ONOMY Science

International Journal of Nutritional Health & Food Safety

Short Communication Open Access

# Domination of Pollutant Residues Among Food Products of South-East Asian Countries

**Abdul Kader Mohiuddin**

Department of Pharmacy, World University of Bangladesh, 151/8, Green Road, Dhanmondi, Dhaka – 1205, Bangladesh

***Corresponding Author:** Abdul Kader Mohiuddin, Assistant Professor, Department of Pharmacy, World University of Bangladesh, 151/8, Green Road, Dhanmondi, Dhaka – 1205, Bangladesh, E-mail: mohiuddin3@pharmacy.wub.edu.bd; Ph no: +8801716477485; Orcid Id: 0000-0003-1596-9757

**Citation:** Mohiuddin AK, Domination of Pollutant Residues Among Food Products of South-East Asian Countries. Inte J Nutri Heal & Fo Saf. 2019; 1(2): 001-005.

**Submitted:** 07 August 2019; **Approved:** 11 August 2019; **Published:** 12 August 2019

## Abstract

Southeast Asia is a region that produces high amounts of key food commodities and includes areas of divergent socio-economic status. Food security is a high-priority issue for sustainable global development both quantitatively and qualitatively. In recent decades, adverse effects of unexpected contaminants on crop quality have threatened both food security and human health. Public concern about the adverse environmental and human health impacts of organochlorine contaminants led to strict regulations on their use in developed nations two decades ago. Nevertheless, DDT and several other organochlorine insecticides are still being used for agriculture and public health programs in developing countries in Asia and the South Pacific. As a consequence, humans in this region are exposed to greater dietary levels of organochlorines. Heavy metals and metalloids (e.g., Hg, As, Pb, Cd, and Cr) can jeopardize human metabolomics, contributing to morbidity and even mortality. Those during crop production include soil nutrient depletion, water depletion, soil and water contamination, and pest resistance/outbreaks and the emergence of new pests and diseases.

**Keywords:** Pesticides; Cancer; Organochlorine Insecticides; Heavy Metal Poisoning; Fertilizers; Food-Processing Operations

