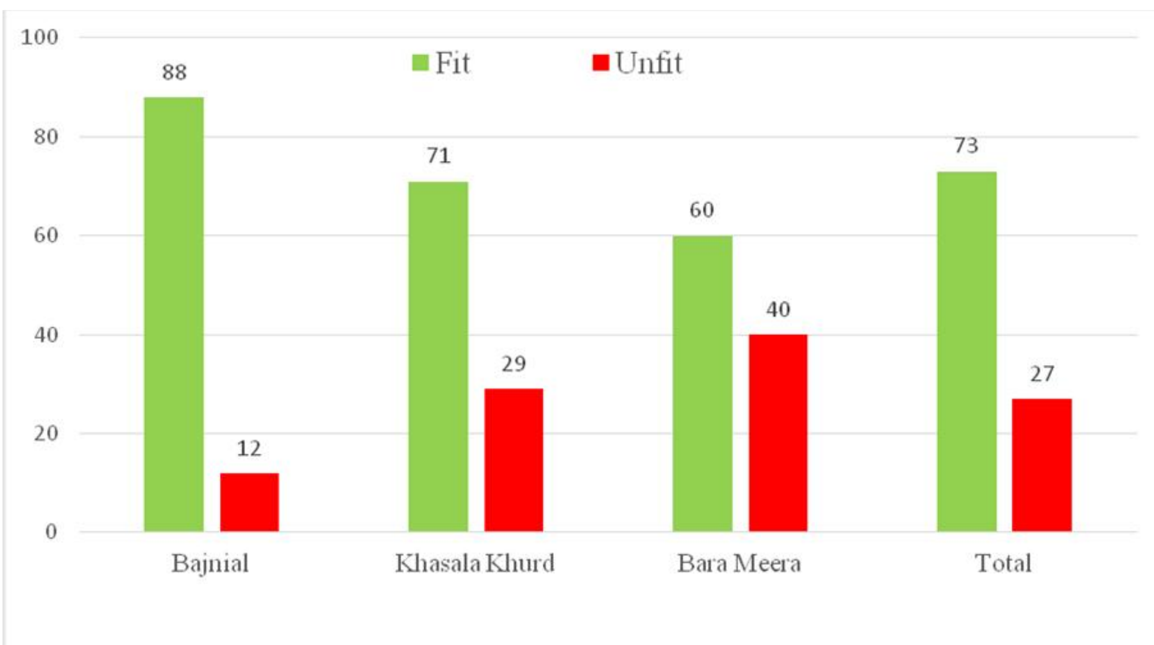

Figure 6. Perceptons about water safety

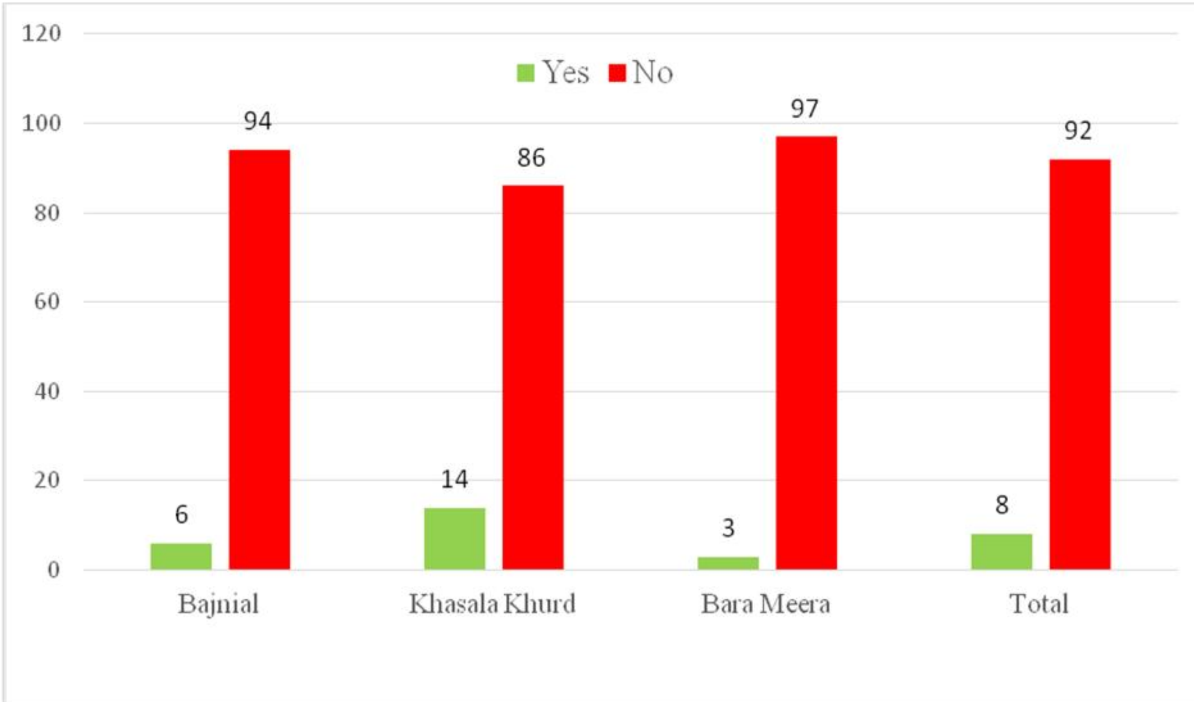

Figure 7. Water test statistics.

