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Short Communication

Chemical Residues in Food Grains: The Burning Health Issues in Asian Countries

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Abstract

Providing food to more than seven billion people living on the planet is among the key challenges for today's world and one of the Millennium Development Goals. The most problematic food situation continues to affect Sub-Saharan Africa and Central Asia. Food security is a high-priority issue for sustainable global development both quantitatively and qualitatively. Once pesticides are applied, residues may be found in soil, on plant, on harvested product, on application equipment, in water and irrigation canals, in pesticide storage area, on cloth of applicant. Short term poisoning effects like nausea, vomiting, headache, chest pain, eye, skin and throat irritation etc. and potential long-term health effect like allergies, cancer, nervous system damage, birth defects, reproductive problem have been reported in recent decades, adverse effects of unexpected contaminants on crop quality have threatened both food security and human health. Heavy metals, metalloids (e.g., Hg, As, Pb, Cd, and Cr) from pesticides and fertilizers 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. The current literature emphasizes evidence for human health risks of agricultural intensification in Asian countries.

Keywords: Cancer; Fertilizers; Food-processing operations; Heavy metal poisoning; Organochlorine insecticides; Pesticides

Abbreviations

Ministry of Environmental Protection (MEP); Dichloro-diphenyl-trichloroethane (DDT); Brown Planthopper (BPH); White-Backed Planthoppers (WBPH); International Food Policy Research Institute (IFPRI); Glucose Transporters (GLU-T)

Purpose of the Study

Discussion and projection of practical issues of chemical contamination in food products of Asian countries obtained from agriculture source (Figure 1).

Findings

Developed or under developed country, aberrant use of chemical fertilizers and pesticides have been reported with their possible health effect to both farmers and end users. It would be very difficult to introduce newer safe and effective alternatives to root level but it's a crying necessity for sure.

Practical Implication

Along with agricultural researchers, policy makers, public representatives, and regulatory authorities have to acquire much from this article.

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Figure 1: Asian Continent with subregions (Source: Wikipedia).

Introduction

Pesticides are possibly toxic to humans and can have both acute and chronic health impacts, contingent upon the quantity and manners by which an individual is uncovered. They assume a critical job in food production, ensure or increment yields and the times each year a crop can be developed on a similar land. This is especially significant in nations that face food deficiencies. A significant number of the more seasoned, less expensive (off-patent) pesticides, for example, DDT and lindane, can stay for quite a long time in soil and water. These chemicals have been banned by nations who marked the 2001 Stockholm Convention. As they are intrinsically toxic and deliberately spread in the environment, the production, dispersion, and utilization of pesticides require severe regulation and control. Standard checking of buildups in food and the environment is likewise required.

Methodology

The research is conducted through secondary data search from several sources from books, technical newsletters, newspapers, journals, and many other sources. The present study was started from the beginning of 2018. PubMed, ALTAVISTA, Embase, Scopus, Web of Science, and the Cochrane Central Register of was thoroughly searched. The keywords were used to search for different publishers' journals like Elsevier, Springer, Willey Online Library, Wolters Kluwer were extensively followed.