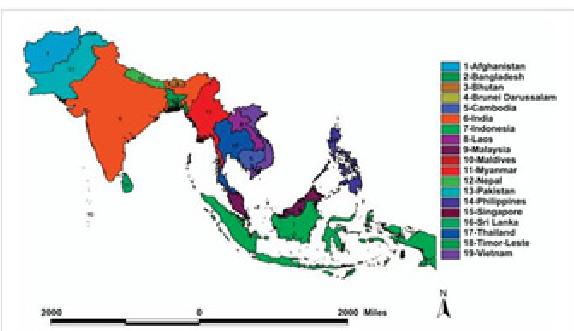


**Figure:** South/Southeast Asian countries (Modified from asiasociety.org)

Growth in global population means that farmers must produce food for an estimated 9.1 billion people expected to inhabit the earth by 2050 [1]. Globally, there are over 50,000 edible plants. Just three of these (rice, maize and wheat) provide about 60% of the world's food energy intake [2]. The countries of South and Southeast Asia span an area of about 9.75 million km2 and have a population of 2.4 billion. According to Sabir et.al, 2017 they represent almost 30.66% of the world's population in only 6.57% of the world's land area [3]. According to World Bank, South Asian countries are home to home to 33% of the world's poor and economies have among the highest levels of public debt in the world [4]. Mean consumption of whole grains was 38.4 g/day in between 1990 to 2010. Southeast Asian nations along with 2/3 Sub-Saharan African regions had the highest intakes. Overall, 23 of 187 countries had mean whole grain intake ≥2.5 (50 g) servings/day, representing 335 million adults and 7.6% of the world adult population [5]. Southeast Asia is a region that produces high amounts of key food commodities and includes areas of divergent socio-economic status. The major grain crops produced in the region are rice and maize [6]. The potential sources for the contamination of grains are mostly environmentally based and include air, dust, soil, water, insects, rodents, birds, animals, microbes, humans, storage and shipping containers, and handling and processing equipment [7]. Contamination by chemicals from the environment include metals/metalloids, polycyclic aromatic hydrocarbons (PAHs), persistent organic pollutants (POPs), per-fluorinated compounds (PFCs), pharmaceutical and personal care products (PPCPs), radioactive elements, electronic waste, plastics, and nanoparticles [8]. At same time, agricultural land has been used for estate or factory development resulting in pollution of the land and water [9]. In managed ecosystems such as those in cultivation for food crops, on the other hand, conditions are often manipulated to maximize crop yields through irrigation and fertilization [10]. Research has clearly identified environmental harm from the presence of micro-pollutants in soils, groundwater and surface water. Surface water was found to be more contaminated than ground water with a greater number of and more concentrated pesticides (organochlorines and organophosphates) [11]. Plants are the world's major source of food. These plants are susceptible to 80,000 to 100,000 diseases caused by everything from viruses to bacteria, fungi, algae, and even other higher plants [12]. Humans cultivate only about 150 of an estimated 30,000 edible plant species worldwide, with only 30 plant species comprising the vast majority of our diets [13]. Again, Food plants have to compete with some 30,000 different species of weeds worldwide, of which at least 1800 species are capable of causing serious economic losses [14]. Globally, around 20–30% of agricultural produce is lost annually due to insect pests, diseases, weeds and rodents, viz, growth, harvest, and storage [15,16]. The rates of destruction often are higher in less developed nations and they are now accounting for a quarter of the world's pesticide use [14], [16]. Therefore, judicious use of pesticides plays a major role in plant protection. Farmers habitually apply fertilizers and hazardous insecticides in high quantities without assessing the actual field requirements due to inadequate knowledge [1], [15], [17]. Since pesticides are directly applied on crops, fruits, and vegetables in most agricultural applications, infants, children, and adults can be exposed to pesticides by the ingestion of those pesticide-contaminated foods [18-22]. Pesticides can exist in residential air by the evaporation of volatile and semi-volatile pesticides, such as organochlorine pesticides, from crops and residential surface soil [23-26]. Soil is an important source for heavy metals (like mercury/cadmium) in crops and vegetables since the plants' roots can absorb these pollutants from soil, and transfer them to seeds [27,28]. According Retamal-Salgado et.al, 2017 cadmium (Cd) distribution in the different plant organs, more than 40% of Cd is absorbed and translocated to the aerial part of the plant (grain and straw), and it could be directly (grains) or indirectly (animals) ingested and negatively affect humans [29]. It accumulates in the liver and kidneys for more than 30 years and causes health problems. Toxicity of this metal involves kidney and skeletal organs and is largely the result of interactions between Cd and essential metals, such as calcium [30-34]. Hassan et.al, 2017 says increased prevalence of diabetes in South Asia may be related to the consumption of arsenic contaminated rice depending on its content in the rice and daily amount consumed [35]. Sabir et.al, 2019 demonstarted that arsenite can bind covalently with sulfhydryl groups in insulin molecules and receptors, enzymes such as pyruvate dehydrogenase and alpha keto-glutarate dehydrogenase, and glucose transporters (GLU-T), which may result in insulin resistance [36]. According to Kumar et.al, 2017 50%-60% cereal grains can be lost during the storage stage due only to the lack of technical inefficiency. Use of scientific storage methods can reduce these losses to as low as 1%-2% [37]. Factors like increasing climatic variability, extreme weather events, and rising temperatures pose new challenges for ensuring food and nutrition security in Asian region. The South Asian region is one of the least integrated regions according to Washington based-International Food Policy Research Institute (IFPRI) [38]. China feeds 22% of the world population with 7% of the worlds arable land. Sodango et.al, 2018 reported that 20 million hectares (approximately 16.1%) of the total arable land in China is highly polluted with heavy metals, according to Ministry of Environmental Protection (MEP), China [39]. It is estimated that between 900,000 and 1,360,000 kg arsenic per year was introduced into Bangladesh soil through contaminated groundwater used for irrigation [40]. Pajewska-Szmyt et.al, 2019 reported that maternal exposure to heavy metals as Pb or Hg and persistent organic pollutants were associated with children neurodevelopment delay and also indirectly affects reproductive, respiratory, and endocrine system [41]. The US Centre for Disease Control and Prevention confirmed more than 11,000 foodborne infections in the year 2013, with several agents like viruses, bacteria, toxins, parasites, metals, and other chemicals causing food contamination [42]. Widespread agricultural use of pesticides and home storage make them easily available for acts of self-harm in many rural households. Stability of organophosphorus pesticides are also important issue [43]. It was found that malathion was more unstable than dichlorvos and diazinon, there was an over 70% loss in 90 days even at -20 °C in coarsely chopped form