In response to the last question, i.e. have you or any family member experienced water borne illness (diarrhea) during the past 30 days? More than 70% of the respondents reported that they or any of the family members suffered from water borne diseases once or more than once a month (Figure 8).

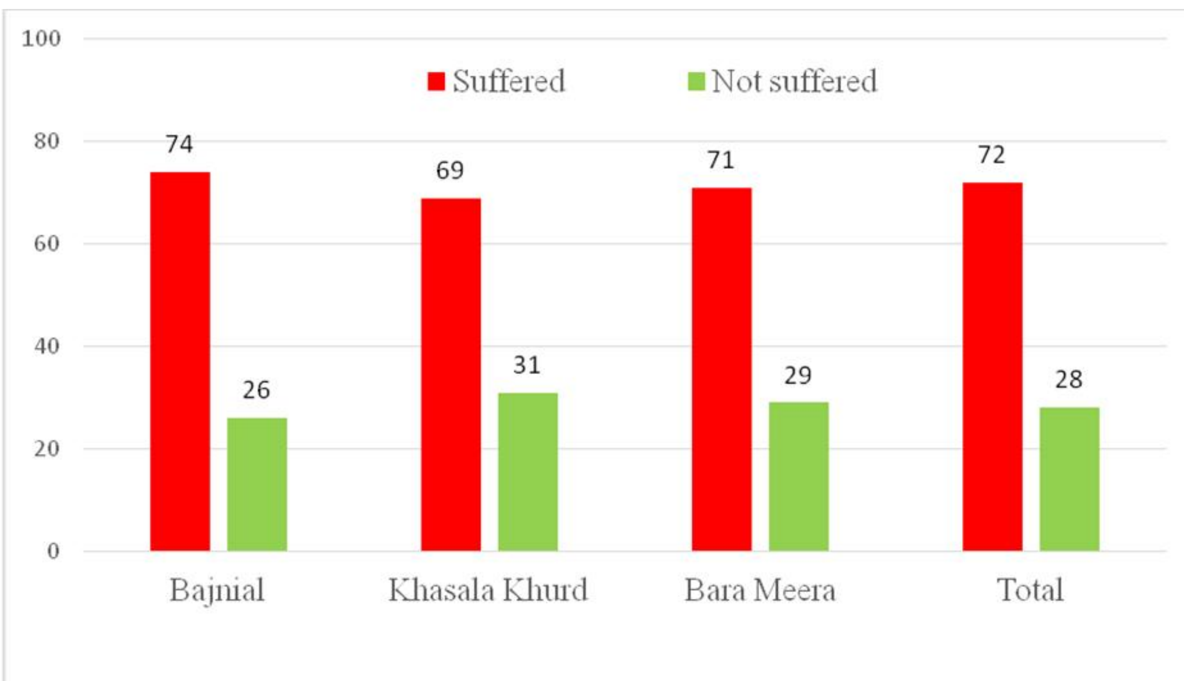

Figure 8. Prevelance of Water borne diseases.

From the above results, it is clear that perceptions of the respondents do not match with their personal experience. Majority of them perceived that the food (vegetables) and drinking water which they are consuming are safe and harmless. But, the never got their drinking water and food (vegetables) tested for harmful materials. Also, majority of them reported the incidence of water borne diseases. Pakistan is facing huge costs annually in terms of lost work days and cost of illness due to poor drinking water quality. Almost 80% of the diseases are caused by bad quality water which is a cause of 40% deaths (Zia, 2013).

Chemical analysis for heavy metals presence in water and vegetables

Heavy metals contamination of vegetables and drinking water: The results of heavy metal detection are presented in Table 2. According to the results, **cadmium (Cd)** concentration was ranged from 0.03±0.04 to 0.25±0.27 mg/kg in the vegetable samples. The maximum Cd concentration was found in cauliflower (0.25±0.27mg/kg) and tomatoes (0.25±0.23mg/kg) followed by peas (0.20±0.09mg/kg) while least contents (0.03±0.04 mg/kg) were found in onion. However, water samples collected from the study area were Cd free. Permissible limit for Cd is 0.2 mg/kg set by the Joint FAO/WHO Expert Committee on Food Additive, while the mean values of cauliflower and tomato (0.25 mg/kg) were slightly higher than the acceptable limit (0.2 mg/kg).

High cadmium concentration in vegetables is attributed to its easy accumulation by the plants (MacFarlane *et al*., 2002). Cadmium being a serious accumulative body poison enters into body through air, water and food and cannot be removed by washing vegetables. Cadmium has the tendency accumulates in liver and kidney (Jin *et al*., 2008). In Pakistan, untreated waste water is used for irrigation purposes especially in the peri-urban areas (Ashraf *et al*., 2013). Cd concentration among samples collected from Rawalpindi was higher possibly due to more pollution in proximities as well as nature of the soil. Khan *et al*. (2013) found very high concentration of Cd (6.7 mg/kg) in cauliflower and tomatoes (6.1 mg/kg) from Lahore district.

The concentration of **Chromium (Cr)** ranged from 6.35±5.50 mg/kg to 19.05±32.99 mg/kg in the vegetables samples collected from the study area. Maximum Cr concentration (19.05±32.99 mg/kg) was found in onions followed by tomatoes (6.35±11.00 mg/kg) and carrots (6.35±5.50 mg/kg) while it was not detected in cauliflower, turnip, potatoes, cucumber and pea samples collected from this study area. However, it was not present in the water samples.