Results and Discussion

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]. Humans cultivate only about 150 of an estimated 50,000 edible plant species worldwide, with only 30 plant species comprising the vast majority of our diets. Just three of these (rice, maize and wheat) provide about 60% of the world's food energy intake [2,3]. 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 [4]. 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 [5]. Globally, around 20-30% of agricultural produce is lost annually due to insect pests, diseases, weeds and rodents, viz, growth, harvest, and storage [1,6]. 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 [7]. Mean consumption of whole grains 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 [8]. 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 [9]. 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, handling and processing equipment [10]. 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 [5,11]. Therefore, judicious use of pesticides plays a major role in plant protection. Today's more than 10,400 pesticides are approved worldwide. It has been reported that the consumption of pesticides accounts two million tons every year worldwide [12]. Interestingly, many pesticides still widely used in the USA, at the level of tens to hundreds of millions of pounds annually, have been banned or are being phased out in the EU, China and Brazil [13]. Pesticide residues reported in fruits, vegetables and grains of India [14], Nepal [15], Bangladesh [16], China [17] and Indonesia [18]. Farmers habitually apply fertilizers and hazardous insecticides in high quantities without assessing the actual field requirements due to inadequate knowledge [1,19]. 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 [20-23]. 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 [24-27]. 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 [28,29]. 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 [30]. 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 [31-35]. China feeds 22% of the world population with 7% of the world's 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 [36]. 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 [37]. The use of sewage sludge for agricultural purposes can be limited by the potential content of heavy metals and toxic organic compounds that pose a threat to the environment (See dietary limit of heavy metals in Table 1) [38]. 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 [39]. The use of pesticides has helped to increase rice yields but has also led to an increased pollution that presents a potential toxicity threat to the environment and public health [40]. Combined with outdated waste management technologies, there are potential health risks to farmers through occupational waste management practices, along with consumers through consumption of waste-contaminated products [41]. The WHO has estimated that more than three million farmers in developing countries are poisoned by agrochemicals each year [42]. In another study, WHO and UN Environmental Program estimated that one to five million cases of pesticide poisoning occur among agricultural workers each year with about 20000 fatalities [43]. Skin injury, eye injury, headache, stomachache, and fever reported in cotton workers in southern Pakistan due to pesticide exposure [44]. Pesticide induced occupational hazards has been reported to many other similar studies in Nepal [45], China [46-48], India [49-51], Bangladesh [52], Sri Lanka [53], Myanmar [54] and Philippines [55]. The US Centre for Disease Control and Prevention confirmed more than 11,000 food borne illnesses in the year 2013, with several agents like viruses, bacteria, toxins, parasites, metals, and other chemicals causing food contamination with the possible reason is resistance to commonly used pesticides [56]. 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 [57]. 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 [58]. It could be another reason for haphazard use of pesticides in the field and stored food commodities [59]. 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 [60,61]. 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 [62]. Sabir et.al, 2019 demonstrated that arsenide 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 [63]. 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% [64]. 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-IFPRI [65]. Agriculturally beneficial microorganisms may also contribute directly (i.e., biological N2 fixation, P solubilization, and phytohormone production, etc.) or indirectly (i.e., antimicrobial compounds biosynthesis and elicitation of induced systemic resistance, etc.) to crop improvement and fertilizers efficiency [66]. Overuse of chemical fertilizers and pesticides have effects on the soil organisms that are similar to human overuse of antibiotics. Indiscriminate use of chemicals might work for a few years, but after a while, there aren't enough beneficial soil organisms to hold onto the nutrients [67]. Also, resistance to certain pesticides against brown planthopper (BPH), *Nilaparvatalugens*, and the white-backed planthoppers (WBPH), *Sogatella-furcifera* reported in Asian countries has been reported [68-72]. Also, the higher exposure of crop plants to heavy metal stress reduces growth and yield, and affect the sustainability of agricultural production [73]. Cadmium (Cd) is a well-known metal imposing threats to human health, and it can be accumulated in polished rice over the permitted range of 0.2 mg kg^{-1} [74]. It leads to reduction in the plant productivities as well by inhibiting their growth, photosynthesis, pigments, nutrient uptake, germination, electron transport chain [75]. Applications of phosphorus-based fertilizers improve the soil fertility and agriculture yield but at the same time concerns over a number of factors that lead to environmental damage need to be addressed properly [76]. Easy availability of pesticides has another interesting but pathetic outcome. approximately 110,000 pesticide self-poisoning deaths each year from 2010 to 2014, comprising some 14% of all global suicides [77]. According to Serrano-Medinaet.al, 2019 higher rates of suicide committed in areas with intensive use of pesticides compared to areas with less use of pesticides [78]. In Bangladesh, self-poisoning by pesticide is responsible for about 40% of poisoning cases admitted to hospital and 8–10% of overall mortality in medical wards [79]. At the Philippine General Hospital in Metro Manila, Philippines (2000–2001), recorded pesticide poisoning cases showed that more than 80% were intentional in nature [80]. Public concern about the adverse environmental and human health impacts of organochlorine contaminants led to strict regulations on their use in developed nations since 1940 [81]. 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 [82-86]. As a consequence, humans in this region are exposed to greater dietary levels of organochlorines.

Metal	Mean concentration (mg/kg -wet wt.)	Recommended daily dietary allowance (mg/day /person)	Target Hazard Quotient (THQ)	Carcinogenic risk (CR)
Pb	0.593	0.21	0.1223	4.20E-06
Cd	0.017	0.06	0.014	
Cr	0.193	0.2	0.0001	
As	0.332	0.13	0.913	2.70E-04
Hg	0.05	0.03	0.0825	

Table 1: The recommended daily dietary limit of heavy metals [87].

Recommendations

Around 600 million food borne illnesses and 420,000 deaths occur each year due to poor food handling practice around the world. Such contaminants get access to contaminate food mainly due to food handler's poor knowledge and negligence during handling activities [88,89]. Accordingly, alternative methods for exposure and risk assessment have to be developed, which vary from the use of expert opinion and pre-marketing models to the use of combination of data from the literature, measurements, and expert opinion [90]. Many studies are there to overcome fertilizer/pesticide induced health effects. Rastogi et.al, 2019 reported use of silicone nanoparticles can provide green and eco-friendly alternatives to various chemical fertilizers without harming nature [91]. It has been reported that selenium (Se) application decreases Cd uptake [75]. In similar studies, selenium, copper, zinc oxide and many other metallic nanoparticles [92-98] have been studied in food processing, packaging and preservation against phytopathogens and rodents. 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 [99]. Various food-processing operations include sorting, trimming, cleaning, cooking, baking, frying, roasting, flaking, and extrusion that have variable effects on mycotoxins [100]. Cooking rice in excess water efficiently reduces the amount of arsenic (As) in the cooked grain [101]. Regular investments in research are required to innovate non-persistence active chemicals for pest control. Consumers and all players in food production chains should be constantly informed on safe use of pesticides. This should include making convenient access to updated information on pesticides, use of generic and counterfeit pesticides and health risks associated to pesticide residues.

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Conflict of Interest

The author declares that he has no competing interests.

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