[44]. It could be another reason for haphazard use of pesticides in the field and stored food commodities [45]. Around 600 million food borne illnesses and 420,000 deaths occur each year due to poor food handling practice. Such contaminants get access to contaminate food mainly due to food handler's poor knowledge and negligence during handling activities [46,47]]. The washing with water or soaking in solutions of salt and some chemicals e.g. chlorine, chlorine dioxide, hydrogen peroxide, ozone, acetic acid, hydroxy peracetic acid, iprodione and detergents are reported to be highly effective in reducing the level of pesticides [48]. Various food-processing operations include sorting, trimming, cleaning, cooking, baking, frying, roasting, flaking, and extrusion that have variable effects on mycotoxins [49]. Cooking rice in excess water efficiently reduces the amount of arsenic (As) in the cooked grain [50].


## Acknowledgement

I'm thankful to Dr. Hui Key Lee, Institute of Biological Sciences, Faculty of Science, University of Malaya, Kuala Lumpur, Malaysia for his precious time to review my letter to the editor and for his thoughtful suggestions. I'm also grateful to seminar library of Faculty of Pharmacy, University of Dhaka and BANSDOC Library, Bangladesh for providing me books, journal and newsletters.


## Abbreviations

Polycyclic Aromatic Hydrocarbons (PAHs); Persistent Organic Pollutants (POPs); Per-Fluorinated Compounds (PFCs); Pharmaceutical and Personal Care Products (PPCPs); International Food Policy Research Institute (IFPRI); Ministry of Environmental Protection (MEP)