These results revealed several hundred times higher concentration of Cr in vegetables consumed by the residents of the study area compared with the recommended level (0.05 mg/kg). Furthermore, use of pesticides and chemical fertilizers on these short duration crops worsen the situation in Pakistan. Concentration of Cr detected in the onions and tomatoes was much higher than the findings of Farooqi *et al*. (2009) and Fusconi *et al*. (2006).

Copper (Cu) concentration ranged from 0.75±0.67 mg/kg to 18.87±23.49 mg/kg in the vegetable samples. Maximum Cu concentration (18.87±23.49 mg/kg) was found in turnips followed by cauliflower (11.29±6.84 mg/kg), while least contents (0.75±0.67 mg/kg) was found in carrot. However, this metal was not detected in cucumber and pea samples. However, it was not present in the water samples.

The results revealed that Cu concentrations were slightly higher than the permissible limit (10 mg/kg) as described by WHO/FAO.. Copper contents obtained from this study were higher than those obtained by Radwan and Salama (2006) who reported maximum copper contents (5.69 mg/kg) in cucumber followed by tomatoes (1.83 mg/kg) while least concentration (0.83 mg/kg) for potatoes followed by onion (1.49 mg/kg), respectively. In another study Khan *et al*. (2013) collected cauliflower and tomatoes samples from different location of Lahore district and reported copper contamination higher than the present finding.

Nickel (Ni) concentration ranged from 6.40±5.92 mg/kg to 32.98±21.82 mg/kg in the vegetables samples. Maximum Ni concentration (24.63±11.07 mg/kg) was found in pea followed by cucumber (22.97±8.13 mg/kg), while least contents (1.81±1.69 mg/kg) were found in tomatoes. Among vegetables samples from Multan, maximum Ni concentration (32.98±21.82 mg/kg) was found in round gourd followed by bitter gourd (20.18±10.73 mg/kg) while the least concentration (6.40±5.92 mg/kg) was observed in tomatoes. However, it was not present in the water samples.

These results indicated higher concentrations of Ni compared with permissible limits of 0.5-1.0 mg/kg as describe by Joint FAO/WHO Expert Committee on Food Additives. Main source of Ni in the soil is industrial pollution (sewage sludge) and poor agricultural practices. In a study vegetables grown in non-polluted and industrially polluted areas of Bangladesh were evaluated for nickel, cadmium and lead cadmium contents. The results revealed the highest Ni contents in tomatoes (2.03-2.83 µg/g) followed by 1.69-2.66 µg/g in cauliflower (Marschner *et al*., 1995). Present results endorse the previous finding of Nedjimi *et al*. (2009) and Yusuf *et al*. (2003).

Lead (Pb) concentration in the vegetables samples ranged from 2.01±3.48 to 10.03±3.47 mg/kg, respectively. In Rawalpindi, maximum Pb concentration (10.03±3.47 mg/kg) was found in peas followed by turnip (8.52±3.48 mg/kg), while least contents (2.51±4.34

mg/kg) were found in tomatoes. Among vegetables samples from Multan, maximum Pb concentration (7.52 mg/kg) was found in bitter gourd and okra followed by tomatoes (7.32±6.83 mg/kg) while the least concentration (2.01±3.48 mg/kg) was detected in round gourd. However, it was not present in the water samples.

It is obvious from the results that all the vegetable samples were loaded with Pb contents compared with maximum permissible level of this metal in brassica (0.3 mg/kg) and all other vegetables (0.1 mg/kg) as describe by FAO (2002); hence making them unfit for human consumption. High concentration of lead (Pb) in these vegetables can be attributed to pollutants in irrigation water and due to heavy traffic pollution being major cities of the Punjab. In a study, market basket survey for lead, cadmium, copper, chromium, nickel, and zinc in fruits and vegetables reveled high concentration of lead in cucumber (1.72 mg/kg) and tomatoes (1.56 mg/kg) making them unsafe for human consumption (Parveen *et al*., 2003).

Manganese (Mn) concentration ranged from 8.03±1.15 to 27.37±9.27 mg/kg in the vegetables samples. Maximum Mn concentration (27.37±9.27 mg/kg) was found in peas followed by cauliflower (24.69±3.44 mg/kg), while least levels (8.03±1.15 mg/kg) were found in potatoes. It was found in water samples (0.35±0.40 mg/kg).

These concentrations are above the permissible limits (5 mg/kg) set by FAO/WHO. These high concentrations might be due to their high concentrations in the soil, irrigation water and pesticides applied. In a study, vegetables like onion, potato, tomato and cucumber were reported having maximum concentration of Mn (27.84 µg/g) in tomatoes followed by onions (19.05 µg/g) while least concentration (7.61 µg/g) was found in potatoes followed by cucumber (10.92 µg/g), respectively (Iqbal and Shazia, 2004). In another study Khan *et al*. (2013) analyzed cauliflower and tomato samples and found manganese concentration ranged from 37.4 to 75.3 mg/kg in case of cauliflower and 26.9 to 86.4 mg/kg) in tomatoes.

Iron (Fe) concentration in vegetables ranged from 79.40±21.46 mg/kg to 103.72±84.36 mg/kg. In Rawalpindi, maximum Fe concentration (103.72±84.36 mg/kg) was found in onions followed by tomatoes (85.12±41.68 mg/kg), while least contents (32.19±8.58 mg/kg) was found in turnip. Among the vegetables samples from Multan, maximum Fe concentration (248.21±207.49 mg/kg) was found in tomatoes followed by bitter gourd (228.18±132.45 mg/kg) while the least concentration (79.40±21.46 mg/kg) was observed in brinjal. Its concentration in water samples was 0.66±1.01 mg/kg.

Most of the vegetables have higher Fe concentration than the permissible limits set by the FAO (2002). Iron acts as a micronutrient if present in trace amount. Excess of iron associated with many health implications. Maximum iron concentration (364 µg/g) was found in tomatoes followed by cucumber (141.4 µg/g), whereas least (51.9 µg/g) was observed in onions followed by potatoes (70.2 µg/g). Likewise in another study Khan *et al*. (2008) found iron contents ranged from 73- to 190 mg/kg in cauliflower and tomatoes. Present results were higher than recorded by Baccio *et al*. (2005) analyzed different vegetables and reported high concentration (7.9-24.8 µg/g) for iron in these samples. In Pakistan, Ali *et al*. (2012) recorded high concentrations of iron in onion, potato, tomato and cucumber.

Accumulation of heavy metals is attributed to direct use of untreated waste water furthermore; non-judicial application of agricultural practices imparts an extra source of heavy metal to food stuff (Akoto *et al.*, 2015; and Mahmoud and Ghoneim, 2016).

Zinc (Zn) concentrations ranged from 16.56±7.31 to 28.66±4.41 mg/kg in the vegetables samples. Maximum Zn concentration (28.66±4.41 mg/kg) was found in cucumber followed by carrots (25.77±5.84 mg/kg), while least content (16.62±3.82 mg/kg) was found in onions. However it was not found in water samples.

Zinc concentrations in all samples were found far below than the permissible limits of 100 mg/kg described by FAO/WHO. This might be due to established deficiency of this nutrient in Pakistani soils. Zinc is the most important and a vital trace component for higher plants and animals. It plays a vital role to energy metabolism, transcription and translation due to variety of enzyme systems. In some soils the higher amount of zinc is present due to human activities and it is potentially dangerous. Excessive contents in soil results in phyto-toxicity and eventually entry to the food chain (Change *et al*., 2005). In current study, the zinc concentration was found below than the permissible limit as describe by WHO. Results of the present study were similar with the finding of Devi *et al.* (2007) who reported 21.34, 20.08 and 3.56 mg/kg zinc content in onions, cucumber and tomatoes, respectively.

Table 2: Prevalence of heavy metals in vegetables and drinking water.

Samples	Elements (mg/kg) Mean±S.D							
	Cd	**Cr**	**Cu**	**Ni**	**Pb**	**Mn**	**Fe**	**Zn**
Cauliflower	0.25±0.27	0	11.29±6.84	5.57±1.88	4.01±3.78	24.69±3.44	52.22±8.93	21.92±7.96
Turnip	0.10±0.04	0	18.87±23.49	4.87±4.69	8.52±3.48	9.56±1.66	32.19±8.58	21.92±3.01
Onion	0.03±0.04	19.05±32.99	2.36±3.54	6.68±5.79	5.51±7.10	15.37±6.21	103.72±84.36	16.62±3.82
Tomato	0.25±0.23	6.35±11.00	10.75±15.91	1.81±1.69	2.51±4.34	18.20±3.05	52.22±19.35	25.77±4.65
Potato	0.10±0.09	0	6.77±10.90	5.15±8.92	3.51±2.30	8.03±1.15	33.62±16.25	20.47±5.08
Cucumber	0.08±0.08	0	0	22.97±8.13	5.52±5.28	16.28±3.77	73.67±32.78	28.66±4.41
Pea	0.20±0.09	0	0	24.63±11.07	10.03±3.47	27.37±9.27	85.12±41.68	23.84±5.21
Carrot	0.15±0.08	6.35±5.50	0.75±0.67	14.48±18.47	4.51±5.42	20.11±2.30	42.20±15.07	25.77±5.84
Ridge Gourd	0.08±0.13	0	2.15±3.72	18.79±9.40	3.01±3.98	25.00±6.56	148.07±78.67	23.84±6.30
Water	0	0	0	0	0	0.35±0.40	0.66±1.01	0

Source: Authors' own calculations Sample dates: 2015-16

Pesticide residues in vegetables: In Pakistan, organophosphate and pyrethroid group of pesticides are used most frequently (Saleem *et al*., 2008). These include a broad range of compounds with herbicides, fungicides, insecticides and others. Most commonly used organophosphate pesticides to vegetables in Pakistan include chlorpyrifos, trichlorfon, dimethoate, diazinon and methamidophos and pyrethroid group includes cypermethrin about 29% use in vegetables lamdachylothrin, lufenuron, emamectin benzoate and fenvalerate respectively. Imidacloprid (Neonicotinoids) is also very common insecticide used in Pakistan due to its lower cost (Baig *et al*., 2012).

Samples of cauliflower, turnip, onion, tomato, potato, cucumber, carrot, brinjal, round gourd, bitter gourd, okra and ridge gourd were tested for pesticide residues. The results for chlorpyrifos and lambdacyhalothrin residues in the vegetable are presented in Table 3. Standard maximum residue levels set by FAO/WHO and UK and EU standards (EC 2001; FAO 2002) are presented in Tables and 5. These were compared with the pesticide residues of vegetables from the study area. Concentration of chlorpyrifos and lamdacyhalothrin was found to be higher than the recommended limits.

The lowest chlorpyrifos residues were found in the onion (0.312mg/kg) followed by turnip (1.139mg/kg), tomato (1.178mg/kg) and potato (1.801mg/kg). Chlorpyrifos was not detected in cucumber and carrot samples obtained from this region.