**Financial Disclosure or Funding:** N/A

**Conflict of Interest:** The author declares that he has no competing interests.

**Informed Consent:** N/A

**Author contributions:** N/A


## References


1. Rahaman MM, Islam KS, Jahan M. Rice Farmers' Knowledge of the Risks of Pesticide Use in Bangladesh. J Health Pollut. 2018 Dec 6;8(20):181203. doi: 10.5696/2156-9614-8.20.181203. eCollection 2018 Dec. PubMed PMID: 30560002; PubMed Central PMCID: PMC6285676.
2. Thielecke F, Nugent AP. Contaminants in Grain-A Major Risk for Whole Grain Safety? Nutrients. 2018 Sep 2;10(9). pii: E1213. doi: 10.3390/nu10091213. Review. PubMed PMID: 30200531; PubMed Central PMCID: PMC6163171.
3. Sabir S, Akash MSH, Fiayyaz F, Saleem U, Mehmood MH, Rehman K. Role of cadmium and arsenic as endocrine disruptors in the metabolism of carbohydrates: Inserting the association into perspectives. Biomed Pharmacother. 2019 Jun;114:108802. doi: 10.1016/j.biopha.2019.108802. Epub 2019 Mar 25. Review. PubMed PMID: 30921704.
4. Schafer H. South Asia: A bright spot in darkening economic skies? Wirld Bank Blog (End Poverty in South Asia), January 09, 2019.
5. Micha R, Khatibzadeh S, Shi P, Andrews KG, Engell RE, Mozaffarian D; Global Burden of Diseases Nutrition and Chronic Diseases Expert Group (NutriCoDE). Global, regional and national consumption of major food groups in 1990 and 2010: a systematic analysis including 266 country-specific nutrition surveys worldwide. BMJ Open. 2015 Sep 24;5(9):e008705. doi: 10.1136/bmjopen-2015-008705. PubMed PMID: 26408285; PubMed Central PMCID: PMC4593162.
6. Brownlee IA, Durukan E, Masset G, Hopkins S, Tee ES. An Overview of Whole Grain Regulations, Recommendations and Research across Southeast Asia. Nutrients. 2018 Jun 11;10(6). pii: E752. doi: 10.3390/nu10060752. Review. PubMed PMID: 29891782; PubMed Central PMCID: PMC6024883.
7. Brar PK, Danyluk MD. Nuts and Grains: Microbiology and Preharvest Contamination Risks. Microbiol Spectr. 2018 Apr;6(2). doi: 10.1128/microbiolspec.PFS-0023-2018. Review. PubMed PMID: 29701166.
8. Thompson LA, Darwish WS. Environmental Chemical Contaminants in Food: Review of a Global Problem. J Toxicol. 2019 Jan 1;2019:2345283. doi: 10.1155/2019/2345283. eCollection 2019. Review. PubMed PMID: 30693025; PubMed Central PMCID: PMC6332928.
9. Yu T, Sun W. Who Will Feed the Giant? - Chinese Pollution and Grain Crisis. Iran J Public Health. 2015 Oct;44(10):1420-1. PubMed PMID: 26576357; PubMed Central PMCID: PMC4644589.
10. Tie X, Huang RJ, Dai W, Cao J, Long X, Su X, Zhao S, Wang Q, Li G. Effect of heavy haze and aerosol pollution on rice and wheat productions in China. Sci Rep. 2016 Jul 8;6:29612. doi: 10.1038/srep29612. PubMed PMID: 27388031; PubMed Central PMCID: PMC4937395.
11. Lari SZ, Khan NA, Gandhi KN, Meshram TS, Thacker NP. Comparison of pesticide residues in surface water and ground water of agriculture intensive areas. J Environ Health Sci Eng. 2014 Jan 7;12(1):11. doi: 10.1186/2052-336X-12-11. PubMed PMID: 24398360; PubMed Central PMCID: PMC3895686.
12. Northcoast Horticulture Supply. PureAG Pest Control Concentrate 8oz. Available From: https://nhs-hydroponics.com/pureag-pest-control-concentrate-8oz/
13. Shelef O, Weisberg PJ, Provenza FD. The Value of Native Plants and Local Production in an Era of Global Agriculture. Front Plant Sci. 2017 Dec 5;8:2069. doi: 10.3389/fpls.2017.02069. eCollection 2017. Review. PubMed PMID: 29259614; PubMed Central PMCID: PMC5723411.
14. Robson MG, DerMarderosian AH. Chapter 19. Pesticides. In: Loyd V. Allen Jr (Editor). Remington: The Science and Practice of Pharmacy (2 Volumes) 22nd Revised edition. Publisher: Pharmaceutical Press; 22nd Revised edition (September 3, 2012). ISBN: 0857110624, 978-0857110626.
15. Rahaman MM, Islam KS, Jahan M. Rice Farmers' Knowledge of the Risks of Pesticide Use in Bangladesh. J Health Pollut. 2018 Dec 6;8(20):181203. doi: 10.5696/2156-9614-8.20.181203. eCollection 2018 Dec. PubMed PMID: 30560002; PubMed Central PMCID: PMC6285676.
16. Food and Agriculture Organization of the UN (FAO). Controlling pests. Available From: http://www.fao.org/3/u8480e/U8480E0j.htm
17. Franklin N. Mabe, Kwadwo Talabi, and Gideon Danso-Abbeam, "Awareness of Health Implications of Agrochemical Use: Effects on Maize Production in Ejura-Sekyedumase Municipality, Ghana," Advances in Agriculture, vol. 2017, Article ID 7960964, 11 pages, 2017. https://doi.org/10.1155/2017/7960964.
18. Roberts JR, Karr CJ; Council On Environmental Health. Pesticide exposure in children. Pediatrics. 2012 Dec;130(6):e1765-88. doi: 10.1542/peds.2012-2758. Epub 2012 Nov 26. Erratum in: Pediatrics. 2013 May;131(5):1013-4.