According to FAO/WHO and Codex standards maximum residual levels for chlorpyrifos are 0.05mg/kg for cauliflower; however, its contents in present study were 17 folds higher (0.859mg/kg). Among the vegetable samples, okra contained the lower chlorpyrifos residues (1.284mg/kg) than the maximum residual levels (1.5mg/kg) describe by FAO/WHO. Chlorpyrifos residues in turnip, potato, onion and tomato were 22.78, 9.005, 6.24 and 2.35 fold higher than the MRLs as describe by FAO and EU. Among the tomatoes, potatoes, onions and cucumbers which were commonly used in the study area, residues of chlorpyrifos were found higher in potato and tomato from the study area. Furthermore, its concentration was higher than the MRLs as describe by Codex/FAO and EU in onions.

The presence of pesticide residues in okra is very common. Additionally, this vegetable is used without peeling which further increases the risks of toxicity in human. In a Chinese study, among the vegetables okra showed maximum concentration of chlorpyrifos residues (1.71mg/kg) followed by 0.79mg/kg in carrots, 0.29mg/kg in tomatoes, 0.16mg/kg in onions and 0.11mg/kg in cucumbers respectively while lowest residues were detected in potatoes 0.036mg/kg and brinjal 0.086 mg/kg (Yuan *et al*., 2014).

Lambdacyhalothrin residues were detected in many vegetables and found above to their permissible range. Extreme lambdacyhalothrin concentration (1.99mg/kg) was observed in cucumber followed by potato (0.278mg/kg), ridge gourd (0.26mg/kg), turnip (0.117mg/kg) and brinjal (0.032mg/kg). The lowest lambdacyhalothrin residues were detected in tomatoes (0.003mg/kg) followed by bitter gourd (0.004mg/kg) and (0.023mg/kg) in onion respectively. Lamda-cyhalothrin was not detected in cauliflower, okra, round gourd and carrot. Mean contents of pesticide residues in vegetables along with other comparative values are summarized in Table 6. From the values it is clear that concentration of chlorpyrifos and lambdacyhalothrin was above their MRLs.

Table 3. Results of vegetable samples.

Sample	Pesticides (mg/kg)	
	Chlorpyrifos	Lambdachyalothrin
Potato	1.801	0.027
Tomato	1.178	ND
Onion	0.312	ND
Carrot	ND	0.303
Cucumber	ND	1.99
Turnip	1.139	0.117

Source: Authors' own calculations
Sample dates: 2015-16

Table 4. MRLs (mg/kg) of Chlorpyrifos set by various organizations.

Samples	Conc. (mg/kg)	FAO/WHO MRLs	Codex MRLs	ASEAN MRLs	UK/EU. Limits
Potato (M)	ND	0.2	2	0.05	0.05
Potato (P)	1.801	0.2	2	0.05	0.05
Tomato (p)	1.178	0.5	-	-	0.5
Onion (M)	0.525	0.05	0.2	0.05	0.2
Onion (P)	0.312	0.05	0.2	0.05	0.2
Carrot	ND	0.5	0.1	0.5	0.1
Cucumber (M)	1.99	-	-	-	0.05
Cucumber (P)	ND	-	-	-	0.05
Turnip	1.139	-	-	-	0.05

Source: HSE 2016

Table 5. MRLs (mg/kg) of Lamda chyalothrin set by various organizations.

Sample	Conc. (mg/kg)	Codex MRLs	UK/EU Limits
Potato (M)	0.278	0.01	0.02
Potato (P)	0.027	0.01	0.02
Tomato (p)	ND	0.3	0.1
Onion (M)	0.023	0.2	0.2
Onion (P)	N/D	0.2	0.2
Carrot	0.303	0.01	0.02
Cucumber (M)	1.15	0.05	0.1
Cucumber (P)	1.99	0.05	0.1
Turnip	0.117	0.01	0.02

Source: HSE 2016

From the above results, it is clear that the perceptions or the residents of peri-urban areas about food and water safety are not in line with the actual situation. The whole discussion is summarized into Figure 9 which shows that the majority of the respondents perceived that they are consuming safe food (93%) in the form of fresh vegetables and safer drinking water (73%). On the other hand, more than 90% of the vegetable and drinking water samples were not fit for consumption. Vegetables contained both pesticide and heavy metal residues while the water sample contained heavy metal contents which were way above the permissible limits.

Figure 9. Summary of the results

Conclusions: This study aimed to improve food security and safety policies in peri-urban areas. The results of this study, however, cannot be generalized to other areas (rural and urban areas) as the main focus was peri-urban areas in a regional setup. However, these results indicate some very important implications for future research and regional policy setup.

It is important for the future researchers to focus on:

- The comparative analysis of both peri-urban and rural vegetable production for pesticides and sewage water residues.
- As the peri-urban areas are the transitory territory between rural and urban areas, the land has multi-purpose uses. Furthermore, the land may be used for urban purposes in future. The futuristic analyses of peri-urban agriculture will be an important researchable issue.

For the regional policy makers and implementers, following suggestions are made:

- The sewage water must be treated before releasing into the main water streams. This can be achieved by involving all stakeholders i.e. sanitation agencies (government and semi-government e.g. WASA, hospitals and industries). Waste water treatment plant should be mandatory for industrial units and hospitals. Furthermore, the household waste and treated waste water from industries and hospitals must be treated at the main collection points of local at the local sanitation agencies i.e. WASA.
- A comprehensive media campaign must be launched through print and electronic media in order to increase awareness about the harmful effects of untreated waste water and non-judicial use of pesticides.

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REFERENCES

Ali, A., N. Akhtar, B.A. Khan, M.S. Khan, A. Rasul, S.U Zaman, N. Khalid, K. Waseem, T. Mahmood and L. Ali (2012). *Acacia nilotica*: A plant of multipurpose medicinal uses. J Med Pl Res, 6 (9): 1492-1496.

Akoto, O., D. Addo, E. Baidoo, E.A. Agyapong, J. Apau and B. Fei-Baffoe. 2015. Heavy metal accumulation in untreated wastewater-irrigated soil and lettuce (Lactuca sativa). Environmental Earth Sciences, 74: 6193-6198.

AOAC (2006). The official methods of analysis of AOAC International, 18th ed. The Association of Official Analytical Chemists, Arlington, USA.

Arora, M., B. Kiran, S. Rani, A. Rani, B. Kaur and N. Mittal (2008). Heavy metal accumulation in vegetables irrigated with water from different sources. F Chem, 111:811-815.

Ashraf, I., F. Shah, M. Luqman, Samiullah, M. Younis, I. Aziz and U. Farooq. 2013. Use of untreated wastewater for vegetable farming: A threat to food security. International J. Agriculture and Applied Sciences, 5(a): 27-33.

Asi, M.R (2005). Solid phase extraction and chromatographic determination of pesticides in food and water samples. Ph.D Thesis Institute of Chemistry, University of Punjab, Lahore.

Aziz, S (2007). Valuation of avoiding arsenic in drinking water in rural Bangladesh: An averting behavior analysis. PhD Thesis, The University of Maine, USA.

Baccio, D. D., S. Kopriva, L. Sebastiani and H. Rennenberg (2005). Does glutathione metabolism have a role in the defense of poplar against zinc excess? N Phyt, 167(3):73-80.

Baig, S.A., N.A. Akhter, M. Ashfaq, M.R. Asi 3and U. Ashfaq. 2012. Imidacloprid residues in vegetables, soil and water in the southern Punjab, Pakistan. J. Agricultural Technology, 8(3): 903-916.

Bashir, M.K. and S. Schilizzi (2013). Determinants of rural household food security a comparative analysis of Afircan and Asian Studies. J Sci F Agr, 93(6): 1251-1258.

Bempah, C. K., A. Buah-Kwofie, A.O. Tutu, D. Denutsui, E. Enimil, G. Adjei-Martey, B. Blewu and J. Asomaning. 2011. Pesticide residues and heavy metals levels in some selected fruits and vegetables from Ghanaian markets. Food Science, 39: 4964-4972.

Bhandari, G (2014). An Overview of Agrochemicals and their effects on environment in Nepal. Appl Ecol Env Sci, 2(2): 66-73.

Buechler, S., G.D. Mekala and B. Keraita. 2006. Wastewater Use for Urban and Peri-urban Agriculture (Chapter 9). In R. van Veenhuizen (ed.). 2006. Cities Farming for the Future; Urban Agriculture for Green and Productive Cities. RUAF Foundation, the Netherlands, IDRC, Canada and IIRR publishers, the Philippines.

Chandra, S., A.N. Mahindrakar and L.P. Shinde (2010). Determination of cypermethrin and chlorpyrifos in vegetables by GC-ECD. Int J Chemt Res, 2: 908-911.

Change, H.B., C.W. Lin and H.J. Huang (2005). Zinc-induced cell death in rice (Oryza sativa L.) roots. J Plant Growth Regul, 46(3): 261-266.

Chen, M., W. Liu and D. Lu (2016). Challenges and the way forward in China's new-type urbanization. Land Use Pol, 55: 334-339.

Colborn, T (1995). Environmental estrogens: health implications for humans and wildlife. Env Health Persp, 103(7): 135–136.

Devi, R., N. Munjral, A.K. Gupta and N. Kaur (2007). Cadmium induced changes in carbohydrate status and enzymes of carbohydrate metabolism, glycolysis and pentose phosphate pathway in pea. Environ Exp Bot, 61(2): 167-174.

Dias, J. S (2012). Nutritional quality and health benefits of vegetables: A review. Food Nutr Sci, 3: 1354-1374.

EC (2001). Setting maximum levels for certain contaminants in foodstuffs. COMMISSION REGULATION (EC) No 466/2001, Official J. The European Communities.

FAO (2002). Pesticide residues in food - 2002. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Core Assessment Group on Pesticide Residues Rome, Italy.

FAO (2015). The state of food insecurity in the world: meeting the international hunger targets - taking stock of uneven progress. Food and Agriculture Organization of the United Nations, Rome.

Farooqi, Z.R., M.Z. Iqbal M. Kabir and M. Shafiq (2009). Toxic effects of lead and cadmium on germination and seedling growth of albizia lebbeck Benth. Pak J Bot, 41(1): 27-33.

Fusconi, A., O. Repetto, E. Bona, N. Massa, C. Gallo, E. Dumas-Gaudot and G. Berta (2006). Effects of cadmium on meristem activity and nucleus ploidy in roots of Pisum sativum L. cv. Frisson seedlings. Environ Exp Bot, 58: 253-260.

GOP (1998). Population Census of Pakistan. Population Census Organization, Statistics Division, Government of Pakistan.