PubMed PMID: 23184105; PubMed Central PMCID: PMC5813803.
19. National Research Council (US) Committee on Pesticides in the Diets of Infants and Children. Pesticides in the Diets of Infants and Children. Washington (DC): National Academies Press (US); 1993. 7, Estimating Exposures. Available from: https://www.ncbi.nlm.nih.gov/books/NBK236273/
20. Nicolopoulou-Stamati P, Maipas S, Kotampasi C, Stamatis P, Hens L. Chemical Pesticides and Human Health: The Urgent Need for a New Concept in Agriculture. Front Public Health. 2016 Jul 18;4:148. doi: 10.3389/fpubh.2016.00148. eCollection 2016. Review. PubMed PMID: 27486573; PubMed Central PMCID: PMC4947579.
21. UNISEF. Understanding the Impacts of Pesticides on Children: A discussion paper, January, 2018. Available From: https://www.unicef.org/csr/files/Understanding_the_impact_of_pesticides_on_children-_Jan_2018.pdf
22. Centers for Ecogenetics & Environmental Health. Fast Facts about Health Risks of Pesticides in Food. Available From: https://depts.washington.edu/ceeh/downloads/FF_Pesticides.pdf
23. Li Z, Jennings A. Worldwide Regulations of Standard Values of Pesticides for Human Health Risk Control: A Review. Int J Environ Res Public Health. 2017 Jul 22;14(7). pii: E826. doi: 10.3390/ijerph14070826. Review. PubMed PMID: 28737697; PubMed Central PMCID: PMC5551264.
24. Waliszewski SM, Carvajal O, Gómez-Arroyo S, Amador-Muñoz O, Villalobos-Pietrini R, Hayward-Jones PM, Valencia-Quintana R. DDT and HCH isomer levels in soils, carrot root and carrot leaf samples. Bull Environ Contam Toxicol. 2008 Oct;81(4):343-7. doi: 10.1007/s00128-008-9484-8. Epub 2008 Jul 15. PubMed PMID: 18626561.
25. Batterman SA, Chernyak SM, Gounden Y, Matooane M, Naidoo RN. Organochlorine pesticides in ambient air in Durban, South Africa. Sci Total Environ. 2008 Jul 1;397(1-3):119-30. doi: 10.1016/j.scitotenv.2008.02.033. Epub 2008 Apr 8. PubMed PMID: 18396319.
26. Mai C, Theobald N, Hühnerfuss H, Lammel G. Persistent organochlorine pesticides and polychlorinated biphenyls in air of the North Sea region and air-sea exchange. Environ Sci Pollut Res Int. 2016 Dec;23(23):23648-23661. Epub 2016 Sep 12. PubMed PMID: 27617333; PubMed Central PMCID: PMC5110590.
27. Zhang X, Zhong T, Liu L, Ouyang X. Impact of Soil Heavy Metal Pollution on Food Safety in China. PLoS One. 2015 Aug 7;10(8):e0135182. doi: 10.1371/journal.pone.0135182. eCollection 2015. PubMed PMID: 26252956; PubMed Central PMCID: PMC4529268.
28. Li R, Wu H, Ding J, Fu W, Gan L, Li Y. Mercury pollution in vegetables, grains and soils from areas surrounding coal-fired power plants. Sci Rep. 2017 May 9;7:46545. doi: 10.1038/srep46545. PubMed PMID: 28484233; PubMed Central PMCID: PMC5422849.
29. Retamal-Salgado J, Hirzel J, Walter I, Matus I. Bioabsorption and Bioaccumulation of Cadmium in the Straw and Grain of Maize (Zea mays L.) in Growing Soils Contaminated with Cadmium in Different Environment. Int J Environ Res Public Health. 2017 Nov 16;14(11). pii: E1399. doi: 10.3390/ijerph14111399. PubMed PMID: 29144431; PubMed Central PMCID: PMC5708038.
30. Rodríguez J, Mandalunis PM. A Review of Metal Exposure and Its Effects on Bone Health. J Toxicol. 2018 Dec 23;2018:4854152. doi: 10.1155/2018/4854152. eCollection 2018. Review. PubMed PMID: 30675155; PubMed Central PMCID: PMC6323513.
31. Liu Y, Xiao T, Baveye PC, Zhu J, Ning Z, Li H. Potential health risk in areas with high naturally-occurring cadmium background in southwestern China. Ecotoxicol Environ Saf. 2015 Feb;112:122-31. doi: 10.1016/j.ecoenv.2014.10.022. Epub 2014 Nov 14. PubMed PMID: 25463862.
32. Chang YF, Wen JF, Cai JF, Xiao-Ying W, Yang L, Guo YD. An investigation and pathological analysis of two fatal cases of cadmium poisoning. Forensic Sci Int. 2012 Jul 10;220(1-3):e5-8. doi: 10.1016/j.forsciint.2012.01.032. Epub 2012 Feb 19. PubMed PMID: 22349354.
33. Jaishankar M, Tseten T, Anbalagan N, Mathew BB, Beeregowda KN. Toxicity, mechanism and health effects of some heavy metals. Interdiscip Toxicol. 2014 Jun;7(2):60-72. doi: 10.2478/intox-2014-0009. Epub 2014 Nov 15. Review. PubMed PMID: 26109881; PubMed Central PMCID: PMC4427717.
34. Jan AT, Azam M, Siddiqui K, Ali A, Choi I, Haq QM. Heavy Metals and Human Health: Mechanistic Insight into Toxicity and Counter Defense System of Antioxidants. Int J Mol Sci. 2015 Dec 10;16(12):29592-630. doi: 10.3390/ijms161226183. Review. PubMed PMID: 26690422; PubMed Central PMCID: PMC4691126.
35. Hassan FI, Niaz K, Khan F, Maqbool F, Abdollahi M. The relation between rice consumption, arsenic contamination, and prevalence of diabetes in South Asia. EXCLI J. 2017 Oct 9;16:1132-1143. doi: 10.17179/excli2017-222. eCollection 2017. Review. PubMed PMID: 29285009; PubMed Central PMCID: PMC5735331.
36. Sabir S, Akash MSH, Fiayyaz F, Saleem U, Mehmood MH, Rehman K. Role of cadmium and arsenic as endocrine disruptors in the metabolism of carbohydrates: Inserting the association into perspectives. Biomed Pharmacother. 2019 Jun;114:108802. doi: 10.1016/j.biopha.2019.108802. Epub 2019 Mar 25. Review. PubMed PMID: 30921704.
37. Kumar D, Kalita P. Reducing Postharvest Losses during Storage of Grain Crops to Strengthen Food Security in Developing Countries. Foods. 2017 Jan 15;6(1). pii: E8. doi: 10.3390/foods6010008. Review. PubMed PMID: 28231087; PubMed Central PMCID: PMC5296677.
38. Khaled MS. Food systems at a crossroads in South Asia. The Financial Express, May 15, 2018.
39. Sodango TH, Li X, Sha J, Bao Z. Review of the Spatial Distribution, Source and Extent of Heavy Metal Pollution of Soil in China: Impacts and Mitigation Approaches. J Health Pollut. 2018 Mar 12;8(17):53-70. doi: 10.5696/2156-9614-8.17.53. eCollection 2018 Mar. Review. PubMed PMID: 30524849; PubMed Central PMCID: PMC6221442.
40. McCarty KM, Hanh HT, Kim KW. Arsenic geochemistry and human health in South East Asia. Rev Environ Health. 2011;26(1):71-8. PubMed PMID: 21714384; PubMed Central PMCID: PMC3128386.
41. Pajewska-Szmyt M, Sinkiewicz-Darol E, Gadzała-Kopciuch R. The impact of environmental pollution on the quality of mother's milk. Environ Sci Pollut Res Int. 2019 Mar;26(8):7405-7427. doi: 10.1007/s11356-019-04141-1. Epub 2019 Jan 28. PubMed PMID: 30687894; PubMed Central PMCID: PMC6447517.
42. Rather IA, Koh WY, Paek WK, Lim J. The Sources of Chemical Contaminants in Food and Their Health Implications. Front Pharmacol. 2017 Nov 17;8:830. doi: 10.3389/fphar.2017.00830. eCollection 2017. Review. PubMed PMID: 29204118; PubMed Central PMCID: PMC5699236.
43. Guo G, Jiang N, Liu F, Bian Y. Storage stability of organophosphorus pesticide residues in peanut and soya bean extracted solutions. R Soc Open Sci. 2018 Jul 25;5(7):180757. doi: 10.1098/rsos.180757. eCollection 2018 Jul. PubMed PMID: 30109115; PubMed Central PMCID: PMC6083714.
44. Bian Y, Liu F, Chen F, Sun P. Storage stability of three organophosphorus pesticides on cucumber samples for analysis. Food Chem. 2018 Jun 1;250:230-235. doi: 10.1016/j.food