GOP (2014). Economic Survey of Pakistan, 2013-14. Ministry of Food and Agriculture. Finance Division, Economic Advisor's Wing, Islamabad, Pakistan.

GOP (2016). Economic survey of Pakistan 2015-16. Ministry of Finance, Government of Pakistan, Islamabad, Pakistan.

Haiyan, W. and A.O. Stuanes (2003). Heavy metal pollution in air, water, soil-plant system of Zhuzhou city, Hunan province, China. Water Air Soil Pollu, 147:79-107.

Halimatunsadiah, A.B., M. Norida, D. Omar and N.H. Kamarulzaman (2016). Application of pesticide in pest management: The case of lowland vegetable growers. Int Food Res J, 23(1): 85-94.

Haq, R (2011). Urbanization in Pakistan Highest in South Asia. Haq's Musings, Saturday, September 12, 2009. Online Available at: http://www.riazhaq.com/2009/09/urbanization-in-pakistan-highest-in.html accessed on 23/07/2017.

HSE (2016). Maximum residual level database. Health and Safety Executive, UK. Online available at https://secure.pesticides.gov.uk/MRLs/main.asp. Accessed on 18/02/2017.

Iaquinta, D.I. and A. W. Drescher. 1999. Defining the peri-urban: rural-urban linkages and institutional connections. Rome: UN Food and Agriculture Organization online available at http://www.fao.org/DOCREP/003/X8050T/x8050t02.htm#P13_2357 accessed on 05/07/2018

Iqbal, M. Z. and Y. Shazia (2004). Reduction of germination and seedling growth of Leucaena leucocephala caused by lead and cadmium individually and combination. Ekologia (Braslava), 23: 162-168.

Jin, X., X. Yang, E. Islam, D. Liu and Q. Mahmood (2008). Effects of cadmium on ultrastructure and antioxidative defense system in hyperaccumulator and non Hyper-accumulator ecotypes of Sedum alfredii Hance. J Hazard Mater, 156(1-3): 387-397.

Kadenezki, L., Z. Arpad, I. Garth, A. Ambrus, L. Gyorfi, G. Reese and W. Ebing (1992). Column extraction of residues of several pesticides from fruits and vegetables; a simple multi residue analysis method. J AOAC Intern, 75:53-61.

Kausar, S., K. Asghar, S.M. Anwar, F. Shaukat and R. Kausar (2011). Factors affecting drinking water quality and human healthat household level in Punjab, Pakistan. Pak J Life Soc Sci, 9(1):33-37.

Khan, B.A., A. Farid, M.R. Asi, H. Shah and A.K. Badshah (2009). Determination of residues of trochlorofon and dimethoate on guava using HPLC. Food Chem, 114: 286-288.

Khan, A., S. Javid, A. Muhmood, T. Majeed, A. Niaz and A. Majeed (2013). Heavy metal status of soil and vegetables grown on peri-urban area of Lahore district. Soil Environ, 32(1): 49-54.

Khan, S., Q. Cao, Y.M. Zheng, Y.Z. Huang and Y.G. Zhu (2008). Health risks of heavy metals in contaminated soils and food crops irrigated with wastewater in Beijing, China. Environ. Pollu. 152:686-692.

Kirezieva, K., P.A. Luning, L. Jacxsens, A. Allende, G.S. Johannesses, E.C. Tondo, A. Rajkovic, M. Uyttendaele and A.J.S. van Martinus (2015). Factors affecting the status of food safety management systems in the global fresh produce chain. Food Control, 52: 85-97.

Koutsoumanis, K.P., A. Lianou and J.N. Sofos (2014). Food Safety: Emerging Pathogens**.** Reference Module in Food Science, Encyclopedia of Agriculture and Food Systems**:** 250–272.

Kumari, B., V.K. Madan, J. Singh, S. Singh and T.S. Kathpal (2004) Monitoring of pesticidal contamination of farmgate vegetables from Hisar. Environ. Monit. Assess, 90: 65-71.

Losio, M.N., E. Pavoni, S. Bilei, B. Bertasi, D. Bove, F. Capuano, S. Farneti, G. Blasi, D. Comin, C. Cardamone, L. Decastelli, E. Delibato, P.D. Santis, S.D. Pasquale, A. Gattuso, E. Goffredo, A. Fadda, M. Pisanu and D.D. Medici (2015). Microbiological survey of raw and ready-to-eat leafy green vegetables marketed in Italy. Int J Food Micr, 210: 88-91.

Lund, B.M. and S.J. O'Brien (2011). The Occurrence and Prevention of Foodborne Disease in Vulnerable People. Foodborne Path Dis, 8(9): 961–973.

Lund, B.M (2015). Microbiological Food Safety for Vulnerable People. Int J Env Res Publ Health, 12: 10117-10132.

MacFarlane, G.R. and M.D. Burchett (2002). Toxicity, growth and accumulation relationships of copper, lead and zinc in the grey mangrove Avicennia marina (Forsk.) Vierh. Marine Environ Res, 54(1): 65-84.

Mahmoud, E.K. and A.M. Ghoneim. 2016. Effect of polluted water on soil and plant contamination by heavy metals in El-Mahla El-Kobra, Egypt. Solid Earth, 7: 703–711.

Mapanda, F., E. Mangwayana, J. Nyamangara and K.E. Giller (2007). Uptake of heavy metals by vegetables irrigated using waste water and the subsequent risks in Harare, Zimbabwe. Phys Chem Earth, 32:1399-1405.