chem.2018.01.008. Epub 2018 Jan 2. PubMed PMID: 29412916.
45. Thapa K, Pant BR. Pesticides in vegetable and food commodities: environment and public health concern. J Nepal Health Res Counc. 2014 Sep-Oct;12(28):208-10. PubMed PMID: 26032063.
46. Chekol FA, Melak MF, Belew AK, Zeleke EG. Food handling practice and associated factors among food handlers in public food establishments, Northwest Ethiopia. BMC Res Notes. 2019 Jan 14;12(1):20. doi: 10.1186/s13104-019-4047-0. PubMed PMID: 30642374; PubMed Central PMCID: PMC6332519.
47. Tegegne HA, Phyo HWW. Food safety knowledge, attitude and practices of meat handler in abattoir and retail meat shops of Jigjiga Town, Ethiopia. J Prev Med Hyg. 2017 Dec 30;58(4):E320-E327. doi: 10.15167/2421-4248/jpmh2017.58.4.737. eCollection 2017 Dec. PubMed PMID: 29707664; PubMed Central PMCID: PMC5912786.
48. Bajwa U, Sandhu KS. Effect of handling and processing on pesticide residues in food- a review. J Food Sci Technol. 2014 Feb;51(2):201-20. doi: 10.1007/s13197-011-0499-5. Epub 2011 Aug 26. Review. PubMed PMID: 24493878; PubMed Central PMCID: PMC3907644.
49. Kaushik G. Effect of processing on mycotoxin content in grains. Crit Rev Food Sci Nutr. 2015;55(12):1672-83. doi: 10.1080/10408398.2012.701254. Review. PubMed PMID: 24915313.
50. Gray PJ, Conklin SD, Todorov TI, Kasko SM. Cooking rice in excess water reduces both arsenic and enriched vitamins in the cooked grain. Food Addit Contam Part A Chem Anal Control Expo Risk Assess. 2016;33(1):78-85. doi: 10.1080/19440049.2015.1103906. Epub 2015 Nov 2. PubMed PMID: 26515534

***Cite this article:*** Mohiuddin AK, Domination of Pollutant Residues Among Food Products of South-East Asian Countries. Inte J Nutri Heal & Fo Saf. 2019; 1(2): 001-005.