Marschner, H (1995). Mineral Nutrition of Higher Plants, second Ed. Academic Press, San Diego, USA.

Nedjimi, B. and Y. Daoud (2009). Cadmium accumulation in Atriplex halimus subsp. schweinfurthii and its influence on growth, proline, root hydraulic conductivity and nutrient uptake. Flora, 204: 316-324.

Omari, R. and G. Frempong (2015). Food safety concerns of fast food consumers in urban Ghana. Appetite, 98: 49-54.

Optiz, I., R. Berges, A. Piorr and T. Krikser. 2016. Contributing to food security in urban areas: differences between urban agriculture and peri-urban agriculture in the Global North. Agriculture and Human Values, 33: 341-358

Parveen, Z., M.I. Khuhro and N. Rafiq (2003). Market basket survey for lead, cadmium, copper, chromium, nickel, and zinc in fruits and vegetables. Bull Environ Cont Toxicol, 71: 1260–1264.

Porter, W.P., J.W. Jaeger and I.H. Carlson (1999). Endocrine, immune and behavioral effects of aldicarb (carbamate), atrazine (triazine) and nitrate (fertilizer) mixtures at groundwater concentrations. Toxicol Industr Health, 15:133-150.

Radwan, M.A. and A.K. Salama (2006). Market basket survey for some heavy metals in Egyptian fruits and vegetables. Food Chem Toxicol, 44:1273-1278.

Randhawa, M.A., F.M. Anjum, A. Ahmed and M.S. Randhawa (2007). Field incurred chlorpyrifos and 3,5,6-trichloro-2-pyridinol residues in fresh and processed vegetables. Food Chem, 103:1016-1023.

Saal, V.F.S., B.G. Timms, M.M. Montano, P. Palanza, K.A. Thayer, S.C. Nagel, M.D. Dhar, V.K. Ganjam, S. Parmigiani and W.V. Welshons (1997). Prostate enlargement in mice due to fetal exposure to low doses of estradiol or diethylstilbestrol and opposite effects at high doses. Proc Nat Acad Sci, 94:2056-2061

Saleem, M.A., M. Ahmad, M. Ahmad, M. Aslam and A.H. Sayyed. 2008. Resistance to selected organochlorin, organophosphate, carbamate and pyrethroid, in Spodoptera litura (Lepidoptera: Noctuidae) from Pakistan. J. Economic Entomology, 101(5): 1667-1375.

Sarantakos, S (2005). Social Research. Palgrave Macmillan, London, UK.

SDPI (2003). Food insecurity in rural Pakistan - 2003. World Food Programme (WFP), Pakistan. Online at http://www.sdpi.org/publications/files/Food%20 Insecurity%20 in%20 Rural%20 Pakistan%20 2003.pdf accessed on 19/02/2017.

SDPI (2009). Food insecurity in Pakistan. World Food Programme (WFP), Pakistan. Online available at http://documents.wfp.org/stellent/groups/public/documents/ena/wfp225636.pdf accessed on 19/02/2017.

Shah, Q.A. and H. Abbas (2015). Livelihoods and access to services: An analysis of peri-urban areas of Lahore, Pakistan. Working paper number 148, Sustainable Development Policy Institute, Islamabad, Pakistan.

Sharma. K., A.D. Assefa, S. Kim and E.T. Lee (2014). Evaluation of total phenolics, flavonoids and antioxidant activity of 18 Korean onion cultivars: a comparative study. J Sci Food Agric, 94:1521-1529.

Snelder, D.J., M.D. Masipiquen and G.R. Snoode (2008). Risk assessment of pesticide usage by smallholder farmers in the Cagayan Valley (Philippines). Crop Protection, 27(3):747-762.

UNICEF (2012). Definitions. The United Nations Children's Fund, New York, USA. Online available at https://www.unicef.org/sowc2012/pdfs/SOWC-2012-DEFINITIONS.pdf accessed on 05/07/2018.

Unnevehr, L.J (2003). Food safety in food security and food trade. 2020 Vision for Food, Agriculture and Environment, International Food Policy Research Institute, Washington, DC. USA.

Wong, C.S.C., X.D. Li, G. Zhang, S.H. Qi and X.Z. Peng (2003). Atmospheric depositions of heavy metals in the Pearl River Delta, China. Atm Environ. 37:767-776.

Yapp, C. and R. Fairman (2006). Factors affecting food safety compliance within small and medium-sized enterprises: implications for regulatory and enforcement strategies. Food Control, 17: 42–51.

Yuan, Y., C. Chenb, C. Zhengb, X. Wanga, G. Yanga, Q. Wanga and Z. Zhanga (2014).. Residue of chlorpyrifos and cypermethrin in vegetables and probabilistic exposure assessment for consumers in Zhejiang Province, China. Food Control, 36(1): 63–68

Yusuf, A.A., T.A. Arowolo and O. Bamgbose (2003). Cadmium, copper and nickel levels in vegetables from industrial and residential areas of Lagos City, Nigeria. Food ChemToxicol, 41: 375-378.

Zaidi, M.I., A. Asrar, A. Mansoor and M.A. Farooqi. 2005. The heavy metal concentrations along roadside trees of Quetta and its effects on public health. J. Applied Sciences, 5(4): 708-711.

Zia, A (2013). 80% of diseases are waterborne. The Express Tribune, Lahore, Pakistan. Online available at http://tribune.com.pk/ story/ 524428/80-of-diseases-are-waterborne/ accessed on 20/02/2017.